INTERNATIONAL COURT OF JUSTICE

CASE CONCERNING
AERIAL HERBICIDE SPRAYING
(ECUADOR v. COLOMBIA)

# REJOINDER OF THE REPUBLIC OF COLOMBIA

VOLUME III

ANNEXES 20 - 33

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## VOLUME III

## Annex 20

**NATIONAL NARCOTICS DIRECTORATE (DNE), ENVIRONMENTAL MANAGEMENT PLAN (EMP) ERADICATION OF ILLICIT CROPS, CHAPTER VII, IDENTIFICATION AND ASSESSMENT OF ENVIRONMENTAL IMPACT, 30 OCTOBER 1998.**

*(Archives of the Colombian Foreign Ministry)*

# 1. IDENTIFICATION AND EVALUATION

This identification and assessment of environmental impact of representative zones located in natural regions of Colombia in which the program for the eradication of illicit crops with the glyphosate herbicide is being executed through spraying, seeks to make a direct specification of environmental conflicts which may be generated both by the establishment of illicit crops and by the program.

It is important to note that the establishment of illicit crops in Colombia, where coca-leaf, opium poppy or marihuana is in breach of established law and regulations. They also fall within the description of activities causing environmental degradation defined in Law 99/1993, Article 5.14. Therefore, the eradication program for illicit crops arises as a response for the interdiction of the problem caused. Therefore, eradication program is in no way similar to an economic or social development project which seeks to consolidate a specific area of production. On the contrary, its objective is to do away with or reduce a problem of a criminal nature, contrary to the laws in force in Colombia on the subject.

## 1.1 IMPACT ANALYSIS

### 1.1.1. General matters and methodology

The currently existing environmental conditions in the zones representative of the natural regions considered in the study have been taken into account for the assessment of impacts, as follows:

- The current environmental situation, without the program, Scenario A.
- The current environmental situation with the program, Scenario B.

The method used to assess environmental impacts identified in this study is based essentially on the appreciation of the magnitude, extent, duration, reversibility and recoverability of identified impacts, whether positive or negative. This allows to make an overall judgment of impacts identified for a component, as a result of interventions on the environment.

The assessment method followed the next main steps:

- **Identification of project/environment interactions**

A matrix is prepared, capturing the interrelationships between activities in each scenario and the elements of the environment grouped into biophysical and socio-economic components.

- **Identification of impact in each Scenario, and classification**

Here, the effects caused are described, and qualitatively assessed, making it possible to identify the actions causing most impact and the elements of the environment potentially most affected. At the same time, effects were considered in accordance with their importance, and estimate was made of the assimilation capacity of the environment: principally on land, i.e., soils, vegetation and water; in the face of environmental risks generated by the establishment of illicit crops, and the eradication with agricultural chemicals

The impacts identified must be assigned a value, and their occurrence must be predicted, in order to identify which are the most important and environmental aspects. This defines the areas on which environmental management should focus its attention, since it is there that the important results may be obtained, with the greatest possible economic efficiency.

### 1.1.2. Classification of environmental impact

The classification of impact is a complex exercise which means that the points of view of different specialties intervening in the assessment needs to be recognized.

For this study, an arbitrary scale was drawn up as shown in Table 7.1, developed with the experts who took part in the study. We say that the scale is "arbitrary", because there is no particular criterion applied, and it only tends to reflect the importance of the matter evaluated.

The importance of the aspect is simply the sum of the foregoing criteria, when applied to the analysis of one issue in particular.

- **Probability of occurrence**

The probability that an impact will materialize is given by the following scale of values, which is also arbitrary:

Frequent: 1.0
Occasional: 0.5
Rare: 0.1.

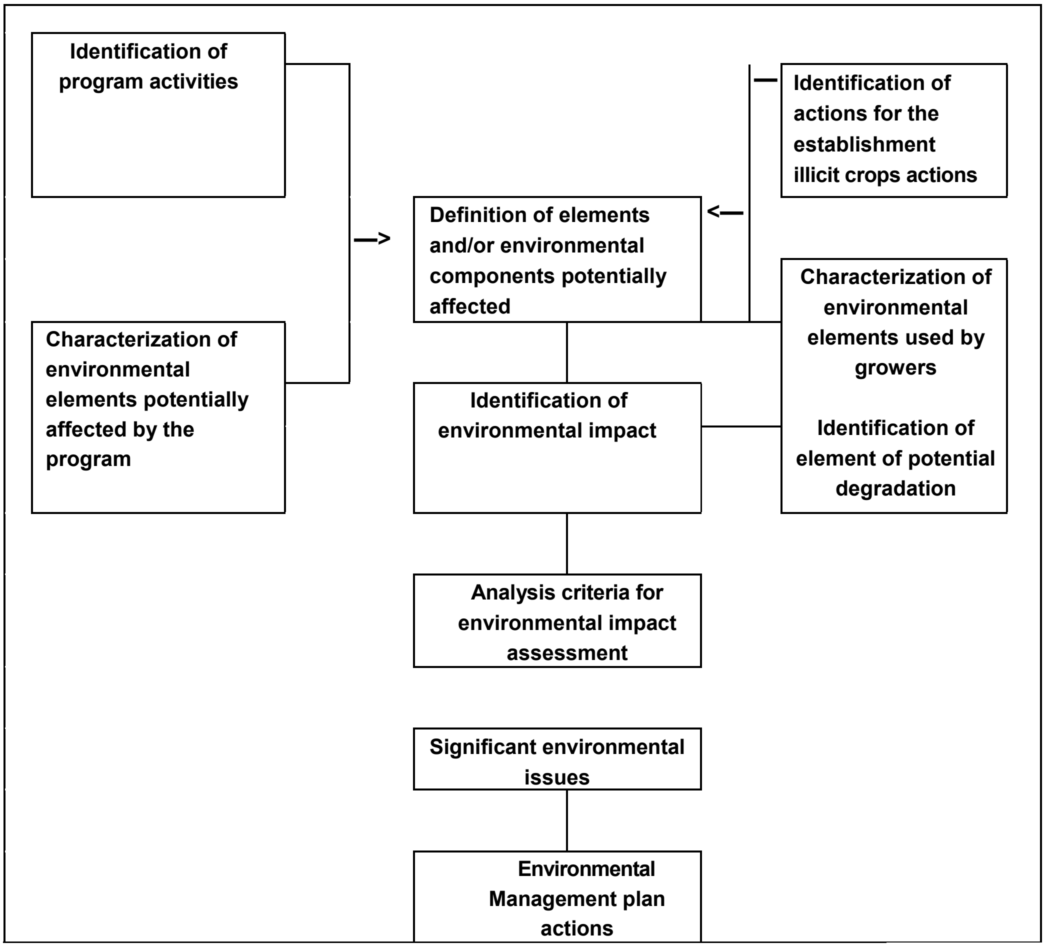
**Chart 7.1**

**CRITERIA FOR ENVIRONMENTAL IMPACT CLASSIFICATION**

| CRITERION | MEANING | SCALE OF VALUES |
|---|---|---|
| Magnitude | Degree of incidence of the impact | Low 1 Medium 2 High 4 Very high 8 |
| Extent | Area of influence | Specific 1 Partial 2 Widespread 4 |
| Persistence | Permanence/duration | Fleeting (<1 month) 1 Temporary (1-12 months 2 Prolonged (1-5 years) 4 Permanent (over 5 years) 8 |
| Reversibility | Natural return to original conditions | Short term (<1year) Medium term 1-5 years Long term (over 5 years) |
| Recoverability | Possibility of reconstruction | Immediate 1 Medium term 2 Mitigable 3 Unrecoverable 8 |

FIGURE 7.1

ESTABLISHMENT AND ERADICATION OF ILLICIT CROPS
ENVIRONMENTAL IMPACT ASSESSMENT PROCESS



**d. Interaction matrix**

The interaction matrix 'establishment of illicit crops-environment' points to cases in which a given activity causes some type of effect, whether beneficial or harmful for one of the environmental elements. In total, 62 interactions were found, as shown in Chart 7.3.

The greater part of the interactions occur during the felling and burning of native forest, and the execution of crop tasks (agronomic practices

### 1.2.2. Effects of the project

Initially, in Chart 7.4, the activities and actions for the establishment of illicit crops that cause impacts on the environment are identified and described. Subsequently, and depending on the environmental element affected, the impact caused is determined, and finally, the nature of the impact is described.

In Chart 7.5., The actions for the establishment of illicit crops are shown, as well as the elements that the affect positively or negatively, and they are classified according to the following criteria:

- Character

It was Classified as positive when it corresponds to interaction whose activity generates an improvement or at least allows observation of the initial environmental conditions of a given indicator. Negative corresponds to the interaction whose activity generates deterioration decrease of a given indicator in comparison to the identified baseline,

- Magnitude

This refers to the impact as an environmental change produced, and it is a function of the variation in baseline conditions. This is classed as low, medium, high and very high.

- Extent

This refers to the area of influence where a given effect develops, in our case, to the representative zones of the regions studied. It is determined as specific for the effect around the site of the impact, it is partial for those effects inside the representative zone, and it is extensive for the regions of study, and also, at national and international level.

- Persistence

This refers to the existence of the impact over time, since it may be very variable in each case, and is classified as fleeting, temporary, prolonged and permanent

- Reversibility

This considers the possibilities of natural return to the original conditions of the media after the occurrence of the impact. This is classed as short-term, medium-term or long-term.

- Recoverability

This refers to the possibility of the environment, or (resilience) man's capacity to reconstruct or mitigate the impact caused. This is classified as immediate, mid-term, mitigable, and unrecoverable.

- Importance

This is an aspect which takes into account the sum of all the preceding criteria, when an expert judgment is made on a particular issue.

TABLE No. 7.4

## IDENTIFICATION OF ENVIRONMENTAL IMPACT DUE TO THE PRESENCE ILLICIT POPPY, COCA AND MARIJUANA CROPS

### SCENARIO A: WITHOUT THE ILLICIT CROP ERADICATION PROGRAM

| \| ACTIVITY | DESCRIPTION OF ACTIVITY | ENVIRONMENT ELEMENT AFFECTED | IMPACT | DESCRIPTION OF IMPACT |
|---|---|---|---|---|
| Slash and burning of native forests | Removal of vegetation cover of the cloud forest and humid forest<br>Uncontrolled fire of felled vegetable material and neighboring woods due to indiscriminate fire activity | Vegetation | Deforestation | Depletion of national flora inventories which endangers between 40 and more species *per* hectare in<br>the case of poppy and up to 300 species in the case of coca,<br>Destruction of minor vegetation, epiphytes and parasites.<br>Affectation of ecologic interaction of soil-plant-fauna.<br>Reduction of food supply for land and air fauna.<br>Destruction of native plant cover in a range between 160,000 and 240,000 ha for coca and between<br>60,000 -100,000 per poppy crops<br>Decreased evapotranspiration rates |
| | | | Destruction of Biodiversity | Decline of floristic wealth<br>Disappearance of endemic flora and fauna. In the case of the Andean region, the Byophytes (mosses) which can absorb up to 40 times its dry weight in water within its tissues; the Hepatic \r\ which 80% of the species are restricted to the Andes; ferns with more than 82% of species. The families of tree species threatened are melastomes. Piperaceae and Malptghiaceae and insectivorous plants such as; alpine Utricularia and Pinguicola elongata. Among the plants are genera Aiphares and some wax palms (Ceroxylon, Mooreanum, Ceroxylon aipinum). The fauna include: brown butterfly (Pronophilinum sp.) Paramo tapir (Tapirus pincacne), The spectacled bear (Tremaretos ornatus),<br>In the Amazon region, endangered are the palm {Zamia cupatensis, Zamia jirijimensis), species of the communities "Forestry shrubs" and gallery forests. Among the mammals are: the Water Dog (Pteronoura brasiliensis). Capuchin monkeys (Cebus apella), jaguar (Panthera onca), Amazon tapir (Tapirus terrestris); among birds: the hawk (Falco sp.) the guan (Crax sp.) parrots (Pionus sp.) macaw (Ara sp.) among the reptiles: the stifle (Cayman crocodriius), the turtle (Chelonia sp.) caiman (Crocodylus intermedius).<br>Biotechnoiogical potential loss.<br>Exhaustion of strategic resources.<br>Reduction of genetic material and destruction of germoplasm banks.<br>Deterioration of ecosystems because of the poppy and marijuana: Premountain forest ecosystems,<br>Low mountain, mountain, in the case of coca, the tropical rainforest<br>Disappearance of valuable and endangered species |

Source; Environmental Audit. Environmental Impact of Coca Illicit Crops and the Eradication by Aerial Spray with Glyphosate in the Colombian Amazon and Orinoco Biogeographic Region, Adapted for the EMP.

(TABLE 7.4 Continued)

| ACTIVITY | DESCRIPTION OF ACTIVITY | ENVIRONMENT ELEMENT AFFECTED | IMPACT | DESCRIPTION OF IMPACT |
|---|---|---|---|---|
| Crop labor | Agricultural preparation of the land | Vegetation | Modification types of forests | Establishment of monocrops (coca, poppy or marihuana)<br>Elimination of minor vegetation and rupture of plant succession Reduction of food supply for fauna (land and air)<br>Destruction of trophic chains |
| | | Floor | Alteration potential use | Modification of land use<br>Alteration of the natural layout of the soil structure |
| | | Fauna | Destruction and reduction of populations | Affectation of the microfauna species of the soil<br>Destruction of habitats and ecologic niches<br>Disappearance or reduction of communities of arthropod fauna, insects, land vertebrates and birds<br>Migrations of fauna to other habitats and alteration of local and regional ecological balance |
| | Indiscriminate and uncontrolled use and application of pesticides and inorganic fertilizers | Soil | Desertification | Loss and/or modification of natural fertility, causing reduction in production capacity of goods and services derived of the forest and/or natural plant coverage |
| | | | Contamination | Accumulation and persistence of parental molecules *m* the soil |
| | | Water | Surface contamination of bodies of water | Bioaccumulation of biocide agents in fauna populations in streams, rivers and swamps and in the rest trophic chains Dispersion of ions in bodies of water Alteration of physical-chemical quality indicators increase of eutrophication in lakes and swaps |
| | | Fauna | Affectation of water, land and air fauna | Changes in biologic composition of communities<br>Disappearance of microbiota (fungi and bacteria)<br>Alteration of edofauna Bioaccumulation of biocide agents in the trophic chain |
| | | Landscape or scenic beauty | Modification of landscape structure and primary (visual) qualities | Disappearance of scenic beauty by contrast between natural morphology and the aspect of deforested plots, eroded slopes and altered bodies of water<br>Destruction of scientific-education resources to know current or past natural processes<br>Destruction of plastic and emotional values of the surrounding (creation of vegetation areas visibly dead, dying, decaying or unhealthy)<br>Modification of visual basins |

Source; Environmental Audit. Environmental Impact of Coca Illicit Crops and the Eradication by Aerial Spray with Glyphosate in the Colombian Amazon and Orinoco Biogeographic Region. Adapted for the EMP.

(TABLE 7.4 Continued)

| ACTIVITY | DESCRIPTION OF ACTIVITY | ENVIRONMENT ELEMENT AFFECTED | IMPACT | DESCRIPTION OF IMPACT |
|---|---|---|---|---|
| | | Cultural - regional | Deterioration of socio anthropogenic qualities and values | Decay of social, economic and cultural life of the native communities {indigenous population)<br>Disrespect to traditional autochthonous values<br>Abandonment of moral and ethical values<br>Effects by change in habitat in local communities<br>Destruction of biogeographic interest areas<br>Generation of "effervescent economy" groups<br>Increase of administrative and judicial corruption<br>Increase of prostitution |
| Production of | grinding and maceration of coca leaves and marihuana plants. Extraction of alkaloids by solvents with successive steps. recrystalization, etc. | Vegetation | Destruction and deterioration of vegetable cover | Clearing of native forest, destruction of minor vegetation for construction of camps and facilities for processing labs |
| | | Atmosphere | Gas emission and noise | Contamination by volatile hydrocarbons, combustion gasses and solid particles<br>Exaggerated generation of sound emissions due to electric plants and motor pumps |
| | | Water | Affectation of bodies of water | Uncontrolled dumping of liquid residue such as solvents and lubricants |
| | | Soil | Contamination | Uncontrolled spilt of fuels, solvents and lubricants directly to the soil<br>inadequate and uncontrolled placement of plastic, metallic and non perishable containers |
| | | Socio economic | Appearance of groups outside the law | Pressure groups, private justice, lacking in values either moral, legal or ethical<br>Increase of violence and administrative and judicial corruption |
| | | | Affectation of international relations | Deterioration of conditions of commercial and diplomatic reciprocity of the country with the international community |

Source: Environmental Audit. Environmental Impact of Coca Illicit Crops and the Eradication by Aerial Spray with Glyphosate in the Colombian Amazon and Orinoco Biogeographic Region. Adapted for the EMP.

CHART 7.5

| ACTIVITY | DESCRIPTION OF THE ACTIVITY | ENVIRON MENTAL ELEMENT AFFECTED | IMPACT | CHARACTER | MAGNITUDE INTENSITY | VALUE SCALE | EXTENSION | VALUE SCALE | PERSISTANC E | VALUE SCALE | REVERSIBILI TY OR DURATION | VALUE SCALE | RECOVERABI LITY | VALUESCAL | RELEVANCE | OCCURENCE PROBABILIT Y | VALUE SCALE | VALUE OF ENVIRONMENT AL IMPACT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Crop activities | Agronomical preparation of | Vegetation | Modification of forest types | (-) | High | 4 | Partial | 2 | Permanent | 8 | Long term | 4 | Mitigable | 4 | 22 | Frequent | 1 | 22-HI |
| | | Soil | Potential alteration of soil | (-) | High | 4 | Partial | 2 | Prolonged | 4 | Mid term | 2 | Mitigable | 4 | 15 | Frequent | 1 | 16-VI |
| | | Fauna | Population destruction and reduction | (-) | Very high | 8 | Partial | 2 | Prolonged | 8 | Long term | 4 | Mitigable | 8 | 30 | Frequent | 1 | 30-VHI |
| | Uncontrolled and indiscriminate | Soil | Desertification | (-) | High | 4 | Partial | 2 | Prolonged | 4 | Mid term | 2 | Mitigable | 4 | 16 | Occasional | 1 | 8-LI |
| | | | Contamination | (-) | High | 4 | Partial | 2 | Prolonged | 4 | Mid term | 2 | Mitigable | 4 | 16 | Occasional | 1 | 8-L1 |
| | | Water | Contamination of superficial bodies of water | (-) | High | 4 | Partial | 2 | Prolonged | 4 | Mid term | 2 | Mitigable | 4 | /6 | Frequent | 1 | 16-V1 |
| | | Fauna | Affectation of water and land fauna | (-) | High | 4 | Extensi ve | 4 | Prolonged | 4 | Long term | 4 | Mitigable | 4 | 20 | Frequent | 1 | 20-HI |
| | | Landscape and/or scenic beauty | Modification of landscape structure and primary qualities | (-) | Very high | 8 | Partial | 2 | Prolonged | 4 | Long term | 4 | Mitigable | 4 | 22 | Frequent | 1 | 22-HI |

LI- Little important VI – Very important HI – Highly Important VHI – Very highly important

**CHART 7.5**

| ACTIVITY | DESCRIPTION OF THE ACTIVITY | ENVIRON MENTAL ELEMENT AFFECTED | IMPACT | CHARACTER | MAGNITUDE INTENSITY | VALUE SCALE | EXTENSION | VALUE SCALE | PERSISTANC E | VALUE SCALE | REVERSIBILI TY OR DURATION | VALUE SCALE | RECOVERABI LITY | VALUESCALE | RELEVANCE | OCCURENCE PROBABILIT Y | VALUE SCALE | VALUE OF ENVIRONMENT AL IMPACT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Bulb grating and latex collection of poppy and heroine based processing - commercial iz ation Marijuana plant collection and pressing for commercial iz ation | Economic | Local and regional inflation increase | (-) | Very High | 8 | Partial | 2 | Prolonged | 4 | Med. Term | 2 | Mitigable | 4 | 22 | Frequent | 1 | 20-H1 |
| | | | Regional GDP improvement | (+) | Medi um | 2 | Extensi ve | | Prolonged | 4 | Med. Term | 2 | | | | Occasion al | 0.5 | 6-LI |
| | | | Property and public services demand | (-) | medí um | 2 | | | Temporary | 2 | Med. Term | 2 | Mitigable | 4 | 12 | Occasion ai | 0.5 | 6-LÍ |
| | | Social - family | Affectation of family life | (-) | Very High | 8 | Partial | 2 | Prolonged | 4 | Long term | 4 | Mitigable | 4 | 22 | Frequent | t | 22-HÍ |
| | | Service infrastructure | Deterioration and/or absence of health, housing and public services | (-) | High | 4 | Partial | 2 | Prolonged | 4 | Med. Term | 2 | Mitigable | 4 | 15 | Frequent | 1 | 18 VI |
| | | Education | Low educational levels | (-) | High | 4 | Partial | 2 | Prolonged | 4 | Long term | 4 | Mitigable | 4 | 18 | Frequent | 1 | 18-VI |
| | | Community participation | Low community participation | (-) | High | 4 | Partial | 2 | Prolonged | 4 | Med term | 2 | Mitigable | 4 | 16 | Frequent | 1 | 16-VI |
| | | Employment | Immigration of work force | (-) | High | 4 | Extensi ve | 4 | Temporary | 2 | Short term | 1 | Med term | 2 | 13 | Frequent | 1 | 13-V1 |
| | | Culture | Loss of community, ethnic and legal values | (-) | High | 4 | Partial | 2 | Prolonged | 4 | Long term | 4 | Mitigable | 4 | 18 | Frequent | 1 | 18-VI |
| | | Social - security | Violence increase | (-) | Very high | 8 | Extensi ve | | Permanent | 8 | Long term | 4 | Mitigable | 4 | 28 | Frequent | 1 | 28-HI |

**LI- Little important VI – Very important HI – Highly Important VHI – Very highly important**

### 1.2.3. Analysis of elements

The elements most affected -beneficially or otherwise-and the related actions are:

- Land (soils, geoforms, stability and landscape)

Affected by total removal of the vegetation cover. This leaves it exposed to the phenomena of erosion by action of rain and wind. This phenomenon has its greatest impact in the representative zones where opium poppy, marijuana and coca leaf are grown on mountainsides, as in the case of the Andean region, the Caribbean and Catatumbo.

As a consequence of the steep slopes there, and the instability of the soil, there are phenomena of mass removal and processes of erosion in furrows or gullies.

At the same time, the action of burning off vegetation cover which has been felled or stripped seriously affects the edaphobiota, reducing existing populations. In all cases, there is a conflict on regarding the use of the soil, because the natural use of the soils is not precisely for agricultural work. In particular, this negative effect is increased in zones with steep slopes, in which any type of crop established (local or otherwise) comes into conflict with the environment.

Further, the structure of the scenic beauty of the landscape is affected and seriously diminished when the visual values of the basins intervened are lost.

Farm crop work modifies the structure of the soil and affects ecological niches of microorganisms in the soil. Likewise, the incorporation of fertilizers and pesticides of different kinds, indiscriminately, reduces the possibility of recovering the different biota. Finally, unsuitable management of waste generated by these agricultural chemical practices (containers, bags, small implements, etc), and the activities of processing and refining of drugs (containers, bags, metal drums, precursors, plastic, cement, leaf bagasse, etc) produce phenomenon of contamination of the soil and water which have not yet been evaluated.

- Water (quality, alteration of water courses, sedimentation)

The activities of establishment of illicit crops cause negative effects on adjacent on adjacent bodies of water. These effects are expressed in an alteration of the physical and chemical conditions of water quality due to the direct or indirect discharge of residues of fertilizers, pesticides and chemical precursors used in processing of drugs.

At the same time, the process of deforestation and subsequent burning off alters the courses of small streams, and means that smaller drainage systems disappear.

The erosion processes subsequent to slash and burn practices, especially all the phenomena of mass removal caused in the Andean zones, increased sedimentation of streams, watercourses, lakes and rivers, so affecting the fauna populations of the environment,

- Air (climate change)

This element is to affected temporarily and regularly by the effect of emissions of particles in suspension and gases, is a product of the burning off of vegetation cover. Similarly, the use of generating plants and the unsuitable handling of pesticides and chemical precooked curses eventually and specifically deteriorate air quality,

- Biotic aspects

Wildlife and native flora are the elements most affected by the establishment of illicit crops.

Flora .............

Conjugal, non-parental, single-person and reconstituted families.

In the Caribbean, Amazon, Andean and Orinoco regions there is a wide cultural heterogeneity, and a wide range of family structures and dynamics.

In most of these regions, the dynamics of the population have generated a high proportion of families in the expansive stage of the life-cycle, producing a greater demand for support services for family functions of socialization and rearing of the young.

Generally, these regions have processes of an economic adjustment which have been disengaged from social processes, which have affected sectors of the population and have had a range of effects on the performance of family functions.

In these regions, for a number of reasons, including the increased poverty, conditions of violence, drug trafficking, illicit crops, the improper use of alcohol and drugs, family violence and violence in the media, have placed many families in situations of crisis and particular vulnerability, including notably forcible separation, displacement, and disintegration of the family.

Most of the economic and social policies and programs do not consider family affairs as an integral matter, and do not evaluate the impact of their actions on the structure, function and quality of life of the families,

There is a weak presence of public and private institutions in the area of family, and information and gaps in is in the quality of information, statistics and research on the situation, due to insufficient financial capacity and installed technical capacity to make an adequate approach to the proper family problem.

In particular, there is a greater participation by women in the workforce, and the change which in which the composition of the workforce has suffered. The proportion of farm workers has fallen, and the number of workers in commerce and services, in particular, has increased. The salaried workforce seems not to have increased, but the number of self-employed has risen. Further, the coverage of Social Security is still very low among subsistence farmers.

The families in these regions have some special characteristics, which are constantly changing, adapting different forms in their structure depending on the point of life-cycle all conjugal cycle in which the members of the central nucleus are, and according to survival strategies which they have two adopt, proper to the social factors to which they are exposed daily.

The practices of child-rearing in rural areas are mediated by the intra-familiar intra-family violence, and this produces the phenomenon which some have called *rootlessness,* which appears when there is a traumatic rupture with break with the past, a deficient or non-existent adaptation to the present, an uncertain future which is not desired by those who live it. In this situation, there is a real inability to construct a new project of life, and therefore, to participate effectively and fully in community life.

The municipalities indicated as the object of study, by their pack characteristics present complex panorama of poverty, which exceeds any social service, and which are permanently exposed to high indices of social risk and vulnerability in the face of unemployment, lack of work, alcoholism and drug addiction.

The municipalities studied previously are a representative sample of what may be occurring in the other municipalities in which there are illicit crops, which seem mainly lack development plans, an indicator which may allow an inference of the level of organization and management in the municipalities. There are also no programs for inter-institutional coordination which would allow integrated action and joint development projects.

## 1.3. Scenario B. Analysis of impacts with the execution of the illicit crop eradication program

According to the methodology explained for scenario A, the simple matrices are drawn up for the interaction, identification and classification of impact

1.3.1. Interaction of crop eradication-environment

The illicit crop eradication program using glyphosate generates impact on the biophysical and socio-economic components, and - as in Scenario A- a local, regional and national area of influence, and even an international one.

**a. Biophysical component**

a. Land

This includes the elements of soil, geoforms, stability and landscape. Likewise, the physical and chemical conditions of this oil

- Water

Surface water is considered for its physical and chemical environmental qualities

- Air

Consideration is given to eventual contamination produced by the application of the herbicide

Biotic Component

- Flora

Consideration is given to the illicit crop affected and the adjacent vegetation cover

- Fauna

Wildlife and then, fauna in the soil are considered

b. Socio-economic components
- The local economy
- The regional economy
- Social infrastructure
- Civic participation
- Security
- Population
- Public health

• Regional culturec. Activities or actions proper to the illicit crop eradication process
- Preparation of the mix
- Loading of aircraft
- Transport of aircraft
- Application of the herbicide
- Solid waste management at the base
- Liquid waste management at the base
- Support for the alternative development process

CHART 7.5
SCENARIO B
MATRIX OF INTERACTIONS - PROGRAM FOR THE ERADICATION OF ILLICIT CROPS - ENVIRONMENT

CUADRO Conceptos Verticales

**COMPONENTS**
**PHYSICAL**

| | | |
|---|---|---|
| **EARTH** | **WATER** | **AIR** |
| **SOIL** | **QUALITY** | **CONTAMINATION FROM SPRAYING** |
| **GEOFORMS** | **ALTERATION OF COURSES** | |
| **STABILITY** | **SEDIMENTATION** | |
| **LANDSCAPE** | | |

**BIOTÍC**

| | |
|---|---|
| **FLORA** | **FAUNA** |
| **BIODIVERSITY** | **LAND** |
| **LAND** | **AIR** |
| **AQUATIC** | **AQUATIC** |

**SOCIOECONOMIC**

**LOCAL ECONOMY**
**REGIONAL ECONOMY**
**FAMILY**
**SERVICE INFRASTRUCTURE**
**EDUCATION**
**EMPLOYMENT**
**POPULATION**
**HEALTH**
**COMMUNITY PARTICIPATION**
**CULTURE**

Horizontal concepts
**ACTIVITIES THAT MAY CAUSE IMPACT**
**PREPARATION OF THE MIX**
**LOADING OF AIRCRAFT**
**TRANSPORT OF AIRCRAFT**
**APPLICATION OF HERBICIDE**
**SOLID WASTE MANAGEMENT**
**LIQUID WASTE MANAGEMENT**
**ERADICATION OF ILLICIT CROPS**
**SUPPORT FOR ALTERNATIVE DEVELOPMENT**

**Biodiversity** **landsoil**

(TABLE 7.7 Continued)

| ACTIVITY | DESCRIPTION OF ACTIVITY | ENVIRONMENT ELEMENT AFFECTED | IMPACT | DESCRIPTION OF IMPACT |
|---|---|---|---|---|
| Aerial Spraying with | | Social-family | Deterioration of family life | Existing conditions are maintained without program's implementation |
| | | Services infrastructure | Deterioration and lack of health and, living care and public services facilities | Existing conditions are maintained without program's spraying |
| | | Education | Low educational levels | Existing conditions are maintained without program's spraying |
| | | Community participation | Increase In community participation levels. | Increase in association processes and community participation interest to stop eradication process due to pressures of subversive and drug trafficking groups<br>Onset of farmers' marches<br>Opportunity to discuss and raise social issues before dialogue committees designated by the Government.<br>Organizational capability to obtain signed agreements with the central Government. |
| | | Employment | Movement of work force | Displacement of "moving" work force to other crop sites, nearby districts or their places of origin. |
| | | Social-security | Attacks to the public forces | Increase of violent and terrorist acts against the Police and the Army |
| | | Economy | Change in income | Migration to other areas Reduction of temporary employment Maintenance of local inflation Reduction of nominal and real salary Reduction of local trade |
| | | | End to effervescent economy | Normalization of the inflation phenomenon, consumption habits and agricultural activities.<br>Reduction of family income<br>Consumption reduction of agrochemicals and fuels<br>Closing of amusement centers |
| | | | Reduction of drug traffic offer at national and international levels. | Reduction in the number of cultivated hectares, particularly, poppy<br>Reduction in local production of cocaine and heroin Increase in trust by the International community in the country |

Source: Environmental Audit, Environmental Impact of Coca Illicit Crops and the Eradication by Aerial Spray with Glyphosate in the Colombian Amazon and Orinoco Biogeographic Region. Adapted for the EMP.

**CHART 7.8**

**QUALIFICATION OF ENVIRONMENTAL IMPACT DUE TO PRESENCE OF ILLICT CROPS OF POPPY, COCAINE AND MARIJUANA**

**SCENARIO B: WITH EXECUTION OF ERADICATION OF ILLICT CROPS PROGRAM BY SPRAYING WITH GLYPHOSATE**

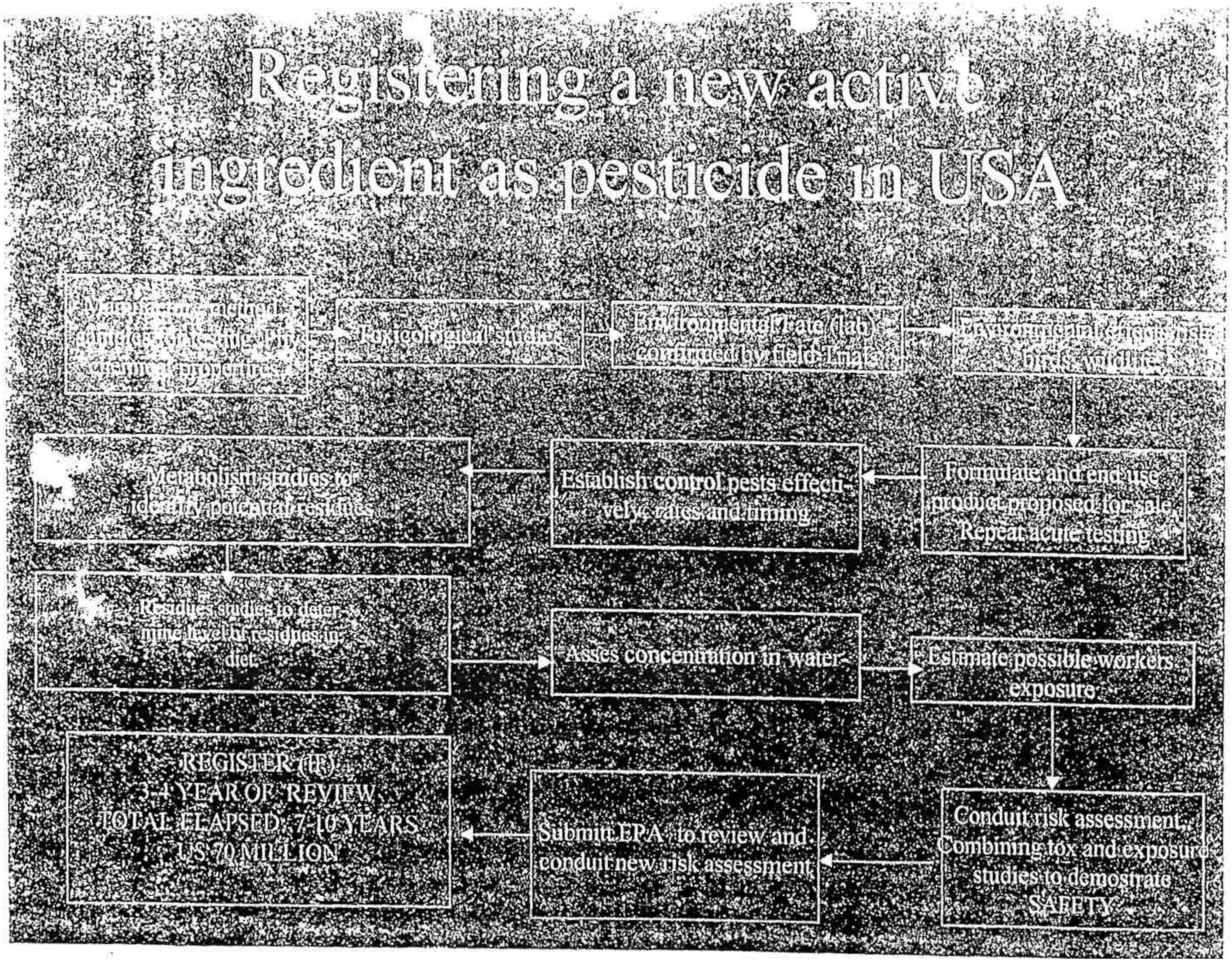
| ACTIVITY | DESCRIPTION OF THE ACTIVITY | ENVIRON MENTAL ELBMBNT AFFECTED | IMPACT | CHARACTER | MAGNIT UDE INTENSIT | VALUE SCALE | EXTENSION | VALUE SCALE | PERSISTANC E | VALUE SCALE | REVERSIBILI TY OR DURATION | VALUE SCALE | RECOVERABI LITY | VALUESCALE | RELEVANCE | OCCURENCE PROBABILIT Y | VALUE SCALE | VALUE OF ENVIRONMENT AL IMPACT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aerial spraying with ate | Application of 10.4 l/ha commercial liquid glyphosate 48% dissolved in 13 litres of water illicit coca crops crops. | Vegetation | Destruction of coca and poppy crops | (+) | Very high | 3 | Partial | 2 | Permanent | 8 | Short-term | 1 | Unrecover able | 8 | 27 | Frequent | i | 27-HI |
| | | | Marginal affectation of dosage due to drift | (-) | Low | 1 | Specific | ! | Temporary | 2 | Short-term | 1 | Immediate | 1 | 6 | Occasion ai | 0.5 | 3-LI |
| | 2.5L/ha of commercial liquid glyphosate "Roundup" at 48% Dissolved in 47.5 litres of water for illict poppy crops | Soil | Restoration of plant coverage | (+) | High | 4 | Specific | 1 | Permanent | 8 | Mid. Term | 2 | Mid term | 2 | 17 | Prequent ^ | 1 | 17-VI |
| | | | Effects on edalophobiot a | (-) | Low | 1 | Specific | 1 | Temporary | 2 | Mid term | 2 | Mid term | 2 | 8 | Occasion al | 0,5 | 4-LI |
| | 3.5L/ha of commercial liquid glyphosate "Round up" at 48% dissolved in 46.5 litres of water for illict marihuana crops (no eradication of marijuana being done) | Water | Contaminad on of sources Violence increase | (-) | Low | 1 | Specific | 1 | Temporary | 2 | Short term | 2 | Mid term | 2 | 7 | Occasion ai | 05 | 3.5-LI |

**LI- Little important VI – Very important HI – Highly Important VHI – Very highly important**

**CHART 7,8 (Continued)**

| ACTIVITY | DESCRIPTION OF THE ACTIVITY | ENVIRON MENTAL ELEMENT AFFECTED | IMPACT | CHARACTER | MAGNITUDE INTENSITY | VALUE SCALE | EXTENSION | VALUE SCALE | PERSISTANCE | VALUE SCALE | REVERSIBILITY OR DURATION | VALUE SCALE | RECOVERABILITY | VALUESCALE | RELEVANCE | OCCURENCE PROBABILITY | VALUE SCALE | VALUE OF ENVIRONMENTAL IMPACT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alternative development | Development of small production areas of illicit crops through actions that allow the gradual reduction of the cropped area and establishment of bases for a local and regional development under sustainability criteria and social and economy autonomy | Socio-economic, cultural, biotical and physical | Decrease of cropped area | (+) | High | 4 | Extensive | 4 | Prolonged | 4 | Med term | 2 | Mitigable | 4 | 16 | Frequent | 1 | 18-VI |
| | | | Diminution and elimination of (actors and environmental damage causes | (+) | Very high | 8 | Partial | 2 | Prolonged | 4 | Med term | 2 | Mitigable | 4 | 20 | Occasion al | 05 | 10-VÍ |
| | | | Improvement of life quality | (+) | Medium | 2 | Partial | 2 | Prolonged | 4 | Long term | 4 | Mitigable | 4 | 16 | Occasional | 0.5 | 8-L1 |
| | | | Improvemen tof municipal development and community participation | (+) | Medium | 2 | Partial | 2 | Prolonged | 4 | Long term | 4 | Mitigable | 4 | 16 | Frequent | ! | 16-VI |

**LI- Little important VI – Very important HI – Highly Important VHI – Very highly important**


Registering a new active ingredient as pesticide in USA
Toxicological studies
Environmental Fate (lab) confirmed by field Trials
Formulate and end use product proposed for sale. Repeat acute testing
Establish control pests effectively, rates and timing
Metabolism studies to identify potential residues
Residues studies to determine level of residues in diet
Asses concentration in water
Estimate possible workers exposure
Conduit risk assessment. Combining tox and exposure studies to demostrate SAFETY
Submit EPA to review and conduit new risk assessment
REGISTER (IF)
3-4 YEAR OF REVIEW
TOTAL ELAPSED 7-10 YEARS
US 70 MILLION

## Chart 43
## COMPARISON BETWEEN DATA OF GLYPHOSATE TOXICITY ACCEPTED BY SEVERAL INTERNATIONAL AGENCIES FOR RISK EVALUATION

| | FAO | IPCS | BPA | WSSA | Health Ministry |
|---|---|---|---|---|---|
| Acute toxicity | | | | | |
| LD 50 oral | >5,000 | >5,000 | >5,000 | 5,600 | >5,600 |
| LD50 skin | >17600 | >5000 | >S00O | >50G0 | >5,000 |
| LC 50 inhalation mg/kg (1) | >3.8 | >3.5 | >3-5 | >3.2 | >5.48 |
| Skin irritation | No | No | No | No | No |
| Eye irritation | Moderate/severe irritation | Slight/moderate irritation | Slightly irritating formulas | Slightly irritating | Irritating |
| Dermal sensibilization | No | No | No | No | No |
| Sub-acute toxicity NOAEL 2) | 1,267mg/ka | 1,267 mg/ka | 4,320 mg/kg | 1,400 mg/kg | 1,400 mg/kg |
| Chronic toxicity NOEL (3) | 3l0 mg/ka | 4l0 mg/ka | 410 mg/ka | 400 mg/ka | 362 mg/ka |
| Cancerogenicity (4) | No | No | No | No | No |
| Teratogenicity (5) | No | No | No | No | No |
| Gcnotoxicity/Mutagenicity (6) | Not mutagenic | Not mutagenic | Not mutagenic | Not mutagenic | Not mutagenic |
| Toxicity in birds | >2,500 mg/kg | >2500 mg/kg | >2500 mg/kg | 960 mg/kg | 960 mg/kg |
| Toxicity in fish | 15-26 mg/L | 14-33 mg/L | 15-26 mg/L | 86 mg/I. | |
| Toxicological category | NA | NA | Ill | NA | IV |

(1) Applicable to glyphosate and commercial formulations as salts, corresponds to that used in PECIG
(2) Eradication of illicit crops
(3) Without observable adverse effect
(4) Without observable adverse effect
(5) Opacity to produce cancer
(6) Production of congenital malformation
(7) Toxicity in the genome in the form of mutations and malformation of chromosomes

FAO United Nations Food and Agriculture Organization
LPCS International Program for Chemical Safety (FAO/WHO/UNEP/ILO)
EPA: US Environmental Protection Agency
WSSA: Weed Science Society of America
Minsalud: Colombia Health Ministry

*[The first section of this document is illegible for the most part Translation of random words will not aid in its understanding. It has therefore not been translated.]*

CHAPTER HI

OF THE CLASSIFICATION OF TOXICITY AND THE PERMIT OF USE IN THE COUNTRY

Article 13. OF THE OPINION OF CLASSIFICATION OF TOXICITY AND THE PERMIT OF USE IN THE COUNTRY. All individuals or legal persons that import or manufacture pesticide products for application in the country, independent of the quantity that they need to import or market, must obtain favorable opinion of the Ministry of Health or its delegate of the toxicological classification and use permit in the country, complying with what is established in Chapter X of this Decree»
Paragraph. When the matter pertains to pesticides with experimental purposes, there must be total compliance with the specifics of this Decree.

Article 14. OF THE CATEGORIES. For purposes of classification, the following toxicological categories of pesticides are established, whether for the formulation of one of its components.

CATEGORY I Extremely toxic
CATEGORY I Highly toxic
CATEGORY I Moderately toxic
CATEGORY I Slightly toxic

Article 15. OF THE CLASSIFICATION CRITERIA. For pesticide classification, the following criteria will be considered:

a) Lethal oral and inhalation dose on rats and dermal on rabbits
b) Studies of chronic toxicity
c) Potential carcinogen, mutagenic and teratogenic effects
d) Appearance and formulation
e) Application form and dose
f) Persistence and degradability
g) Toxic, acute, sub-acute and chronic action on humans and animals h) Feasibility of medical diagnosis and total recovery treatment
i) Environmental effects in the short term

Article 16. OF THE CLASSIFICATION ACCORDING TO LETHAL DOSE 50. The table of ranges and values of lethal dose 50 referred to in section a) of the previous article for each category shall be established by the Ministry of Health by resolution.

Article 17. OF THE CHANGE IN CLASSIFICATION. The Ministry of Health may vary the toxicological classification of pesticides when toxicity tests or risks of use so justify.

Article 18. OF THE OPINION OF CLASSIFICATION OF TOXICITY AND THE PERMIT OF USE. Once the documentation has been studied, the Ministry of Health, through the Division of Potentially Toxic Substances, will issue the opinion of classification of toxicity and will allow or deny the use of the product in the country. The technical information provided will have the character of reserved and will be protected under the law.

Article 19. OF THE REVIEW OF THE OPINION. The Ministry of Health ex officio or upon application will review the opinions issued on pesticide products that it deems appropriate, for which the holders of the respective register must attach the updated toxicology information to the Division of Potentially Toxic Substances.

Article 20. OF OPINIONS FOR DEFINED AREAS. For purposes of the toxicological opinion of the pesticides for application in buildings, vehicles, products and public areas, interested parties must satisfy the pertinent regulations herein.

bioaccumulate in the tissues of animals or agricultural crops. The Environmental Protection Agency (EPA) classifies herbicides for acute toxicity in four categories where "I" is the most toxic and "IV" is the least toxic. Based on oral rat tests, the EPA currently rates glyphosate as a Category IV herbicide. More extensive studies have shown no evidence of mutagenic, carcinogenic, teratogenic, or allergenic activity in a wide battery of assays and tests. The toxicology and environmental properties of glyphosate are summarized in Chapter 5. In 1991, glyphosate was newly classified as a Category E herbicide by the EPA. As shown in Table 1-2, the Category E classification is the most favorable rating granted for pesticides. Glyphosate was designated as a Category E herbicide because there is "evidence of noncarcinogenicity for humans."

Table 1-2 EPA Category Classifications

| | |
|---|---|
| Group A | Human carcinogen |
| Group B | Probable human carcinogen |
| Group C | Possible human carcinogen |
| Group D | Not classifiable as to human carcinogenicity |
| Group E | Evidence of noncarcinogenicity for humans |

3. Glyphosate is a systemic herbicide (Figure 1-3) that is rapidly translocated from foliage to the roots, rhizomes, and apical tissues of treated plants. This results in the destruction of hard-to-kill perennial weeds such as rhizome johnsongrass (Plates 1-1, 1-2), quackgrass (Plates 1-3, 1-4), field bindweed, Canada thistle, nutsedge, bermudagrass, cogongrass, kudzu, foxtail barley, smartweed (Figure 1-4). These perennial weeds seriously reduce crop yields in the U.S. and many foreign countries. Cogongrass is a problem perennial weed primarily found in Australia, Malaysia, and other Asian countries. Kudzu is an oriental vine that grows particularly well in the southeastern U.S. and often covers everything in its path, including tall trees and utility poles. Johnsongrass and quackgrass produce extensive rhizome systems, which lie hidden well below the soil. The uptake, transport, and metabolism of glyphosate in plants is summarized in Chapter 6.

4. In contrast to its good unit activity when used as a postemergence spray, glyphosate exhibits essentially no preemergence or residual soil activity even when applied at high rates. The compound is tightly bound to soil particles, is not leached into ground water, and is readily metabolized by soil microorganisms into plant nutrients. The behavior of glyphosate in soils, hydrosoils, and water is presented in Chapter 4.

*Figure 1-3 When glyphosate is sprayed onto plant foliage, it is absorbed and then moved — or translocated — throughout the plant's tissues. Once inside the plant, glyphosate inhibits an enzyme, called EPSP synthase, which in turn prevents the plant from making certain aromatic amino acids essential for plant growth. courtesy of Monsanto Company.*

5. Glyphosate does not penetrate the ... stems of trees, grapevines, etc., is nonvolatile, and is safe for use in orchards, vineyards, nurseries, etc., provided foliage is not contacted.

6. Some plants (e.g., conifers, bermudagrass) in the dormant or "hardened-off" state are resistant to foliage application of glyphosate at normal use rates.

7. Once inside the plant, glyphosate inhibits a key enzyme known as EPSP synthase. The inhibition of this important enzyme prevents the plant from synthesizing certain

100

1

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**Toxicology of Crop Protection Products in Combination**[1]

## 1. Introduction

Human beings are permanently exposed to a variety of chemical substances, both natural and synthetic, throughout their lives. The human body is highly fit to address the day to day variations of such exposure by preparing its defense mechanisms in a way that they are not overloaded. Therefore, it is almost impossible to address and define a single assessment of all possible combinations of substances to which an individual might be exposed daily. However, there is the obligation to try to assess the exposure impact to combinations of certain products when the extension and type are known.

For instance, in agriculture, crop protection workers are sometimes exposed to more than one agrochemical by applying combinations of products or sequential applications of more than a single product. In the context of crop residues, ¡t may be possible that individuals consume the residues of than a product present in food. In these cases, questions are whether health assessment of exposure to the combination of components is different than that expected for individual components. This document analyzes the factors that can be taken into account when making the assessment and describes how security assessment must be made in these circumstances.

## 2. Definitions

The investigation of combined effects basically implies the comparison of equivalent effects. In the context of this document, the following effects are differentiated (Doul et al) (1)

## 3. Synergic Effects

This occurs when the combination effect of active ingredients is much higher than what is expected from its individual effects (Super-additive effects)

## 4. Potentiating effect

When a substance by itself does not have a toxic effect on certain organ, it makes other substance substantially more toxic when administered in combination therewith, and this is known as potentiating effect.

**Antagonism**

An interaction of two or more active ingredients may lead to reduce the effect of these substances in combination than that expected from its individual effects, is known as antagonism.

# Toxicology of Crops Protection Products in Combination

## 1. Introduction

Human beings are constantly exposed to a variety of chemical substances, both natural and synthetical throughout their lives. The human body is quite capable of dealing with day to day variations of exposure provided its defence mechanisms are not overburdened. It is of course almost impossible to try and define, let alone assess, every possible combination of substances to which a person may be exposed daily. There is however some obligation to try to assess the impact of the exposure to combinations of certain products when the extant and type of their usage is known

For example, in agriculture, crop protection operators are sometimes exposed to more than one agrochemical either, through applying products in combination or by sequential application of more than one individual product. In the context of crop residues it may be possible for consumers to ingest the residue of more than one product present in foodstuffs. In cases such as these, questions are sometimes raised whether the health assessment of exposure to a combination of components is different from that expected of the individual components. This paper reviews the factors that should be taken into account when making such assessments and describes how safety evaluations should be undertaken in these circumstances.

## 2. Definitions

The investigation of combined effects basically involves the comparison of affect equivalent: In the context of this paper the following effects are differentiated and outlined by Doull et al (1).

# ラットにおける除草剤ラウンドアップの急性毒性の検討

[illegible]*
[illegible]*
[illegible]*
[illegible]*
[illegible]**
山下 [illegible]***

* [illegible]
** [illegible]
*** [illegible]

## Acute Toxicity of the Herbicide "Roundup®" in the Rat

[illegible]*
[illegible]*
[illegible]*
[illegible]*
[illegible]**
[illegible]***

* Department of Chemistry, University of [illegible]
** [illegible] Medical Schools, University of [illegible]
*** [illegible] University of [illegible] Hospital

Key Words: [illegible]
[illegible]

[illegible] 年 [illegible] 月 [illegible] 日
[illegible] 年 [illegible] 月 [illegible] 日

Summary

Roundup® is a widely used herbicide which is a mixture of glyphosate, surfactant and water. $LD_{50}$ of glyphosate, main component of Roundup®, is 5,[illegible] g/kg in rat. However, it has been reported that severe poisoning cases such as coma, shock and death had occurred by accidental or intentional ingestion.

In this study, we determined the oral median lethal dose ($LD_{50}$) of Roundup®, glyphosate and surfactant, and evaluated the interaction of toxic effect between glyphosate and surfactant.

Male Wistar rats were divided into five to seven groups with seven rats in each group. Roundup®, glyphosate and surfactant were orally administered. The $LD_{50}$ was calculated by the method of Litchfield and Wilcoxon as a standard of mortality to 72 hours following administration. The interaction of toxic effect between glyphosate and surfactant was determined by using Shirasu's diagram and Finey's formula.

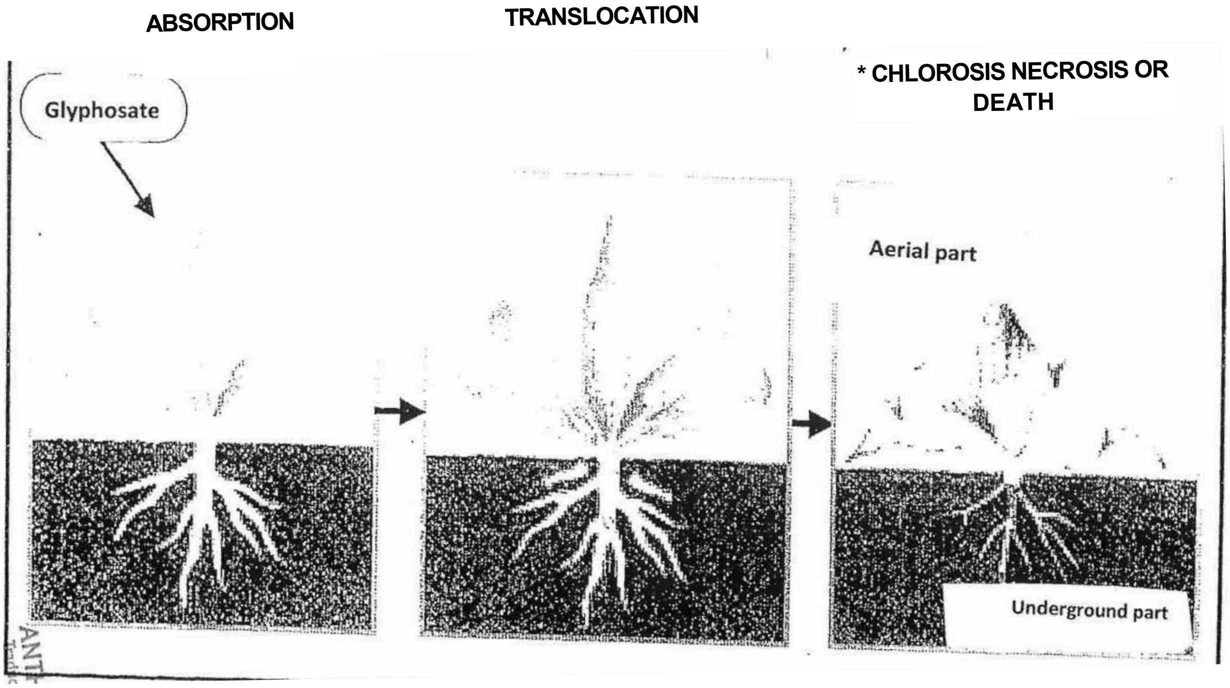
$LD_{50}$ of Roundup®, glyphosate and surfactant were 5,317, 5,957, 681 mg/kg, respectively. The interaction of toxic effect between glyphosate and surfactant was antagonism.

The acute toxic effect of Roundup® is thought to be more related to the toxic effect of surfactant than to that of glyphosate.

## 緒　言

ラウンドアップ®（以下，RUNと略す）は，グリホサートイソプロピルアミン塩（以下，GLと略す）41%，非イオン界面活性剤15%およびその他からなる除草剤である．その主成分GLの急性毒性は動物実験の結果から低いことがわかっているが，動物におけるRUNの毒性は，GLの含有量が少ないにもかかわらず，比較的高いことが知られている．一方，自殺企図によりRUNを大量に服用することによって，重篤な中毒症例の発生例が報告されている．この原因として，GLと界面活性剤の混合によってGLの毒性が相加・相乗的に増強されている場合と，RUNに含まれる界面活性剤が強い毒性をもっ

## *ACTION OF GLYPHOSATE IN THE PLANT*




## *PRODUCT AND MODE OF ACTION*

GLYPHOSATE ($C_3H_8N0_5P$)

```
 O         O
 ||        ||
OH-C-CH2-NH-CH2-P-0
          I
          OH
```

**N (phosphomethyl) glycine**
**Isopropanolamine salt**

**MODE OF ACTION**

- **Exclusive amino acids of plants are not synthetized by animals: lysine, isoleucine, methionine and veline.**
- **Glyphosate inhibits synthesis of chemical acid -» synthesis of amino acids: (two words illegible) and tyrosine**

**OPERATING PARAMETERS OF THE PROGRAM FOR THE ERADICATION OF ILLICIT CROPS BY AERIAL SPRAYING**

| PARAMETER | UNIT/MEASURE | VALUE OR RANGE | VALUE OR RANGE |
|---|---|---|---|
| | | COCA | POPPY |
| FLIGHT ALTITUDE | Meters | Less than 25 | Less than 12 |
| Aircraft speed | Miles | 120 -150 T 65 | 120 -150 T 65 j |
| Cargo of Aircraft | Gallons | 350 - 500 | 200-350 |
| Discharge expected | Liters/hectare | 234 (30-50 drops/cm2) | 50 (15-20 drops/cm2) |
| Deposit of mixture | mm3/cm2 | 0,40-0.70 | 0.20-0.50 |
| Droplet size | Microns | 300-1500 | 300-1000 |
| Hours of application | Optimum hours | 5:30 to 10:00 a.m.<br>4:00 to 5:00 p.m. | 5:30 to 10:00 a.m. |
| Magnitude of recovery | In % of the spraying | >80% | >80% |
| Pump pressure | Pounds per cm2 (psi) | 20 to 25 | 20-25 |
| Expected drift | Meters | <5 | <2 |
| Swath width | Meters | 30-52 | 16-20 |
| T.V.B. Nozzles | hole mm | 2 | 2 |
| Ambient temperature | Degrees Celsius | <32. | 13 |
| Wind | KNOTS | <4 | <4 |
| Relative humidity | Percentage | >75 | >75 |

**Notes:**

**(1) In the case of the OV-10 aircraft, this speed is 170 knots.**
**(2) These are the most adequate times, however, operating time may be extended depending wind speed.**

**Operating and technical parameters of the process are within a continuous enhancement program.**

**COSMOAGRO**

***Technical specification 313.03 May 30/94***

COSMO-FLUX® 411F
Coadjuvant of Agrochemical application
***Lie. ICA 05.4 2-2186 - Colombia***

Specifications

| | | |
|---|---|---|
| Classification | Spraying additive | |
| Chemical description | Mixture of Mineral oil and non-ionic specialized surfactants with coupling agents | |
| Active Ingredient | Mixture of Mexitan esters. Linear alcohols + aryl ethoxylate, **Mixtures of stereospecific non-ionic tensoactive based on ethoxylated propoxylated linear alcohols with small quantities of aryl ethoxylated compound.** | EPA regulation: **Tolerance exempt under regulation 40 CFR 180.1001 ( c);{e)** |
| Active Ingredients | Liquid isoparafins **Highly pure, very low phyto-toxicity, low content of aromatics and low superficial stress isoparafinlc oil that enhances humectability, thus promoting efficacy of active ingredients.** | EPA regulation: **Tolerance exempt under regulation 40 CFR 180.1001 ( c);(e)** |

**General characteristics**

| | |
|---|---|
| Appearance at 25°C | Yellowish liquid |
| Flash point | >148°C |
| Specific gravity | 0.89 |
| Viscosity at 25°C | 60mPa |
| pH in (illegible) solution of distilled water | Between 63 and 6.8 |

**Solubility**

| | |
|---|---|
| (Illegible) oils | Soluble |
| Vegetable oils | Soluble |
| Organic solvents | Soluble |
| Water | Dispersible, forming a rapid emulsion |

**COSCOSMOAGRO**

**Characteristics of Mixtures generated with COSMO-FLUX® 411F**

| | |
|---|---|
| Homogeneity | Excellent |
| Persistence | <24 hours |
| Compatibility with active ingredients | Excellent (see ANNEX "Assessment of physical compatibility" |
| Mixture speed | Rapid |
| adherence | Excellent |

**Toxicological summary**

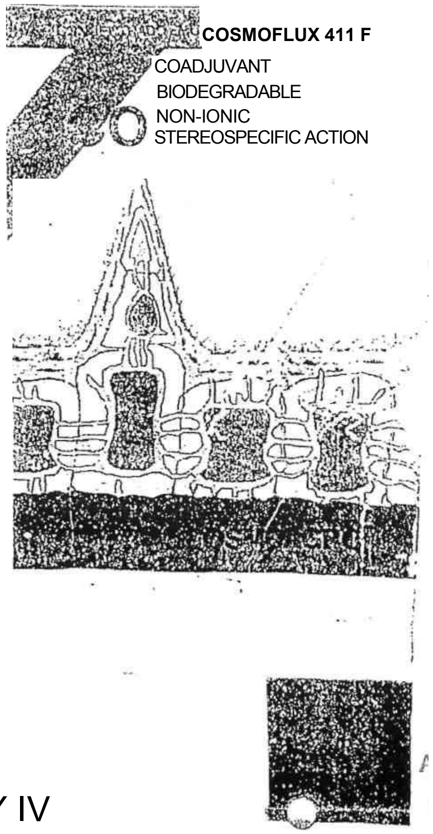
| | |
|---|---|
| Classification by Ministry of health (Colombia) | Toxicological concept LP-0593 corresponding to TOXICOLOGY CATEGORY IV - SLIGHTLY TOXIC (Green band) |
| Classification as poison | Not classified |
| Irritation in rabbit eyes (according to Kay D. Calandra's application) | Virtually non-irritant |
| Irritation in rabbit skin | After 24 hours of non-diluted application, small irritation could be observed. |
| Sensibility in human skin | Does not cause irritation nor sensitization in human skin, |
| Biodegradability (OECD's method for non-ionic tensoactives) | Non-ionic components of COSMO-FLUX 411F have biodegradability of <90% |

**First aid In any case, you must see a doctor**

| | |
|---|---|
| Skin contact | Wash with water and soap |
| Eye contact | Wash immediately with abundant clean water or eye-wash solution for 15 minutes |
| inhalation | Symptomatic treatment |
| Ingestion | *Do not induce vomit* Drink milk or water, Symptomatic treatment<br>See a doctor and show him the label |

READ THIS LABEL COMPLETELY BEFORE USING THE PRODUCT

**COSMOFLUX** 411




SALES LICENSE
Colombia I.C.A. No. 2186
Ecuador MAF No. 03199075

GUARANTEED COMPOSITION

**ACTIVE INGREDIENTS**:

| | |
|---|---|
| **Ethoxylated -aryl ethoxylated linear alcohols**<br>Mixtures of stereospedflc non-ionic tensoactive based on ethoxylated propoxylated linear alcohols with small quantities of aryl ethoxylated | 17% |

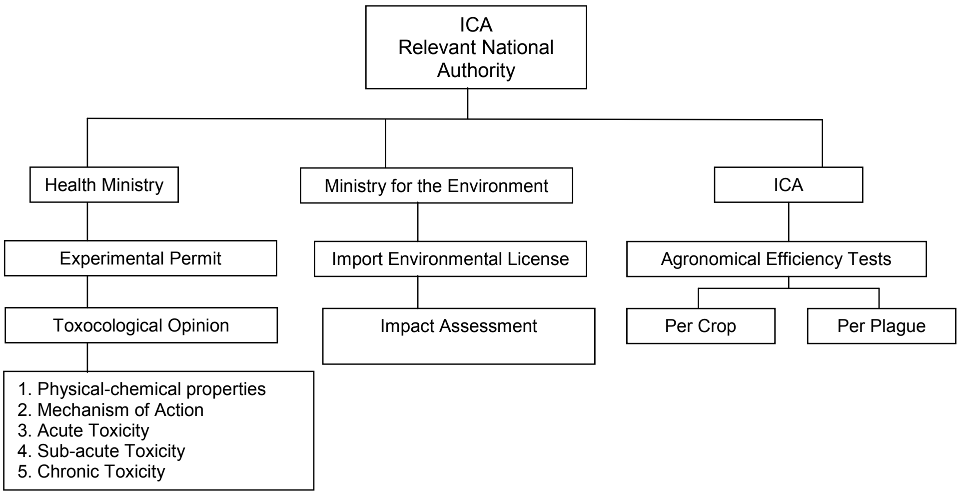
**ADDITIVE INGREDIENTS** 83%

20 litres
NET CONTENT 200 litres

Calle 42 No. 30-39 Telélon ■ (S2) 2?5 1a 81 Fax: (92) 273 SG 76 Palmira (V )
COLOMBIAN INDUSTRY

TOXICOLOGICAL CATEGORY IV
SLIGHTLY TOXIC "USE WITH CARE"

**PRODUCTS REGISTRATION PROCESS OF FOR CROP PROTECTION .COLOMBIA**



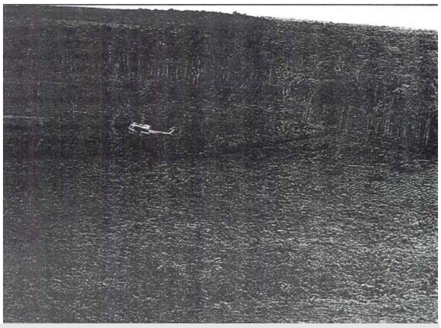
# Annex 21

## NATIONAL NARCOTICS DIRECTORATE (DNE), ENVIRONMENTAL IMPACT OF ILLICIT COCA CROPS AND THEIR ERADICATION BY AERIAL SPRAYING WITH GLYPHOSATE IN THE BIO-GEOGRAPHICAL REGION OF THE COLOMBIAN AMAZON AND ORINOCO BASINS, DECEMBER 1994

*(Archives of the Colombian Foreign Ministry)*

MINISTRY OF JUSTICE
**NATIONAL NARCOTICS DIRECTORATE**

ENVIRONMENTAL IMPACT OF THE ILLICIT COCA CROPS AND THEIR ERADICATION BY AERIAL SPRAYING WITH GLYPHOSATE IN THE BIOGEOGRAPHIC REGION OF THE COLOMBIAN AMAZON AND ORINOCO BASINS



Santafé de Bogota D.C.
December 1994

LUIS EDUARDO PARRA P
Head of Environmental Audit
Illicit Crop Eradication



## 1. INTRODUCTION

The millennial existence in South America of over 200 species of the 250 Erythroxylum species that exist throughout the world, forming the floral composition of the so-called cocas, is the clearest example of humanity's poor use of a lush nature, by giving only two of the species, E. coca and E. novogranatense, some use for cocaine production purposes.

The most serious of the associated problems is the environmental deterioration of valuable –and still poorly scientifically understood– ecosystems. This is particularly true in the case of the Colombian Amazon and Orinoco regions.

Little or nothing is known about the serious environmental consequences of the cultivation and production of the coca paste. However, there is plenty of evidence that both activities have a lasting impact with irreparable consequences in the ecosystems developed today.

The devastation of a number that ranges between 160,000 and 240,000 hectares of lowland tropical forest means about 30% of the annual deforestation rate in Colombia for several reasons. This destruction in ecological terms represents, for the country and its people, the loss or impairment of:

- 380 tons/ha of biomass[1], for a cumulative deficit of 60.8 to 91.2 million tons of biomass that have been turned water bodies to ashes and sediments.
- Some 210 species of mammals reported in the Colombian Amazon, seriously endangered by habitat alteration.
- In other animal species the numbers are: 600 birds, 170 reptiles, 100 amphibians and 600 fish.
- In flora, danger is encroaching on some single species in the world (endemism), since 80% of all reported tree species only exist in this biome.
- In the case of the Colombian Amazon region, there is risk of deforestation associated with illicit crops on 96 to 120 species of trees/ha with more than 500 individual trees per hectare. This represents losing 140 $m^3$/ha of wood of which 30% have proven commercial potential.
- Unknown biogenetic potential and with great pharmaceutical, food, recreational and economic value.

[1] The figure of 380 Ton/Ha is an index according to Klinge (1972).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- The Sierra de la Macarena biome, considered unique in the world by UNESCO scientists and experts for its biophysical characteristics. Without a doubt threatened before the nation's dauntlessness.

- A valuable accumulated flow of the rivers Vichada, Guaviare, Caquetá, Putumayo, Apoporis, Inirida, Vaupés, Guainía, Orteguaza, Caguán and Amazon.

- Structural heterogeneity of the ethnic groups inhabiting the region. This wealth, also threatened today, is represented in 52 ethnic groups divided into 15 linguistic groups which posses a sociopolitical, territorial and culturally well-defined reality.


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## 2. ECOLOGICAL CHARACTERIZATION OF THE ILLICIT COCA CROP

Illicit coca crops in Colombia are substantially located in different biogeographic regions, that is, with areas by region, which easily surpass the figure of 1,000 hectares.

Among them the following can be mentioned:

a. **Serrania de San Lucas**. A nature reserve that has significant coca crops (Erythroxylum coca, Var coca and E. Novogranatense). These varieties are grown and processed locally. The existence of such crops has been reported since 1988. The serrania (mountain range) is located in southern Bolivar Province.

b. **Provinces of Cauca and Nariño**. This nucleus is located south of the Cauca and north of Nariño. These crops date from the 80's and have settled in smallholder rural areas and indigenous reservations. Mainly E. novogranatense is grown.

c. **Biogeographic regions of the Amazon and Orinoco Basins**. The areas with the highest individual crop-cultivated land are located here, by plots or as nuclei. The estimated coca surface is between 40-60 thousand hectares.

In cases a and b, the crop develops in undulating to hilly physiographic landscapes (slope crops), at altitudes ranging from 500-1500 m.s.l. and at temperatures between 24° C and 20° C on average. Rainfall varies between 1,500 - 2,500 mm per year on average. In general, crops are medium sized (2.0 to 6.0 hectares) and small (less than 2.0 hectares). Also, most owners are colonizers who settled over 5 years before, or marginal rural economy farmers and indigenous communities.

In the third case (c), which constitutes the central focus of this report, coca cultivation is developed, perhaps, in the biogeographic region with the largest biodiversity in the world: the Amazon. And to complete the stage, next to it, that is, in the Orinoco, the existence of coca cultivation is also the main activity of the colonization fronts. Next, the document will refer to this natural area specifically.

### 2.1 COCA CULTIVATION IN THE ORINOCO BASIN

The entire region covers an area of 23,096.725 ha which correspond to 20.23% of the national [2] surface, which are an integral part of the provinces of Arauca,

[2] Soils and forests of Colombia. IGAC, Archaeology Branch. 1988


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Casanare, Meta and Vichada. In the case of coca, the region of interest is the one that extends to the south of Vichada River and to Guaviare River, as well as the natural reserve of high biodiversity and ecological value known as the Sierra de la Macarena.

**Briefly, some of the ecological considerations of these biomes are listed:**

### 2.1.1 Natural Plains with Gallery Forests and Transition Forest Biome

These are areas with predominantly flat to undulating landscape bearing dissected terraces, where a transitional vegetation of tropical very wet forest of the Amazon and the less humid savanna vegetation of the Orinoco River grows.

The flora consists of trees up to 35 m high and a diameter ranging between 40-100 cm., palms and grass or smaller species such as heliconia, Heliconia bihai and Tarriago (*Euphorbia lathyris*).

The eco-system interaction of the gallery forest (borders of streams and rivers) and water body (flow, aquatic flora and fauna) is the most important biotic and ecological relationship and it is seriously threatened by the coca crops.

The future persistence of water resources in that biome depends, in great part, on this ecological balance.

### 2.1.2 Sierra de la Macarena Biome

This corresponds to a set of ecosystems that occur, as a special biome of the Colombian Andes, in isolation. It has three thermal floors (warm, temperate and cold) with different types of forests. Their flora richness is unquestionable, becoming a unique gene bank for the region and country.

## 2.2 COCA CULTIVATION IN THE AMAZON

This biogeographic region covers an area of 39,205,918 hectares, of which 81% are natural forests (32,349,775 hectares). Vegetation is composed of several layers (3 or 4), with tree canopy reaching up to 40 meters. It consists of the provinces of Guaviare, Amazonas, Putumayo, Guainía, Vaupés and Caquetá.

The region is divided into three major biomes:

### 2.2.1 Dense Forest of the Amazon, Putumayo, Caquetá and Apoporis Rivers Biome


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This is the first south-north large region with little or no human intervention. This flora consists mainly of large trees (40 m high) with extended epiphytes and parasitism. The understory is dense and rich in species. Its rich fauna is immense and with proven ecological and economic value.

### 2.2.2 Dense Forest and Terrace Plains and High Erosion Surfaces of the Vaupés Biome

Composed of under-dissected terraces with less dense forest, up to 40 m-tall trees and abundant epiphytes and parasitism. Natural rubber grows in almost homogeneous patches in regions close to Miraflores and Mitu.

In the previous two biomes Coca crops are located in these nuclei, namely:

Putumayo Province: Guaumués River Valley, La Hormiga, Orito, San Miguel and Puerto Leguizamo

Caqueta Province: Cagúan River, Tres Esquinas region upward, and Cartagena del Chaira

Guaviare Province: San José-Calamar-El Retorno, Tomachipán, Sierra de la Macarena and Miraflores

### 2.2.3 Mixed Forests and Plains of the Guainía Region Biome

Consisting of by high terraces and flat to undulating topography, sandy soils of the Guiana Shield. The size of the trees decreases from 30 m in some places to 10 m in others, and their trunks are thinner than in the other two biomes.

In general, in both the Orinoco and the Amazon, the soils are characterized by:

- Low to extremely low organic carbon content (1.5% -0.5%).
- Organic matter undergoes a rapid process of mineralization that is absorbed largely by the trees and the rest is washed by heavy rains.
- Very acid soils (pH 3.5) with high aluminum saturation, a situation that is considered critical for most agricultural crops.
- 90% of the soils are within agrologic Classes V, VI, VII and VIII, which are considered forest land.


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- Soils that show all levels of erosion (slight, moderate and severe) caused primarily by slash and burning.

- The crop and livestock productivity is considered very low, and improving it would mean getting a negative return.


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## 3. ENVIRONMENTAL IMPACT OF COCA CROP ON THE ORINOCO AND THE AMAZON BASIN

Undoubtedly, the greatest loss in ecological terms is derived from illicit crop model implemented by the settlers and farmers in the region of the Colombian Amazon and Orinoco basins. The following is a summary of the four (4) categories of environmental impacts caused by these activities:

a. **The first and most obvious environmental impact**: is the deforestation of hundreds of thousands of hectares, whose largest and single vocation, in more than 90%, is the protection of watersheds, surface water production, the habitat of countless, unknown record of flora and fauna species and conservation of land whose vocation is, fundamentally forest. In Colombia, the Coca cultivation alone has destroyed more than 160,000 to 240,000 hectares of rainforest in the biomes of the Orinoco and the Amazon basins; along the lines of 30% of the annual deforestation rate estimated in Colombia.

b. **The second environmental impact:** the resulting erosion as soils are unprotected of their vegetation cover in areas where annual rainfall is estimated between 2,500 and 4,500 mm. In addition, some clay and sandy soils which actually aid in growing the estates of some extensive farms whose agriculture and livestock practices are highly deteriorating to the ecosystems where they are established.

c. **The third environmental impact:** is the contamination of surface water by the indiscriminate and uncontrolled use of pesticides (herbicides, fungicides and insecticides, all of them highly toxic), the intensive use of inorganic fertilizers and chemical use, highly polluting, in the processing of the coca base.

d. **The fourth environmental impact:** and, perhaps the one causing the most concern in the future survival of humanity, is the destruction of some unknown and valuable flora and fauna genetic resources. In other words, without being able to quantify the real dimension, on account of the illicit coca crops, true gene banks are disappearing; vast habitats of mammals, fish, insects, etc., and the next generations are being deprived of scenic beauty, which are uplifting steps of human dignity.

Table No. 3.1 further details the listing of: the specific source of impact (action or cause), brief description of the action, the impact or environmental impacts generated, the environmental component affected and the nature of impact.


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**TABLE No. 3.1**
**IDENTIFICATION OF ENVIRONMENTAL IMPACT CAUSED BY ILLICIT COCA CROPS**

| SOURCE OF ACTION | DESCRIPTION OF THE ACTION | COMPONENT AND/OR ENVIRONMENTAL ELEMENT AFFECTED | IMPACT | NATURE OF IMPACT |
|---|---|---|---|---|
| Slash and burning | Removal of rainforest vegetation (slash and clearing).<br>Uncontrolled fire of felled plant material and nearby forest by indiscriminate fire action. | Vegetation | Deforestation. | Exhaustion of national inventories of flora<br>Lower vegetation destruction, epiphytes and parasites<br>Impact on ecological soil-plant-fauna interactions<br>Decrease in food supply to air and land fauna<br>Destruction of native vegetation<br>Decreased rates of evapotranspiration |
| | | | Destruction of Biodiversity | Floristic richness decrease<br>Disappearance of endemic species<br>Loss of Biotechnological potential<br>Exhaustion of strategic resources<br>Decreased genetic material and germoplasm bank destruction<br>Deterioration of ecosystems<br>Disappearance of valuable and endangered species |
| | | Soil | Erosion | Soil denudation increases erosivity index from high to very high (1500-3000 Kg-mm/m2)<br>Loss of detrital formations<br>Accelerated loss of scarce topsoil<br>Reduction of microflora and microfauna communities<br>Loss of soil of agro-ecological vocation<br>Increased structural susceptibility<br>Increase annual erosion rate and in mild to severe degree<br>Increased mass movements (diffuse, runoff and spoon effect) |

**TABLE No. 3.1**
**IDENTIFICATION OF ENVIRONMENTAL IMPACT CAUSED BY ILLICIT COCA CROPS**

| SOURCE OF ACTION | DESCRIPTION OF THE ACTION | COMPONENT AND/OR ENVIRONMENTAL ELEMENT AFFECTED | IMPACT | NATURE OF IMPACT |
|---|---|---|---|---|
| Slash and burning | Removal of rainforest vegetation (slash and clearing).<br>Uncontrolled fire of felled plant material and nearby forest by indiscriminate fire action. | Water | Impaired streams and water supply | Upper watershed destruction or “water sources,” affect primary sources of water<br>Modification of flow regimes<br>Morphological modification of flows<br>Decreased quality and quantity of water supply<br>Destruction microflora, Impact on food chains<br>Migration and reduction of aquatic species |
| | | | Sedimentation | Increased total solids in water bodies<br>Pollution of water bodies beds and food chains |
| | | Atmosphere | Climate change | Alteration of local and regional system of rainfall and other climatic parameters<br>Increased CO2 in biosphere and increased suspended particulate matter<br>Modification of moisture in atmospheric masses by altering rates of evapotranspiration |
| Tillage | Agronomic preparation of field (weeding, make holes, rings, earth up, etc.) | Vegetation | Changing forest types | Establishment of monocultures (Coca)<br>Removal of lower vegetation and break of plant succession<br>Reduced food availability for wildlife<br>Destruction food chains |
| | | Soil | Alteration potential use | Changing land use, Altered natural disposition of soil structure |

**TABLE No. 3.1**
**IDENTIFICATION OF ENVIRONMENTAL IMPACT CAUSED BY ILLICIT COCA CROPS**

| SOURCE OF ACTION | DESCRIPTION OF THE ACTION | COMPONENT AND/OR ENVIRONMENTAL ELEMENT AFFECTED | IMPACT | NATURE OF IMPACT |
|---|---|---|---|---|
| Tillage | Agronomic preparation of field (weeding, make holes, rings, earth up, etc.) | Fauna | Destruction and decline of populations | Affect species of microfauna<br>Destruction of habitats and ecological niches<br>Disappearance of arthropod fauna communities, insects, birds and terrestrial vertebrates<br>Migration of wildlife habitats and other ecological balance altering local and regional levels |
| | Use and application uncontrolled and indiscriminate use of pesticides and inorganic fertilizers | Soil | Desertification | Loss of fertility caused by decline in production capacity of goods and services from the forest |
| | | | Pollution | Accumulation and persistence of parent molecules in soils |
| | | Water | Contamination of surface water | Bioaccumulation of biocides in wildlife populations of streams, rivers and swamps and in other food chains<br>Ion scattering to bodies of water<br>Increased eutrophication processes in lakes, swamps and old streams |
| | | Wildlife | Impact on aquatic, land and air fauna | Biological changes in composition of communities<br>Disappearance of microbiota (fungi and bacteria) |
| | | Landscape | Changing landscape structure and primary (visual) qualities | Disappearance of scenic beauty<br>Destruction of educational science resources to know current or past natural processes<br>Destruction of plastic and emotional values of the environment<br>Changing view sheds |

**TABLE No. 3.1**
**IDENTIFICATION OF ENVIRONMENTAL IMPACT CAUSED BY ILLICIT COCA CROPS**

| SOURCE OF ACTION | DESCRIPTION OF THE ACTION | COMPONENT AND/OR ENVIRONMENTAL ELEMENT AFFECTED | IMPACT | NATURE OF IMPACT |
|---|---|---|---|---|
| Production of illicit Coca crops | Leaf Collection (“scraping”), paste or base production and processing to cocaine hydrochloride Marketing | Cultural | Anthropological impact | Affecting native communities by pressure on land and foreign agricultural practices<br>Decomposition of indigenous cultures<br>Disrespect for indigenous cultural values<br>Destruction of biogeographical sites<br>Generation of groups of “effervescent economy,” “boom” type<br>Abandonment of moral and ethical values<br>Increased administrative corruption<br>Increased prostitution |

**TABLE No. 3.1**
**IDENTIFICATION OF ENVIRONMENTAL IMPACT CAUSED BY ILLICIT COCA CROPS**

| SOURCE OF ACTION | DESCRIPTION OF THE ACTION | COMPONENT AND/OR ENVIRONMENTAL ELEMENT AFFECTED | IMPACT | NATURE OF IMPACT |
|---|---|---|---|---|
| Production of illicit Coca crops | Leaf Collection ("scraping"), paste or base production and processing to cocaine hydrochloride Marketing | Socio economic | Negative return | Decreased ability to produce goods and services derived from ecosystems<br>Inadequate change of potential land use |
| | | | Increased local and regional inflation | Unusual demand on sumptuous goods and services<br>Abnormal increase in prices and tariffs for goods and services |
| | | | Improving regional GDP | Increased labor for floating population (employment generation)<br>Increase family income<br>Entry of food and agricultural products from neighboring centers (Villavicencio)<br>Increased construction indicators |
| | | | Demand for goods and services | Dissatisfaction with low supply of public services<br>Increased volumes of household waste<br>Increased risk of parasitic diseases by increased vectors |
| | | | Increased violence | Increased use of firearms deaths<br>Deteriorating of law and order, increase crime and arms trafficking<br>Increased crime rates<br>Emergence of vigilante groups |
| | | | Colonization | Destruction of nature reserves and national parks affected<br>Increase of floating population in urban centers<br>Creation of economic expectations that are impossible to meet<br>Displacement of indigenous communities of ancestral lands<br>Conflict over land ownership |

# 4. ENVIRONMENTAL IMPACT OF ERADICATION BY AERIAL SPRAYING WITH GLYPHOSATE

The establishment of illegal coca crops, as seen in the previous chapter, generates a series of impacts that can only be lessened or mitigated by a technically and environmentally sound method of eradication. For this particular case the aerial spraying of glyphosate was considered the method to be applied, always under the environmental model established for this purpose, which yields better results in those areas where extensions, by crop plots justify implementation.

On the other hand, the comprehensive solution requires additional efforts within the framework of alternative development for communities in marginal rural economy as compensation measures. At large areas of cultivation, with intensive technology and financial resources, only effective eradication is applicable with programs for environmental restoration and conservation of nature reserves that mean tremendous efforts on the national treasury as a cost that the nation assumes for having this scourge and socio-environmental disturbing factor.

Aerial spraying with Glyphosate has two environmental impact areas as follows:

**a. On the crops themselves**

Causing effects connected to the very destruction of illicit crops and which include the following components: biotic, physical and socio-economic development.

**b. On-site natural vegetation**

Represented mainly by isolated trees left on the plots (with epiphytes and parasitic plants), in addition to the soil of the plot itself, which is specifically and temporarily affected by the application of glyphosate. However, the magnitude is low and the duration is temporary (no more than 2 weeks) in terms of quantifying the environmental impact.

**Table No. 4.1** presents more detail of the impacts caused by the eradication activities. Manual eradication is not included given it is not being applied, because the program has focused efforts on plots larger than 6.0 hectares and up to 50 existing in this biogeographic region.


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**TABLE No. 4.1**
**IDENTIFICATION OF ENVIRONMENTAL IMPACT CAUSED BY ILLICIT COCA CROPS BY AERIAL SPRAYING WITH GLYPHOSATE**

| SOURCE OF ACTION | DESCRIPTION OF THE ACTION | COMPONENT AND/OR ENVIRONMENTAL ELEMENT AFFECTED | IMPACT | NATURE OF IMPACT |
|---|---|---|---|---|
| Aerial spraying with glyphosate | Application of a dose of 10.4 1iters / ha of Roundup (48%) dissolved in 60 liters of water- | Vegetation | Coca crop Destruction | Elimination by systemic action of the product in an approximate dose of 1.04 cc of Roundup per plant/m2<br>Eventual affectation of epiphytes and parasites |
| | | | Vegetation restoration | Appearance of light-demanding pioneer species and initiation of succession regenerative processes of forest growth |
| | | Soil | Timely disposal of water-Glyphosate mix | Residuality of 1 to 2 weeks maximum of mixing ratio that may eventually fall to the ground<br>microbial biodegradation and Fixing of organic matter present<br>Low to very low drop of mixture to the ground, Less than 0.1 cc of Round-up / m2<br>Low removal of minor native succession vegetation and grasses present in plots |
| | | Social | Attacks on security forces | Increased acts with a firearm against police |
| | | Socio-economic | Reduction of regional GDP | Decrease in family income and employment decline<br>Recovery of agricultural activities<br>Reduced consumption of chemicals and fuels<br>Closing of business establishments (clubs' (especially liquor) |
| | | Social | National and international supply of narcotics | Decrease in local productions of cocaine |

**TABLE No. 4.1**
**IDENTIFICATION OF ENVIRONMENTAL IMPACT CAUSED BY ILLICIT COCA CROPS BY AERIAL SPRAYING WITH GLYPHOSATE**

| SOURCE OF ACTION | DESCRIPTION OF THE ACTION | COMPONENT AND/OR ENVIRONMENTAL ELEMENT AFFECTED | IMPACT | NATURE OF IMPACT |
|---|---|---|---|---|
| Alternative Development | Development of small areas of illicit crop production, through actions to the progressive reduction of cultivated area and establishing a basis for local and regional development under criteria of sustainability and social and economic autonomy | Socio-economic, cultural, biotic and physical | Decrease in cultivated area<br>Reduction and elimination of factors and causes of environmental degradation<br>Improved level and quality of life | State presence and increased citizen solidarity<br>Decrease and disappearance of factors of violence<br>Transfer and validation of appropriate technologies<br>Natural and induced environmental restoration<br>Conservation, improvement and land reclamation<br>Management planning and watershed management<br>Amazon biotechnology development<br>Ecotourism and establishment of community protectors-producers forests<br>Control, monitoring and preservation of national parks and reserves<br>Return of ethical and moral values<br>Technical assistance and eco-production and sustainable marketing<br>Empowering a “rearguard economy” by small coca crops |

**ANNEX NO. 1**
**CHARACTERIZATION OF ENVIRONMENTAL EFFECTS**

| SPECIFIC SOURCE OF IMPACT | IMPACT | NATURE OF IMPACT |
|---|---|---|
| Logging and burning<br>• Removing vegetation<br>• Burn of vegetation cover | Deforestation | Destruction of ecological niches<br>Disruption of primary sources of water<br>Loss of detrital formations<br>Ecological Impact of destruction of coverage<br>Reduced vegetation cover<br>Altered rainfall patterns and local climate<br>Effect on landscape<br>Increased C02<br>Disappearance scenic beauty |
| | Erosion | Decreased areas of nature reserves<br>Acceleration of mass movements (spoon effect, replicate, diffuse and concentrated runoff)<br>Disappearance of microflora and microfauna<br>Accelerated loss of soil<br>Diminished agrological quality of the soil<br>Effect on landscape<br>Increased structural susceptibility |
| | Depletion of water sources | Disappearance of the phenomenon of horizontal rain<br>Reduced supply of water<br>Impairment of water quality<br>Migration of fauna species<br>Effect of food chains<br>Loss of morphology of watercourses |
| | Loss of biodiversity | Loss of endangered endemic species<br>Biotechnological potential biodiversity loss<br>Deterioration of ecosystems<br>Trophic chain and involvement<br>Disappearance of valuable species |

**ANNEX NO. 1**
**CHARACTERIZATION OF ENVIRONMENTAL EFFECTS**

| SPECIFIC SOURCE OF IMPACT | IMPACT | NATURE OF IMPACT |
|---|---|---|
| | National and international supply of narcotics | Increased psychotropic substances<br>Eventual increase in addicts |
| - Poppy Crop Eradication<br>• Manual<br>• Chemical | Elimination of the crop | Destroying poppy crops<br>Affectation of epiphytes<br>Affectation of lower Indicating vegetation<br>Natural restoration of ecosystems |
| | Decrease GDP | Reduction in revenue<br>Decrease in employment<br>Recovery of traditional activity agricultural |
| | Attacks to armed forces | Increased violence against the police |
| Alternative Development | Quality Improvement | Institutional presence<br>Increase citizen solidarity<br>Technical Assistance<br>Appropriate technology transfer<br>Creation of microbusiness<br>Improvement of housing<br>Improving health care<br>Credit assistance<br>Creation of collection centers<br>Help in marketing<br>Return of ethical and cultural values<br>Decreased violence<br>Family stability |

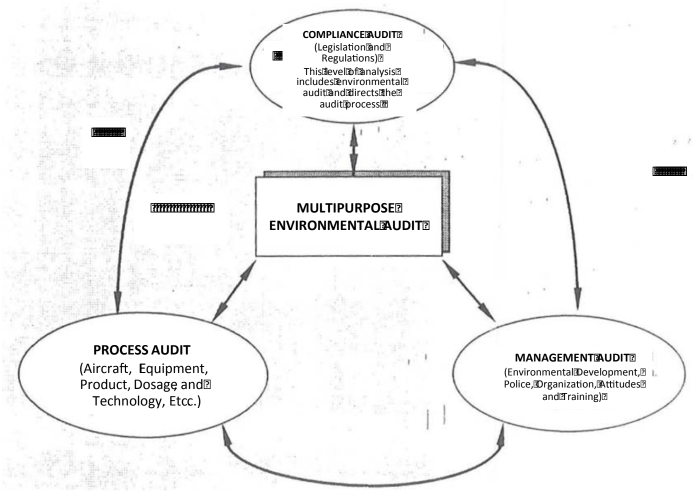
**ANNEX NO. 1**
**CHARACTERIZATION OF ENVIRONMENTAL EFFECTS**

| SPECIFIC SOURCE OF IMPACT | IMPACT | NATURE OF IMPACT |
|---|---|---|
| Tillage<br>• Preparing the ground<br>• Weeding<br>• Peals and hilling<br>• Pesticide Application<br>• Use fertilizers and correctives | Erosion | Increased fragility against internal exploitation<br>Increased sediment to streams<br>Reduced vegetation cover<br>Eventual mass movement (diffuse runoff) |
| | Contamination | Modification of chemical and physical conditions of the soil<br>Destruction of miorofauna<br>Migration of fauna species<br>Deterioration of water quality<br>Effects on the human quality<br>(Gastrointestinal diseases) |
| | Decreased food | Decrease and/or impoverishment of traditional agricultural activities |
| - Poppy Crop production<br>• Collection<br>• Storage<br>• Packing<br>• Marketing | Improvement Regional GDP | Employment generation<br>Increase family income<br>Waste of windfall profits<br>Increased local and regional inflation<br>Import of essential nutrients |
| | Violence | Lack of state leadership<br>Deteriorating law and order<br>Family dissolution<br>Increased criminal activity<br>Increased crime rates<br>Peasant migration<br>Socio-cultural deterioration |
| | Loss of values | Deterioration of the legal situation<br>Abandonment of moral values<br>Corruption<br>Administrative inefficiency<br>Increased individualism<br>Lloss of cultural values |

**Figure 3-1**
**Audit process**

| **Stage 1**<br>**Preparation** | **Stage II**<br>**Verification** | **Stage III**<br>**Execution** | **Stage IV**<br>**Assessment** |
|---|---|---|---|
| Information Collection and processing of coca areas<br><br>Planning aerial surveys for location of plots<br><br>Identifying sensitive ecosystems<br><br>IGAC Pre identification mapping | Detailed aerial reconnaissance, GPS location<br><br>Estimation of plots and total area<br><br>Selection of manual or chemical treatment: airplane or helicopter | Verification of eradication by fumigation operations, Site audit<br><br>Recognition equipment, product, and dose<br><br>Coordinate field record | Periodic monitoring of sprayed areas<br><br>Identification of environmental and ecological considerations<br><br>Verification of effectiveness of treatment Recognition site in plots<br><br>Report to DNE, Ministry of Justice and Anti narcotics Police |
| Planning stage | | Operation and evaluation phase | |

**Figure No. 3-2**
**THEORETICAL PRACTICAL CONTEXT OF ENVIRONMENTAL AUDIT**




eradication of illicit coca crops

TABLE No. 2-1
ACTIONS AND RECOMMENDATIONS - AUDIT OBSERVATIONS

| ACTION | RECOMMENDATIONS/OBSERVATIONS |
|---|---|
| AERIAL RECONNAISSANCE | • Should be permanent and, if possible daily<br>• Identification of crop and potential environmental risks<br>• Selection of treatment: manual, chemical (by plane or helicopter)<br>• Determination of problem regions (with crops) and estimation of area involved<br>• Checking mapping, Comparison of coordinates and local and/or province (approximate) jurisdictions |
| SPRAYING SIMULATION TEST | • Accuracy check on the application of the mixture, minimal drift<br>• Definition of minimal height of flight and identification of obstacles on the ground Maximum 10 to 12 feet above the ground for the planes<br>• Review of regional weather conditions and definition of daily range of fumigation, up to at 10 am<br>• Definition of plots to be fumigated according to the size, Plane for plots larger than 4.0 hectares and for helicopter between 2.0 - 4.0 ha. |
| DRIFT TEST | • Determination of operating conditions for Turbo - Trush aircraft<br>• Apply mixture of 17 gallons/Ha<br>• Glyphosate doses of 2.5 liters/ha of commercial product (1.2 kg/ha of glyphosate technical grade)<br>• Discharge pressure: 10-12 psi<br>• Optimal weather conditions: temperature ≤ 20º C, relative humidity ≥ 80%, Wind speed less than 2 miles/hour<br>• An extension of these parameters, see paragraph 2.5.2 |

Continued...

TABLE No. 2-1
ACTIONS AND RECOMMENDATIONS - AUDIT OBSERVATIONS

| ACTION | RECOMMENDATIONS/OBSERVATIONS |
|---|---|
| FUMIGATION BY HELICOPTER | • For plots between 2.0 - 4.0 Ha<br>• For lots located below 2,800 meters (8500 feet) in the case of the Bell 212 The Ranger max. at 2400 m.s.l. |
| FUMIGATION BY PLANE | • For plots larger than 4.0 hectares<br>• In plots at any level of altitude<br>• Keep nozzles open only on plots with poppy<br>• Register coordinates for each plot and make records using the PathLink Analyzer program<br>• Spraying only on preselected plots |
| EQUIPMENT AND PRODUCT CHECK | • Review approved dose (2.5 l/ha) mix In water<br>• Maintenance of nozzles and spraying equipment<br>• Check water quality used in the mix<br>• Maintain discharge pressure 10 to 12 psi |
| INTER-INSTITUTIONAL MEETINGS | • With regional and national entities<br>• With communities<br>• With international institutions |
| IDENTIFICATION OF ENVIRONMENTAL EFFECTS | • See paragraph 6. 1<br>• Notify the natural resource management agencies (INDERENA, Regional Corporations) about the environmental impact on biodiversity by deforestation in high-value ecosystems |

## Annex 22

### Colombian Law 30 of 1986,
### article 91, para. G, 31 January 1986

*(Official Journal* No. 37.355, 5 February 1986*)*

**Colombian Law 30**
(31 Jan 1986)

Implemented according to National Decree 3788 of 1986
Whereby the National Statute on Narcotics is adopted and other issues are ruled

[…]

Article 91. The National Narcotics Council has the following duties:

[…]

g) Provide for the destruction of coca, marijuana and other crops from which substances causing dependence may be extracted, using the most appropriate means, following the favourable opinion of the agencies entrusted with protecting the health of the population and the preservation and balance of the country's ecosystem.

## Annex 23

### Colombian Law 99 of 1993, articles 49, 52 and 117, 22 December 1993

*(Official Journal* No. 41.146, 22 December 1993*)*

**COLOMBIAN LAW 99 OF 1993**

Whereby the MINISTRY FOR THE ENVIRONMENT is created, the Public Sector in charge of management and preservation of the environment and renewable natural resources is re-structured, the National Environmental System –SINA- is organized and other issues are ruled

[…]

TITLE VIII

OF THE ENVIRONMENTAL LICENSES

**Article 49. Of the compulsory nature of the environmental license**: The executions of works, establishment of industries or the performance of any activity that, according to law and regulations, may cause serious deterioration of natural renewable resources or the environment[,] or introduce considerable or notorious modifications to the landscape will require an environmental license.

[…]

**Article 52. Competence of the MINISTRY FOR THE ENVIRONMENT**. The MINISTRY FOR THE ENVIRONMENT will exclusively grant the environmental license in the following cases:

1. Undertaking of works and activities for exploration, exploitation, transport, and storage of hydrocarbons and the construction of oil refineries.

2. Undertaking of large-scale mining projects.

3. Construction of dams or water-collecting areas with a greater capacity then two hundred million cubic metres and the construction of electricity generating plants that exceed 100,000 Kw installed capacity, as well as setting the transport cables of the electric interconnection national system, and exploration projects and use of virtually contaminating alternative energy.

4. Construction or expansion of deep-draft sea ports.

5. Construction of international airports.

6. Undertaking of public Works for national road, fluvial or rail networks.

7. Construction of irrigation districts for over 20,000 hectares

8. Production and importation of pesticides, and those substances, materials or products subject to control pursuant to international treaties, agreements, and protocols.

9. Projects that affect the National Natural Parks System.

10. Projects undertaken by the Regional Autonomous Corporations referred to in numeral 19, article 31of this law.

11. Transfusing of one basin into another of water streams that exceed two (2) m/s during low flow seasons.

12. Bringing into the country parent species for reproduction of fauna and wild flora foreign species that may affect the stability of ecosystems or wildlife.

13. Generation of nuclear energy.

**Paragraph 1**. The right to grant environmental licenses for construction ports will be applied without prejudice to the legal competence of the General Superintendence of Ports to grant port concessions. However, the environmental license is a pre-requisite to grant the port concession

**Paragraph 2**. The MINISTRY FOR THE ENVIRONMENT will grant a general environmental license for the exploitation of oil and gas fields, without prejudice to the capacity of the environmental authority to add or establish specific environmental terms required for each case, within the authorized production field.

[…]

**Article 117. Transition of procedures**. Permits and licenses already granted will continue to be valid through the issuance time period. The on-going administrative acts will continue its process before the authorities that take on its competence at the stage they are at. The regulations and competences established in the current law will enter in force immediately and will be applied upon issuing of the corresponding regulatory acts, when required.

## Annex 24

### NOTE FROM THE MINISTER FOR THE ENVIRONMENT, MR. JUAN MAYR MALDONADO, TO THE SECRETARY GENERAL OF THE COLOMBIAN SENATE, 10 AUGUST 2001

*(Archives of the Colombian Foreign Ministry)*

**MINISTRY FOR THE ENVIRONMENT**

Bogota, D.C. 10 AUG 2001

Mr.
MANUEL ENRIQUEZ ROSERO
Secretary General Hon. Senate of the Republic
National Capitol
City

Dear Sir:

I am enclosing the answers to the questionnaire sent to the Ministry for the Environment based on Proposal 04 approved by the Honorable senate of the Republic.

I hope to have solved all questions with regard to illicit crops and sprayings. However, if any additional information is required, we will gladly provide it.

Sincerely,

[Signed]
JUAN MAYR MALDONADO
Minister for the Environment

Encl.: As announced

MINISTRY FOR THE ENVIRONMENT

QUESTIONNAIRE TO THE MINISTRY FOR THE ENVIRONMENT

PROPOSAL 04

1. **What are the biophysical and biochemical effects of sprayings in the areas with illicit crops and on flora, fauna, and water sources nearby the sprayed areas**?

According to the information that the Ministry for the Environment has related to possible effects that may result from the application of Glyphosate for the eradication of illicit crops, under the country's environmental conditions, there is no evidence of biophysical and biochemical changes that affect the flora, fauna, and water sources structure.

Specialized international literature on physical and chemical aspects and ecotoxicology report as follows[1234]:

- Glyphosate is an herbicide that, just like any other pesticide, must be handled according to technical specifications recommended by the manufacturer and relevant authorities.

- The physical chemical characteristics of the compound, according to scientific studies, state that it degrades moderately by soil microorganisms action.

- During this period, the compound is absorbed by the soil, where it disappears thanks to the microbial activity, which prevents its displacement to underground and surface water.

- According to studies, Glyphosate disappears rapidly from water; it is absorbed by sediments and microbial activity. Based on literature in

[1] Ministry for the Environment. Some criteria for evaluation of Environmental Impact Studies. Bogota, 1.996

[2] The pesticide manual. The British Crop Protection Publishing Company. Tenth Edition. 1.994

[3] Pesticides Manual. Pesticides Program (Development, Health, and environment). EUNA. Editors Luisa Castillo. Universidad Nacional de Costa Rica. 1.995

[4] Internet EPA/Pesticides. "Reregistration Eligibility decision (RED), Glyphosate". September. 1.993

laboratory conditions it is slightly toxic for fish and aquatic invertebrates, without causing mass death in these species.

- Because of its low volatility, the product does not have any effects in air.

- The compound, being soluble in water and therefore little compatible with fatty compounds, has not been proven to accumulate in animal tissue.

- According to studies reported in specialized bibliography, the compound is classified as slightly toxic for mammals by oral and dermal route and by inhalation. It causes slight eye irritation in mammals.

- In studies reported by the industry, FAO, and WHO neither cancer effects, nor genetic mutations, are evidenced; no neurotoxic effects are suspected either.

- For other species such as birds and bees it is slightly toxic.

Now, in order to determine other adequate management measures to mitigate or control possible effects in the framework of the common natural conditions present where the programme for the eradication of illicit crops is implemented, the Ministry for the Environment by Resolution 341 required the National Narcotics Directorate to develop, among others, a Contingency Plan, an Inspection, Verification, and Control Programme, a Compensation Programme, and a Research Program for that purpose.

**2. According to Resolution 341 of 2001, the Spraying Programme does not have an Environmental Management Plan, why haven´t sprayings been suspended in virtue of the precautionary principle stipulated in Law 99 of 1993?**

To answer that question, it is necessary to make some clarifications before, namely:

Pursuant to provisions in paragraph g) [article 5 sic] of Law 30 of 1.986, it is the National Narcotics Council (CNE)duty to provide for the destruction of coca, marijuana and other crops from which substances causing dependence may be extracted, using the most appropriate means, following the favourable opinion of the agencies entrusted with protecting the health of the population and the preservation and balance of the country's ecosystem.

Following on the aforementioned, on 31 January 1.992, the CNE approved the aerial eradication method by use of chemical agent Glyphosate for the eradication of opium poppy and then it was extended to coca and marihuana crops.

Similarly, and in compliance with the aforementioned provision, the then called INDERENA (National Institute of Renewable Natural Resources, for its acronym is Spanish) by note dated 8 October 1993, ratified the acceptance of the action strategy set by the CNE "pointing out the importance that must be given to compliance with the specific and technical parameters established for the eradication process of poppy crops and that must be kept for eradication of coca and cannabis crops" and sustaining the observations made previously with regard to the "need to have an Environmental Audit for environmental supervision and control of the illicit crops eradication."

In its turn, the Health Ministry by note dated 11 October 1993, addressed to the Narcotics General Director, ratified the validity and convenience of the action strategy set by the National Narcotics Council, recalling that said Ministry submitted to the CNE a "Health Plan based on the epidemiological surveillance principles, which becomes, together with the environmental audit, a safeguard for human health and environmental protection."

There are also technical studies by the ICA -Colombian Agriculture and Livestock Institute- (Experimental phase in the application of Glyphosate for the eradication of sp cannabis in the Sierra Nevada de Santa Marta. June 20 1984, and experimental phase in the application of Glyphosate for the eradication of poppy crops. February 1992), in which it was concluded that Glyphosate herbicide and the equipment used for its application is effective to eradicate this type of crops and that no effects have been observed neither on vegetation nor on animals.

All this means that the aerial aspersion with glyphosate had the favourable opinion of the environmental authorities of the time and was in accordance with environmental regulations, duly supported in technical studies provided by the DNE and as well as those requested by the INDERENA.

Subsequently, the newly created Ministry for the Environment issued Decree 1753 on 3 August 1994, which in its article 38 stipulated that "Projects, works or activities that, in compliance with legislation in force before issuing of this decree, obtained the required environmental permits, concessions, licenses, and authorizations will be allowed to carry on, but the competent environmental authority may require, by means of a reasoned administrative act, the submission of environmental management, recuperation or restoration plans."

The provision transcribed above is absolutely clear in two aspects: first, it refers to those activities that had been authorized in compliance with legislation in force  issuance of the Decree, and second, the relevant environmental authority had the power to require an environmental management plan.

In other words, although the submission of the environmental management plan is compulsory, it is not a prerequisite for continual of the activity, which as has been said many times, was duly authorized in compliance with legislation in force.

In conclusion, the activity of aerial spraying with Glyphosate was duly authorized in compliance with the environmental legislation in force at that time; that is, Law 30 of 1986 and the Ministry for the Environment in application of the aforementioned article 38, by Order No. 558 of 1996 submits to National Narcotics Directorate –DNE, as the entity in charge of coordinating and managing such programme.

In compliance with the above, on 30 July 1998, the DNE submitted the requested document, without including Chapter VII on impacts identification, which was submitted in December that year.

By Order No 599 of 23 December 1999, upon evaluating the document submitted by the DNE, the Ministry for the Environment requested supplementation and broadening of the information based on the basic consideration that gaps detected in the information made it difficult to define necessary measure of  environmental control, prevention, compensation, and restoration to mitigate possible negative impacts of eradication.

The DNE appealed Order 599 of 1999, which was set by Order 143 of March 2000 and a 3-month term was given to submit supplementary information and the other requirements established in Order 599 of 1999 were ratified.

On 10 May 2000, the DNE appealed Order 143 of 2000 requesting extension to 12 months of the time period established to submit the additional information. That request was not granted and provisions set in the Order were confirmed.

On 13 September 2000, the DNE submitted the document "Supplementary information to the Environmental Management Plan for the Application Glyphosate Herbicide in the Eradication of Illicit Crops."

In December 2000, in a meeting held between the Ministry for the Environment and the DNE, it made a commitment to submit a more detailed document with regard to characterization and focused on impacts assessment and risk analysis according to what was requested in the terms of reference for the Environmental Management Plan foreseen in Order No 558/1996 issued by this Ministry, for Putumayo area, with a overall perspective for the whole country.

Subsequently, on 30 January 2001, the DNE submitted the document "Environmental Management Plan based on assessment of potential operation risk resulting from the eradication of illicit crops by spraying in Putumayo province."

On 4 May 2001, by Resolution No. 341 the Ministry for the Environment did not accept the Environmental Management Plan; reason why it demands immediate application of certain prevention measures so that they served, based on their development and results, as foundation for the Ministry to impose the Environmental Management Plan.

Lastly, the Ministry, by Order No. 516 of last 16 July requested the DNE to inform about the progress status and compliance with obligations set in the aforementioned Resolution.

**The precautionary principle**

The precautionary principle is founded on the essentially preventive nature of the action for protection of the environment[5] and it has been

[5] Juste Ruiz, Jose. Environmental International Law. Mc Graw-Hill. Madrid, 1999.

expressly set since 1982 in several international declarations. The definitive incorporation was set in principle 15 of the Rio Declaration on Environment and Development, according to which, "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

In Colombia, the precautionary principle[6], besides the international obligations that include it and that were ratified by the country, it was expressly incorporated in numeral 6 of article 1 of Law 99 of 1993, in the following terms: "Environmental policies making will take into consideration the result of scientific research process. Nevertheless, environmental authorities and individuals will apply the precautionary principle according to which, where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

According to the aforementioned, in the case spraying with Glyphosate, the Ministry for the Environment considered that the precautionary principle does not apply because based on the technical information contained in the environmental file there aren´t threats of serious or irreversible damage, as well as there isn't either absolute lack of scientific certainty regarding its environmental effects. As it has been stated in previous occasions, the technical literature on the active compound does not report evidence of serious and irreversible damage on the environment.

[6] Vienna convention for the protection of the Ozone Layer and its Montreal Protocol, Convention on Climate Change, Convention on Biological Diversity, among others.

## Annex 25

### NOTE 0001-1-928 OF 17 AUGUST 2001 FROM THE OMBUDSMAN REQUESTING A PUBLIC HEARING TO THE MINISTER FOR THE ENVIRONMENT ON THE PROGRAM FOR THE ERADICATION OF ILLICIT CROPS BY AERIAL SPRAYING WITH GLYPHOSATE, AND THE CORRESPONDING MINUTES OF THE HEARING, 24 AUGUST 2001

*(Archives of the Colombian Foreign Ministry)*

**OFFICE OF THE OMBUDSMAN**

Bogota, August 17, 2001 0001 -1 -928
Juan Mayr-Maldonado
Minister, Ministry of Environment
Calle 37 No. 8-40
Bogota

Dear Dr Mayr,

As part of the faculties conferred upon us by the Constitution and the law, it is of interest to the Ombudsman to hold a Hearing with regard to the program for aerial eradication of illicit crops with glyphosate, and part of the National Plan for the Struggle Against Drugs, 1998-2002.

With this Hearing, the Ombudsman's Office wishes to broaden its understanding as to the nature and scope of the program, and to unify criteria to guide the tasks of the various entities engaged in its development, and to become aware of the perception which the various sectors of society have of it.

With the contribution you have made in this field, I wish to invite you to take part in discussions to take place on Friday, 24 August 2001, at 2PM in the Auditorium of the Ombudsman's Office. In the attached document, please find a specification of objectives and the agenda for the Hearing, and the terms of reference for your intervention. I would be grateful if you could put your points of view in writing, and deliver the document on the day of the hearing. If you have any questions, please contact the Deputy Ombudsman for Collective Rights and the Environment, phone 3144000, extension 2324.

Cordially
(signed)
Eduardo Cifuentes -Muñoz
Ombudsman

[Page 1]

# OFFICE OF THE OMBUDSMAN

## OMBUDSMAN'S HEARING ON THE PROGRAM FOR THE ERADICATION AERIAL ERADICATION OF ILLICIT CROPS WITH GLYPHOSATE

### Background

Law 30/1986 gave the CNE the mission of "providing for the destruction of crops of marihuana, coca leaf and other substances and addictive substances, using the most appropriate means, subject to the favourable opinion of the bodies responsible for public health and the preservation and balance of the Colombian ecosystem". From that time on, the strategy for aerial eradication of illicit crops has been founded on the actions of the health and environment authorities.

In the 1991 Constitution, and subsequent legislation, health, the environment, sustainable development and biological diversity, amongst other questions, have become issues open to claims for the protection of fundamental rights, which demand effective mechanisms for protection from the State as a whole, and the materialization of those rights even in circumstances of exception, such as the aerial eradication of illicit crops.

### Objectives

To broaden understanding as to the nature and scope of the program for aerial eradication of illicit crops with glyphosate, based on knowledge of the criteria which guide the actions of State agencies in the design, execution and control of the program, and the perception of different sectors of society of the program.

[Page 2]

### Agenda of the Hearing)

*Opening*
*Part* 1 *Development of the program for forcible eradication of illicit crops*

1. Background to the program of forcible eradication of illicit crops through aerial spraying with chemical substances

### Organizational matters

*Participants and methodology*

The Hearing will have two types of participant: Representatives of public agencies that intervene in the design, execution and control of the program for the forcible eradication of illicit crops, and members of NGOs and private organizations

The various issues on the Agenda will be approached from the perspective of the type of participant Each exponent will have a maximum of 10 minutes to present a synthesis of his main proposals, with regard to the questions put by the

Ombudsman, with several days prior to the Hearing. Further to the oral presentation, each exponent will deliver the document which it is hoped will contain the greatest breadth and depth of argument and evidence to support the position of the position of the organization represented.

When the programmed interventions have been completed, other persons present will be invited to express their opinions on the issues on the Agenda, or the positions proposed by the various departments.

*Place and date*

The hearing will be held on Friday, August 24, 2001, at 2p.m., in the Auditorium of the Ombudsman's Office, Address Calle 55 No. 10.-32 Bloque A

[Page 3]

# OFFICE OF THE OMBUDSMAN
# HEARING ON PUBLIC POLICY FOR THE FORCIBLE ERADICATION OF ILLICIT CROPS

## Terms of reference

Proposers:
Julio Cesar Rodas, former Official of the office of the Public Service Procurator for Environmental Affairs
Juan Mayr-Maldonado, Minister of Environment

*Topic*
The actions of the environmental authorities in the program for the forcible eradication of illicit crops

*Aspects of interest*

The 1991 Constitution brings together a set of rights and duties which together formulate a right to a healthy environment. This formula, in addition to being an expression of popular will, also implies an option for forms of peaceful coexistence and development, and the project for the future of society.

Therefore, all decisions and actions of the State must share this sense, and must comply with the precept. In other words, the State as a whole has a duty to provide project effective protection to the environment, which entails a guarantee of diversity, and rational use of resources, and prevention and control of factors of environmental deterioration; in short, that sustainable development will be achieved.

For these purposes, the Constitution and law have defined several precise criteria of action, and provide mechanisms instruments for action which are differentiated depending on circumstances. This is the sense of the principle of precaution, and also that of planning, consultation, and environmental licensing, amongst others.

In this context, it is of interest to establish:

1. Is the program of eradication of illicit crops with glyphosate part of the transition regime provided for in Decree 1753/1994?

2. In the context of the program for the eradication of illicit crops with glyphosate, what is an Environmental Management Plan? What differences are there between the Plan and an Environmental Licence?

[Page 4]

**HEARING ON PUBLIC POLICY FOR THE FORCIBLE ERADICATION OF ILLICIT CROPS**

**Terms of reference**

*Topic* Environmental audit

*Aspects of interest*

1. Report on environmental audit made by the program for the eradication of illicit drug crops with glyphosate (functions pursued, and impact on the program), and progress in the definition of terms of reference for the contracting of environmental audit and inspection in the context of Resolution 5/2000 and Resolution 341/2001. Proposer, Gabriel Merchan, DNE.

2. Report on the execution of environmental audit contracts signed by DNE. Proposer: Dr Carlos Ossa-Escobar, Comptroller General.

3. Terms of reference for the technical audit and inspection in the context of Resolution 5/2000 and Resolution 341/2001. Expectations of the environmental authority, in accordance with precepts of the constitution and the law. Proposer: Dr Juan Mayr-Maldonado, Minister of Environment.

[Page 5]

HEARING OF THE OMBUDSMAN

1. Is the program for the aerial eradication of illicit crops with glyphosate registered as part of the transition regime of Decree 1753?

A. In accordance with Section g) of Law 30/1986, it is the duty of the CNE to "order the destruction of crops of marihuana, coca leaf and other substances and addictive substances, using the most appropriate means, subject to the favourable opinion of the bodies responsible for public health and the preservation and balance of the Colombian ecosystem".

Based on this, on January 31,1992, CNE approved the method of aerial spraying through the employment with the use of the chemical agent glyphosate to eradicate opium poppy crops, and this was subsequently it expanded to crops of coca leaf and marihuana.

Likewise, and following the same provisions cited, INDERENA, in a letter of October 8, 1993, ratified to DNE that it accepted the strategy of the action set by CNE in its communication of January 31, 1992, and repeated the importance of observers of specific technical regulations established for the process of crops of opium poppy, coca leaf and marihuana, and the need to have an environmental audit, to supervise and provide environmental control of the eradication process.

CNE, as the senior authority on policy on the illicit drugs, issued Resolution 1 of February 11,1994, approving aerial spraying with the chemical agent glyphosate to eradicate illicit crops, having received the pronouncement of INDERENA and the Ministry of Health, competent at that time to do so.

Given that the procedure was authorized prior to the creation of the Ministry of Environment, the environmental measures were covered by the transitional regime established by Article 38 of Decree 1753/1994, which establishes that project, works or activities which, in accordance with laws in force prior to the issue of this decree, had obtained permits, concessions, licences or authorizations of an environmental nature, as then required, might continue, but the competent environmental authority might require them, through motivated order, to present environmental management, recovery and restoration plans..."

[Page 6]

Therefore, this Ministry, in Order 558A of August 13, 1996, ordered the presentation of an Environmental Management Plan in accordance with the terms of reference given by DNE, as the body responsible for directing and administering that program.

This administrative instrument should contain the following points:

- Identification of impacts which the eradication program may cause to environmental, physical biotic and social economic components in the areas

selected
- Evaluation of the offer and vulnerability of ecosystems exposed to the action glyphosate
- Identification of critical, sensitive and environmentally important ecosystems, and national Nature Parks to be excluded from the program or to receive special management.
- Design of programs for follow-up and control of environmental aspects in the program

**2. In the context of the program for aerial eradication of illicit crops with glyphosate, what is an Environmental Management Plan? What difference is there between a plan and an environmental licence?**

A. An Environmental Licence is an administrative instrument through which the execution or development of projects, works or activities that may cause significant environmental impact or impact on renewable natural resources may be to be executed or developed.

This authorization is supported by a tool known as the Environmental Impact Assessment (positive or negative), specifying the impact that these projects, works or activities may cause to the environment, whether in relation to their proper or intrinsic characteristics, or location in areas of special management, or for reasons of vulnerability and sensitivity of the environment in which they are located. This assessment is made ex-ante, that is, prior to the execution of the project, basically in the prefeasibility and feasibility phases of the project, in order to evaluate their cost-effectiveness, and therefore take decisions with regard to the convenience or otherwise, as a function of variables all kinds such as technology, environment, social and economic considerations

The assessment of environmental impact is a tool which can be used at different points or instances in the planning, development and execution of projects, works activities, but in each case, the results are different. If the exercise is ex-ante, it means that a determination can be made whether the project can be undertaken or not, and if it can, what conditions, terms or obligations apply; if it is made during the project or exposed, and the intention is to adjust the that different conditions or measurements of environmental management provided for, in order to exercise effective control on the impacts caused; and in this latter case, it is the basis supporting the environmental management, recovery and restoration plans of the activities in the transition regime.

In consideration of the foregoing, the Environmental Licence should be required only for projects, works activities which are projected into the future, and not projects, works or activities which are already being undertaken, since there is a presumption of legality that such projects, works or activities must have started execution under the legal and administrative rules then applicable, and because the decision to undertake them was taken at the appropriate time, and therefore the correct course is to review performance and adjust it, as a function of the various impacts generated, should they not have been foreseen during the planning phase.

Therefore, the Environmental Licence as an instrument is a development of the obligation of the State to secure development planning, for the purposes of controlling deterioration of the environment.

It is illogical to require an Environmental Licence for an activity which is already in progress, since the environmental studies which support an Environmental Licence are designed in the first instance to determine whether the activity can be undertaken; and then, if it is possible, on what conditions of environmental management, for the purpose of controlling impact or managing it in such a way that it may be possible to make a cost-effective weighting of the convenience or otherwise of undertaking or developing the project, work or activities.

Now, in relation to project works activities in the transition regime, that is, those which were already in progress in Colombia prior to 1993, the intention in regulations, and in scientific techniques (Assessment of Environmental Impact) is the possibility of making a review of the conditions under which the activity is being pursued, in order to adjust those conditions through an Environmental Management Restoration or Recovery Plan, but never in terms of demanding an Environmental Licence.

The Environmental Management Restoration or Recovery Plan for activities in the transition regime aims, as its name suggests, to determine (subject to express review and assessment of the kind already adopted), and to define measures of environmental recovery or restoration management, as the case may be, so that the project, work or activity will meet the new requirements of an environmental nature, in order to manage environmental impacts which as it has not been possible to control or mitigate.

This implies that the activity of is already in progress, and that it will continue to be developed. Nonetheless, if the environmental authority, after a review of actions taken, considers it convenient to adjust the environmental management measures which are being applied to the activity, it may demand that this be done, and the future development of the activity must be re-planned and re-adjusted, with regard to the relevant points, in order to adapt to new legal requirements.

That is to say, the activity must be the object of new planning actions in order to correct the impact of the impacts being caused, but in that instance, there is no option to take decisions such as to proceed or not with developing activity, since the activity is part of the transition regime.

**(See attached chart)**

**3. In the absence of an Environmental Management Plan or Environmental Licence, how has control and supervision been exercised over actions undertaken in the context of the program for aerial eradication of illicit crops with glyphosate?**

A. The following follow-up and monitoring activities of the program for the eradication of illicit crops are set forth in CNE Resolution 1/1994 and Resolution 5/2000, for implementation by a technical audit.

Likewise, Ministry of Environment Resolution 341 of May 4, 2001, establishes a series of preventive measures designed to secure appropriate environmental management of the eradication of illicit crops.

With regards to attention to complaints:

- A request has been sent to the competent CARs, to make verification visits and send in reports about complaints
- DNE and DIRAN have been asked for information with regard to activities undertaken in places where complaints originate
- Complaints which are not of an environmental nature have been sent to the competent authorities
- A proposal has been made to the need to improve the processing of complaints currently managed by DIRAN.

Further, the following activities have been undertaken:

- Reactivation of the meetings of the inter-institutional Technical Committee for the program of eradication of illicit crops, to adjust itself to technical and environmental procedures.
- A proposal has been made to amend CNE Resolution 1/1994.
- A proposal has been made to contract a technical audit, which will be external and independent of the entities engaged in the program

**4. In the absence of an Environmental Management Plan or Environmental Licence, how has the right to participation and the State's responsibility for planning been guaranteed?**

A. Given that the development of an activity is an integral action which involves environmental, social and economic impacts, in which environmental management is only one part of the whole, civic participation in this type of project, in addition to administrative instances as such, can be exercised with the environmental authorities if they are in order; and there are other instances of participation of a general nature, as described below.

If an Environmental Licence is to be a requirement (that is, if in the case of new projects, works or activities), the instances of participation before the environmental authorities, in accordance with the law, are: the right to intervene in the administrative action, the right to request public hearings, subject to compliance with requirements of law, prior consultation in the case of projects which affect ethnic communities, and the right to make petitions for information and consultation.

With regard to civic participation in initiative process of an environmental nature arising with the involvement of the Ministry of Environment, the exercise of this right has been guaranteed as follows:

The file related to the program for the eradication of illicit crops through spraying with glyphosate (No. 793), has been consulted by all persons who have made a request to do so, taking account of the fact that the files passing through the Ministry of Environment are of a public nature.

The right to intervene in Environmental Administrative Proceedings has been applied, and in effect has been exercised in relation to the file in question, consulted by the Ombudsman, FUNDEPUBLICO, Claudia Sampedro and Hectgor Alfredo Suárez-Mejía, who were recognised as third parties intervening in the process, and who had been served notice of the respective orders based on the recognition under Articles 69, 70 and 71 of Law 99/1993.

During the environmental administrative process pursued in this Ministry, a request from the Ombudsman has been studied with regards to the holding a public hearing.

Likewise, the various petitions for information presented by authorities and private individuals in general have been attended to, in relation to the process of the project in question (Article 74, Law 99/1993).

Although planning is an ex-ante-exercise, that is, it is prior to the taking of a decision to execute what is planned or not, it is also a dynamic action over time, especially where the environment is concerned, since the tools of evaluation of environmental impact allow planning of the project to be adjusted so that the impacts which may potentially be caused (ex-ante-evaluation) may be adjusted to the impacts which are actually produced, and to the results which measures for management, control and mitigation (evaluation exposed) that have been adopted, in order to produce adjustments and re-planning.

In accordance with the foregoing, the State is guaranteeing the planning of the use of natural resources in all cases, whether in the form of a demand for an Environmental Licence, or with the production of Environmental Management

Plans, because in both cases, there is insistence on evaluation, whether before or after the environmental effects of action, in order to determine that they be foreseen or corrected, as the case may be.

At the same time, the Stated duty to plan in the program of the for the eradication of illicit crops is also provided for in CNE Resolution 1/1994 and Resolution 5/2000, with regards to the preliminary procedure required prior to the implementation of eradication of illicit crops.

Ministry of Environment Resolution 341 of May 4/2001, establishes some obligations for account of DNE, designed to in relation to the planning of activities, and the creation of mechanisms for dissemination to the communities (Articles 5 and 9)

It is important to clarify that the pursuit of aerial spraying activities for the eradication of illicit drug drugs crops with glyphosate is part of the National Policy for the Struggle Against Drugs, known as the "National Plan for the Struggle Against Drugs Colombia 1998-2002".

In consequence, this National Plan for the Struggle Against Drugs Colombia 1998-2002 is the framework on which the Colombian State will, with the concurrence of government agencies, NGOs, the organized community and the population in general, mount a comprehensive fight against the causes and manifestations of the problem of drugs.

## WHY AN ENVIRONMENTAL MANAGEMENT PLAN AND NOT AN ENVIRONMENTAL LICENCE?

| ENVIRONMENTAL MANAGEMENT PLAN | ENVIRONMENTAL LICENCE |
|---|---|
| The Plan gives details of actions required to prevent mitigate, correct and compensate for possible negative environmental impacts caused in the course of the activity. Includes plans for follow-up, evaluation and monitoring, and contingency plans (Article 1, Decree 1753/1994) | Authorization delivered prior to development of the activity, which in accordance with law or regulation may produce serious deterioration to natural resources or the environment, or introduce substantial changes to the landscape. The license establishes requirements obligations and conditions which the beneficiary must observe in order to prevent, mitigate correct or compensate the environmental effects of the activity (Article 49, Law 99/1993, Article 2, Decree 7053/1994) |
| As under Section 38.1 of Decree 1753/1994, projects which are obtained environmental authorizations formerly required may continue, but the environmental authority may issue a motivated decision ordering the presentation of an Environmental Management Plan (Order 558 A/1996). | Section 38.3 of Decree 73/1994 states that activities initiated prior to Law 99/1993, do not require an environmental licence, but that this is no bar on compliance with environmental regulations. Further, Article 52 of Law 99/1993, establishing the exclusive competency of the Ministry of Environment to grant Environmental Licences, did not provide the activity of eradication of illicit crops with glyphosate as an activity requiring an Environmental Licence |
| In a decision of the Council of State of October 27,1995, in Section 1, Administrative Disputes, taking account of Section 91 g) of Law 30/96 and Article 38 of Decree 1753/1994, concluded that "the activity of eradication of illicit crops is governed by the transition regime, and in order to implement it, CNE must comply with the regulations applicable at the time, and in the opinion of the Council of State, there is no breach of Law 99/1993 or provisions of the Constitution invoked by the claimants, and therefore in decision for the execution requested is not in order[11]. | Section 91 g) of Law 30/1986 states that CNE will order the destruction of illicit crops subject to the prior and favourable opinion of the entities responsible for the preservation and equilibrium of Colombia's ecosystem (Ministry of the Environment), and the health of the public (Ministry of Health), and not subjectto the obtaining of an Environmental Licence. |

CONCLUSION: the destruction of illicit crops by spraying with glyphosate was initiated and authorized prior to the creation of the Ministry of Environment (CNE Resolution 1/1994), INDERENA opinion of October 8,1993), and for this reason, the activity does not require an Environmental Licence but does require an Environmental Management Plan in accordance with the terms of Article 38 of Decree 1753/1994, shared by the Council of State. At the same time, account should be taken of the fact that both the Environmental Licence and Environmental Management Plan are instruments designed to prevent, mitigate, correct and compensate the negative impact of inactivity. Neither Article 52 of Law 99/1993 nor Article 7 of Decree 1753/1994 states that the application of pesticides requires an Environmental Licence, and therefore the aerial spraying with glyphosate is not an object of Environmental Licensing.

## Annex 26

**NOTE N° 01888 FROM THE NATIONAL NARCOTICS DIRECTORATE (DNE), APPEAL SUBMITTED BY DNE, OF ORDER 599 OF 1999 FROM THE MINISTRY FOR THE ENVIRONMENT, 1 FEBRUARY 2000**

*(Archives of the Colombian Foreign Ministry)*

REPUBLIC OF COLOMBIA

*Ministry of Justice and the Law*
*National Narcotics Directorate*

Santafé de Bogotá D.C. 01888 FEB 01

**GUILLERMO ACEVEDO-MANTILLA**
Deputy Director of Environmental Licenses
Ministry of the Environment
Bogotá. D.C.

**RE**: Transfer Order No. 599 of December 23, 1999

**GABRIEL MERCHAN BENAVIDES**, of age, residing in this city, identified with Id. card No. 3.226.822 from Usaquén, in my capacity as National Narcotics Director, a position for which I was appointed by Decree 1362 of July 23, 1999 and sworn in by Minute 380 of August 20, 1999, through this writing and still within the legal term, do lift the transfer of the Order of the reference based on the following:

**WHEREAS**

In connection with the statement made by the Ministry for the Environment on the request of attaching Chapter VII of the Environmental Management Plan (Identification and Assessment of Environmental Impact) by official letter dated November 13, 1998 for not having been included in the initial submission, we clarify that the Environmental Management Plan document was presented in its entirety to Office of the Deputy Director of Environmental Licenses on **July 30**, 1998, as recorded in official letter No. **11430** of the National Narcotics Directorate.

**1. On the Opinion of ICA: Aspects of the Management Plan.**

**Page 6**

The request for the Environmental Audit payroll does not apply since this request is out of context given that the purpose of this evaluation is the Environmental Management Plan for the eradication of illicit crops with glyphosate.

[ Page 1]

The ICA calls into question the effectiveness of spraying aircraft, including the eradication program. The most striking demonstration to evaluate the effectiveness of the aircraft is sampling or verification conducted on the coca fields sprayed with Glyphosate. Based on the verification protocol signed by the governments of Colombia and the United States to evaluate the effectiveness of the applications, such activities have been developed and have shed efficiency above 90%. Engineer agronomist Orlando Briñez (ICA official) attended the verification protocol conducted in October 1999 and endorsed the effectiveness of the application, as recorded in the minutes of the Anti-Narcotics Police signed on October 20, 1999 (see attached copy).

**Pages 9 and 11**

Reconnaissance activities of illicit crops have been developed regularly, and the various state entities have been extended invitation to participate. Suffice it to say that officials from the Ministry for the Environment, Plante, National Parks and Attorney General's Office were invited to the Air National Census of illicit crops developed in March 1999. This same process is currently being developed with the interagency participation of such entities.

The spraying of illicit poppy crops was authorized by the National Narcotics Council in January, 1992, based on Resolution 001 of 1994. The spraying of illegal poppy crops commenced at that time.

Information on the license issued by the ICA for the purchase of the herbicide glyphosate was obtained based on the product listings authorized by the ICA, and by opinion of the Ministry of Health.

**Pages 14 and 18**

It should be noted that the Program for the eradication of illicit crops is a sui generis program and that it is very difficult to apply the methodologies developed for commercial agriculture aviation to illicit crop eradication. The parameters considered in commercial agriculture cannot be applied to the program of eradication of illicit crops. For these circumstances we have developed new methodologies, techniques and systems to make the application of herbicides in extreme conditions safe (altitude, speed, stroke, obstacles, etc.). These practices are in constant research and adjustment due to the particular operating conditions.

[ Page 2]

On flight altitude. As is well known, illicit crops are located in varied landscapes, variations in topographical conditions and many plots have obstacles, in addition to the danger of the drug dealers, which makes it impossible for the operation to have fixed parameters. It is important to remember that these are not plots of rice, cotton and bananas that are being sprayed, where the conditions for spraying are uniform and there are no obstacles. However, with a variable range in altitude the spraying of illicit crops has been a success.

Speed of the aircraft. In Chapter III, paragraph 4.47, the speed range of operation is regulated, depending on the type of crop to be sprayed. While theoretically the discharge may vary with the speed, the aircraft now have an electronic valve that controls the flow of output, allowing regularity in the application.

The methodology used for the calibration of equipment is the one described in the manuals published by CIBA-GEIGY. Due to technological improvements, currently the equipment is calibrated with "Satloc" software, which is electronic calibration.

To clarify the above ICA inquiries, attached are a letter and documents "Experimental Protocol Criteria" and "Testing of Equipment Calibration Protocol," which contains all the results of tests performed by the firm Sociedad las Palmas Ltda., at the request of the consultant who ran the study.

The firm Sociedad las Palmas Ltda. delivered to ICA a report containing the original data, tables, copies of the Records, etc., data that is contained in Annex F of the Environmental Management Plan, which were not evaluated by ICA (see copy of the cover letter). It is clarified that these results lie in the offices of the Ministry of the Environment in the volume ANNEXES of Environmental Management Plan.

**Page 19**

It is clarified that the herbicide Glyphosate is purchased directly from the Monsanto Company, which is the company that is licensed to market the product and is responsible for the sale and relevant paperwork. The Anti-Narcotics Police purchases the commercial product, as would anyone else.

In connection with the information in Table 3.3 of the Environmental Management Plan Chapter III, the mixture applied to the treatment of illicit coca crops …

[ Page 3]

… is 23.65 L/ha, it is clarified that due to a clerical error a different figure appears (50 L/ha).

The agrochemical products manufacturers recommend dose ranges, according to the plant species treated. Because the manufacturer does not recommend dose for the treatment of the coca plant species, the eradication program, based on applied research, determined the effective dose for the control of coca crops.

It must be remembered that the manufacturer says on the label, "The manufacturer guarantees that the product matches the technical specifications of this label but does not assume responsibility for the results obtained, whether or not the suggest is dose used" because the operation is out of its control.

If ICA has a recommended dose for the control of illicit crops, it would be desirable that it suggest or recommend it for use in the Program.

**Page 20**

The volume ratio of glyphosate, water and surfactant, can be seen in the table below.

**COMPOSITION OF THE MIXTURE PER HECTARE FOR THE CONTROL OF ILLICIT COCA CROPS**

| Component | Liters |
|---|---|
| Glyphosate | 10.40 |
| Cosmo-Flux 411F | 0.23 |
| Water | 13.02 |
| **Total mixture** | **23.65** |

**Page 28**

We believe that if the product was approved by the Ministry of Health and the ICA, the multitude of studies made on these issues should not be ignored; they clarify the behavior of the herbicide in different media and were at the time evaluated by such institutions before granting the appropriate license for its marketing in Colombia.

[ Page 4]

**Page 65**

In connection with the information in Table 3.3 of Chapter III, the mixture applied to the treatment of illicit coca crops is 23.65 L/ha; it is clarified that due to a clerical error, a different figure appears (50 L/ha).

It is important to bear in mind that the combination of different types of nozzle diameters and variation in the number of these perfectly makes possible the calibration of a discharge. What is ultimately sought in a calibration is that the total flow per area be uniform.

**Pages 70, 71 and 72**

These issues are clarified in the attached document, Equipment Calibration Test, which describes the methodology and results of these tests.

**2. On the Opinion of the General Ecosystem Directorate - Ministry for the Environment**

**a. Chapter II: Background**

This chapter presents the historical review of the actions taken by the program in accordance with the policies and priorities emanating from the national government, in terms of eradication efforts since the year 1987. ANNEX B of the study presents the tables listed y province and municipality from the year of 1992 for the poppy crop and since 1994 for the coca crop.

The criteria which take into account chemical eradication are those defined in previous studies for the selection of the herbicide glyphosate in phases I, II and III as shown in Chapter II, paragraph 4.

Besides that and overriding the above are the decision criteria of the State to exercise the drug policy referred to in the Master Plan for the fight against addictive substances, through the following four plans:

- National Control and Enforcement Plan
- National Plan for Prevention, Treatment and Rehabilitation
- Information and Logistics Support Plan
- National Plan for replacement of illicit crops

[ Page 5]

There are also some legal grounds set forth in the national law, which criminalizes activities related to illicit crops.

This is included in Chapter II, paragraph 2.

The coordination of the program's actions is defined in the previous plans and laws of the Republic, which define the responsibilities of each institution against combating the drug problem. In addition, the CNE defines the policies and strategies to be developed by members of the CNE as outlined in Chapter III, paragraph 1.1 Program Management and Administration, which defines the functions and duties of the National Narcotics Council (CNE), the National Narcotics Directorate (DNE) and the Anti-Narcotics Police.

The convenience and advantages of the use of a chemical alternative is considered by the lower risk of toxicity attributed to the herbicide glyphosate in accordance with the provisions of Chapter II, paragraph 4.1.1, Table No. 2.5 and, due to the magnitude of the areas seeking to be controlled.

**b. Chapter IV. Identification of the Area of Reference**

Criteria for the selection of nuclei chosen in this study are listed in Chapter III, Project Description.

The problem of establishing illicit crops has expanded to a large part of the Colombian territory. Thus, the national government through the CNE has defined areas where there is greater activity of illegal crops and it is there, where the program is applied with the highest priority. The geographical area of each nucleus is defined by the altitudinal distribution where illicit crops are developed. So for poppy, it covers a range from 1,800 to 3,500 m.s.l. and for coca, lower altitudes to 1,200 m.s.l. It is on this area of influence where direct environmental impact in the natural (biophysical) environment is caused. However, this impact is reflected or enhanced on the socio-political and cultural context of the surrounding communities. Therefore, and according to official letter 04 dated January 7/98 (appendaged hereto) addressed to Dr. Eduardo Verano de la Rosa from the Study Director, the considerations or criteria for the definition of the representative areas considered for the study were sent. These criteria appear in Chapter VI: Analysis of Field Tests, section 2.2 Ecosystem Representativeness Criteria.

[ Page 6]

This official letter requested approval of the representative areas and sample sites previously discussed with Dr. Juan Diego Peña, Program Coordinator of the Illicit Crop Eradication of the Ministry for the Environment. Since there was no response thereto, an administrative silence in favor of the DNE was established.

It is important to note that by letter No. 05/98 dated January 7/98 addressed to Dr. Carlos Mario Hoyos, Acting Director Sustainable Development of the Ministry for the Environment (attached hereto), we requested a meeting with Ministry for the Environment officials, the consultant and other stakeholders, to define the scope of the terms of reference. The meeting was actually held on January 16, 1998 at the offices of the Ministry for the Environment and in letter No. 06/98 dated January 21 (attached hereto) addressed to Dr. Juan Diego Peña, Program Coordinator of Illicit Crop Eradication - Ministry for the

Environment, we sent the record of the most relevant results of the meeting of January 16/98.

The cartography was drawn to the scales that were available for these areas in the Agustín Codazzi Geographic Institute of Colombia - IGAC. The country's shortcomings in this area are no secret. The study did not include the production of new or updated base mapping as this requires aerophotogrammetric restitution.

Because illicit crops are distributed in buffer areas of National Parks and even within them, in any area of the country, it was considered prudent to include these areas in each representative area to show the impact that they may be causing. But there is no indication in any section of the study that there would be eradication of illicit crops by chemical means in these parks.

Also, there, in the areas that are either barren or farther removed from the urban or agricultural nuclei, is where illicit crops are established in order to prevent the action of the authorities and with the knowledge that these are areas that, due to their special control status, prevent eradication by chemical means or methods.

The management plan to be applied in communities that are located within National Park areas refers to the cultural aspects covered here.

**c. Chapter V: Environmental Characterization (physical and biotic components)**

[ Page 7]

The preparation of this chapter followed the guidelines set forth in the terms of reference for each item considered, at the level of a framework of regional physical biotic zoning. In this sense it is good to remember that illicit crops are scattered throughout the biogeographic area with potential to sustain them, and therefore, to specify the baseline at a very detailed level would involve virtually the entire national territory, which was not the object of this study. For this reason, at the meeting of January 16, 1998 at the premises of Ministry for the Environment, chaired by Dr. Juan Diego Peña, Program Coordinator for the Eradication of illicit crops - Ministry for the Environment and consultants, the scope of the study was defined. At that meeting it was indicated that "... the emphasis of the evaluation will be based on assessment of environmental and health risks from the handling and application of the herbicide. The starting point will be the information available in the technical literature, analyzed for the conditions of application– characteristics of the receiving ecosystem–" Other points considered can be seen in the official letter dated No. 06/98 January 21/98, annexed hereto.

Chapter VI in paragraph 7 presents the geotechnical risk analysis, which is reflected in the respective EMP geotechnical risk maps CI - VI - 12, 13, 15, 15 at scales of mapping available on the IGAC, and authorized by the general commander of military forces since it is restricted material.

According to the recommendation proposed by the Ministry for the Environment, of the exclusion of some areas of the country of the chemical eradication program virtually most areas of illicit crop eradication program would be excluded, which would be greatly considered by growers and drug traffickers.

**3. On the Opinion of the Deputy Office of Planning and Management of the National Parks Special Administrative Unit:**

**Point 1**

The supply and vulnerability of the ecosystem is included in Chapter V paragraph 1: Physical-biotic Component. The vulnerability and supply are included in various issues included in the baseline.

**Point 2**

In the Chapter cited above, paragraph 1.5, the critical, susceptible or environmentally significant ecosystems are itemized for each nucleus and in section 1.5.7 Plant biodiversity, these areas are spelled out in general terms, and the status of management of critical areas are specified (section 1.5.7.4).

[ Page 8]

**Point 3**

The actions in the Environmental Management Plan must obey an integrated and coordinated action of various state institutions under the **coordination** of the DNE, which is clearly explicit in Chapter VIII paragraph 1: Introduction. However, the DNE may clarify or expand these competencies and may set a model of inter institutional coordination to define budgets, schedules and competency.

Currently in the coordination framework established for implementing the National Plan to Combat Drugs 1998-2002, through the Management Units for each of the six strategic objectives, DNE has embarked on a process of inter-institutional agreement, which defined strategic plans for four years and annual operating plans. In each of them, strategic actions, responsible parties, resources and indicators for monitoring and evaluating compliance with activities were identified.

**Point 4**

As special control areas administered by the National Parks Unit, this unit is responsible for implementing the eradication of illicit crops, since these areas–from a legal standpoint–cannot be the object of forced eradication. It should be noted that the Environmental Management Plan is for the application of glyphosate in the eradication of illicit crops and therefore, at no time, either in earlier times, or today, or in the future, will the DNE program consider intervention to eradicate illicit crops by chemical methods.

**Point 5**

The DNE, in coordination with the Special Unit of the National Parks, may establish the special eradication strategies that are relevant, because after the delivery of EMP to the Ministry for the Environment, manual eradication programs in concert with communities affected by this scourge have been agreed upon.

**Point 6**

[ Page 9]

Answered in Paragraph 1 subparagraph b, of this document

**Point 7**

Answered in Paragraph 1 subparagraph b, of this document

**Point 8**

What is expressed there is not understood; however, we clarify that the monitored areas had been previously sprayed.

**Point 9**

The mandatory parameters established for the operation to eradicate illicit crops are in accordance with the laws of pesticide use in Colombia (Decree 1843/91). APPENDIX B of the study reiterates that obligation.

**Point 10**

These statements are not true since areas of the National Parks have never been sprayed unless the Ministry for the Environment has evidence to support this comment.

The DNE reiterates that it is complying with paragraph 8 of resolution 0001/94 concerning that the eradication of illicit crops in special management areas and natural reserves will be done by mechanical and manual character process. When deciding to perform such operation it will be agreed with the Ministry for the Environment.

It is inadmissible that actions are undertaken and project financing occurs for productive sustainable alternatives in special reserve areas and national parks, as stated by the Ministry for the Environment, since is strictly prohibited by Colombian law. Furthermore, it would encourage growers of unlawful crops to invade special reserve areas. In this sense the Ministry for the Environment through the Special Unit of National Parks should apply the penalty in force for this type of situation.

**Point 11**

We reiterate that EMP does not consider the chemical method applicable with glyphosate in national parks areas.

[ Page 10]

**Point 12**

This is not true; the level requested in the terms of reference of the environmental characterization is broad and sufficient for the aims of the study. The ecosystems present are identified for each media.

The selection of the sample sites was defined in agreement with the Ministry for the Environment as expressed in paragraph 1 subparagraph b of this document. The multitemporality study suggested by the Ministry for the Environment is not appropriate since it is not covered by the terms of reference for this study.

The environmental impacts of glyphosate herbicide application were evaluated as shown in Chapter 7: Impact Identification and Assessment. These impacts are applicable to the areas of national parks, special reservations as well as the unprotected areas.

**4. On the Clarification Opinion of Deputy Office of Planning and Management of the National Parks Special Administrative Unit**

The formulation of measures referred to in the EMP by the relevant Records are applicable to the national parks system.

**5. On the Opinion of the Office of Environmental Education Citizenship Participation and Population.**

**Point 1, section A**

Table No. 7.7 of Chapter 7 describes the impact caused by the implementation of the specific and particular program at the levels:

- Social - family
- Service infrastructure
- Education
- Community Participation
- Employment
- Social - security
- Economic
- Alternative development

While it is true that eradication affects important indicators, the Program, in light of Colombian law, cannot assume the full …

[ Page 11]

… social costs in areas with illicit crops because they are derived from an activity that is illegal.

However, in the framework of a comprehensive global action, the National Plan to Combat Drugs 1998 - 2002, provides for alternative development as a long-term policy, and one of the central pillars of the current policy of peace, aimed at restoring the legality of marginalized populations and prevent the expansion of subsistence farming. In this sense, it helps to promote the conditions for economic and social development and environmental management, with the purpose of linking areas affected by illicit crops to regional and local development.

It is clear that the Colombian state policy against illegal crops is differentiated according to the extension and purpose of crop cultivation, that is, its type or category; for industrial or extended crops, forced eradication is planned by aerial method or manual eradication, and as noted above, for the farmer and indigenous subsistence economy, alternative development is scheduled.

As for Record 21 “National and International Cooperation and Alternative Development for Illicit Crop Substitution,” it is part of a global and comprehensive perspective on the drug problem. In this regard, the Record proposes strategic actions by major components aimed at achieving international cooperation resources to intervene in the problem of illicit crops, from a perspective of sustainable development that addresses economic and social issues to promote in the affected areas of farmer and indigenous economy.

**Point 1, section B**

The DNE is the Colombian state agency that governs and is responsible for the coordination process for planning, implementation and monitoring of drug policies through management units, interagency and management teams, provided for each of the strategic objectives aimed at intervention in this problem.

Specifically, regarding the problem of illicit crops, there are three strategic objectives which are linked and are complementary, namely an alternative development policy, aimed at the illicit crops of farmer and indigenous economy, environmental management policy aimed at promoting ecological conservation and integral sustainable development in regions of…

[ Page 12]

… illicit crops and high risk of incidence, and technical and controlled actions to eradicate illicit crops by hand or air.

Each strategic objective has an agreed interagency plan with activities, responsibilities, resources and management indicators.

**Point 1, section C**

According to the drug policy in Colombia, it is the National Narcotics Council (CNE), who sets the strategies. Plante is part of the CNE, as a permanent guest. All forced eradication programs and Plante’s programs in common areas are properly agreed. Proof of this is the interinstitutional agreement with the Guambiano community, and the current process underway with the Yanaconas, among others.
Also answered in Point 1, section b.

**Point 2**

Agreements with the communities product of the 1996 farmer marches are agreements for which the National Government at the time created the Southern Management for monitoring and, in the different assessments, the government has always demonstrated compliance. It is also important to understand that the only agreements signed were made in the provinces of Putumayo and Caquetá and social and infrastructure investment present in the agreements was made through the various State institutions involved in each of the components listed.

**Point 3**

The Ministry for the Environment interpretation does not correspond to reality, since the owners of large or industrial crops are directly financed by the powerful drug barons, deriving their profits at the expense of national heritage. In these large plots there are no food crops planted. Farmers and settlers have smaller crops, not object of spraying because of the agreements of the farmer marches in 1996.

**6. About the Requirements:**

**Point 1**

The problem of combating the drug problem in Colombia is such that the struggle is comprehensive and inter institutional, as …

[ Page 13]

… envisaged in the **National Plan to Combat Drugs**. This way, all state institutions are committed and responsible, according to their objectives, to advance the programs proposed in the Environmental Management Plan.

Based on decree 2159 of December/92, it is DNE responsibility to execute the decisions of the National Narcotics Council, and to coordinate the development and implementation of national government policies on the control, prevention and suppression of narcotics. As such, to manage the commitment of institutions and define together the budgets for implementation. Also answered in Point 1 subparagraph b.

**Point 2**

EI alternative development (Plante) is a permanent guest of the regular meetings that the CNE develops, where they set policies and strategies. Permanently, they approve, with the municipal and provincial authorities, the necessary agreements with both farmer and the indigenous communities.

**Point 3**

The information analyzed in this study concerning municipal development plans is limited by the absence or decontextualization of the current problems. These plans are very poor in design and analysis of municipal issues.

The development plans consulted were designed in order to comply with a legal term but not to solve the existing problems. Chapter II: Social Component clearly indicates the difficulties in achieving basic information to enable a more comprehensive analysis. However, an analysis was performed on the subject according to the request in the terms of reference and depth that the study period allowed.

**Point 4**

DNE was not required to submit a design of a citizen oversight program to ensure a monitoring plan for the Social Management Plan (SMP), because this subject is not included in the terms of reference.

**On this it is decided**

[ Page 14]

**Article 1, point 1**

A reasonable term is requested to supplement those aspects that are required, following the resolution of this appeal for reconsideration. For this, the DNE suggests a meeting with the Ministry for the Environment to reach an agreement on the scope of each point considered, as well as the terms and time required. Also, mapping handled by the Ministry for the Environment will be confronted with that presented in the study to verify the geographical location of sampling sites.

**Article 1, point 2**

It is reiterated that the extensions of the national parks in the Program are not being fumigated by aerial spraying. Also, it is clarified that there has been no manual or mechanical eradication. The DNE will send the standing information on the existence of illicit crops in these extensions in order for appropriate action to be taken.

**Article 1, point 3**

Efficacy trials are conducted by the Narcotics Police and they deliver the full reports to the ICA for evaluation.

Adjuvants are compounds properly registered with the ICA. When asked about this, Monsanto believes its use is possible. These adjuvants are specific for glyphosate as registered in their labels, duly authorized by the ICA.

The technical criteria for adjuvant use is as follows:

- That the product is compatible with the herbicide glyphosate
- Low toxicity of adjuvant
- Absence of synergism that would cause greater toxicity
- Reduced drift risks (reducing)
- Ensure a rapid translocation of the product
- Improve the quality of the mixture
- Avoid herbicide washing by rain

In general terms to ensure to the maximum that air applications are effective and that illicit crops sprayed are eradicated.

**Article 1, point 4**

[ Page 15]

The DNE may establish and deliver the dates of fumigation of the sampling sites and determine whether they were sprayed at different times. However, the multitemporal study sought by the Ministry for the Environment was not performed since it was not part of the terms of reference.

**Article 1, point 5**

This requirement is the subject of a specific study and we request agreeing on terms and time for its realization. It is important to clarify that as of the date of completion of the study there was not a laboratory capable of performing the analysis in the country; such tests could be sent to the laboratories in Quebec (Canada).

For this reason it was agreed with Dr. Juan Diego Peña Program Coordinator of Illicit Crop Eradication - Ministry for the Environment, to emphasize the water analysis on the grounds that these presented the greatest risk.

If these studies are agreed upon, it is necessary to investigate if there is now a laboratory in Colombia that can perform the corresponding analysis. The former impasse is framed within the terms of reference in the point Objectives, paragraph 7 defines as identifying gaps in information.

In order to complete information of toxicity in animal species especially in aquatic organisms (although what appears in the EMP is considered sufficient) we request agreeing with the Ministry for the Environment the terms and time of implementation.

**Article 1, point 6**

At this point we request a meeting to agree the precise terms for what is required and the time to achieve this.

With regard to the oversight program, the DNE reiterates that since it is not included in the terms of reference, this requirement is not appropriate.

In relation to the paragraph, the risk analysis presented in Chapter VII of the EMP is sufficient and meets the requirements of the terms of reference. If an expansion of information is required, it will be necessary to agree on the scope and time for implementation.

For the foregoing reasons, I respectfully request the extension of the term to comply with the provisions of the operative part …

[ Page 16]

… of the referred Order, since this requires consultation meetings with the entities involved in the subject.

Sincerely,

*[Signed]*
GABRIEL MERCHAN BENAVIDES
Director

[ Page 17]

## Annex 27

### COUNCIL OF STATE OF COLOMBIA, CHAMBER OF CONTENTIOUS ADMINISTRATIVE AFFAIRS, ORDER OF 15 AUGUST 1995

*(Archives of the Colombian Foreign Ministry, pp.15, 17)*

**Council of State of Colombia, Chamber of Contentious Administrative Affairs, Order of 15 August 1995**

COUNCIL OF STATE, CHAMBER OF CONTENTIOUS ADMINISTRATIVE AFFAIRS
Presenting Counsel: CONSUELO SARRIA OLCOS

**Santa Fe de Bogota, D.C., fifteen (15) de August nineteen ninety-five (1995)**

**Received number: ACU-2820**

…

"Having duly established that the eradication of illicit crops is an activity entrusted to the National Narcotics Council since 1986, which executes it through the Anti-Narcotics Directorate of the National Police, and that it started it prior to the issuance of Law 99 of 1993 and its regulatory decree, as shown by the opinions of the health and environmental authorities referred-to above, it is concluded that the transitional regime provided for in that same law and developed in its regulatory decree, according to which an environmental license is not required is to be applied to said activity, and that it can continue to be carried out, without prejudice to the fact that the environmental authorities can intervene when they deem necessary to enforce compliance with the laws that regulate the environment in order to maintain it healthy, recover it or restore it as the case may be.

The Minister for the Environment so considered it, in letter of 20 December 1994, addressed to the Minister of Justice and Law, in page 119 of the case file, where she states that: 'It is necessary to point out that the opinion rendered by Inderena maintains its legal validity, since it was the relevant agency for environmental matters prior to the entry into force of Law 99 of 1993 and it applied the provisions in force at that time. It should be added, that the spraying is in pursuance of a policy of control of the public order, therefore, there is no discontinuance, and thus the situation of the sprayings fits perfectly within the transitional regime".

[Page 15]

…

In virtue of the foregoing, the Council of State, through its Chamber Contentious Affairs

**DECIDES**

Confirm the ruling of 18 May 1995 of the Administrative Tribunal of Cundinamarca – Section one, whereby it decided to refrain from taking any execution action against the National Narcotics Council, the Nation – Ministry of Interior and Justice.

[Page 17]

…

# Annex 28

## National Narcotics Council, Minutes N° 01 of 8 March 1996

*(Archives of the Colombian Foreign Ministry, Numeral 5)*

REPUBLIC OF COLOMBIA

NATIONAL NARCOTICS COUNCIL

**MINUTES No. 01**

**Session held on 8 March 1996**

[…]

5. Compliance with requirements before the Ministry for the Environment, to carry on with the Programme for Eradication of Illicit Crops by spraying with Glyphosate. Request of resources allocation CNE-4-8-MAR-96.

The National Narcotics Director made a presentation on the legal requirements and controls that the Programme for Eradication of Illicit Crops was subject to prior to entering into force of Law 99 of 1993, and the specific powers conferred upon the National Narcotics Council in virtue of Law 30 of 1986. Likewise, it was explained to the Council members that the corresponding authorizations had been obtained from the National Institute of Renewable Natural Resources [*Inderena* for its acronym in Spanish] and the Health Ministry to implement the Eradication Programme in 1992.

Next, she stated that after issuance of Law 99 of 1993, a new environmental requirement was set out, namely a management plan that must establish the necessary actions to prevent and/or mitigate possible environmental impacts resulting from the implementation of the eradication programme, and that previously the Ministry for the Environment requested an Environmental Impact Assessment, within the framework of the Eradication Program. On this regard, she made clear that this activity was within the transitional regime stipulated in article 117 of Law 99 of 1993, and for that reason, the Programme did not require an Environmental License. She also stated that Decree 1753 of 1994, in article 38 rules that activities that began prior to issuance of that law, which had obtained the environmental permits or authorizations could carry on and that the environmental authorities might require of them "presenting environmental management, recovery or restoration plans". On this last matter, she pointed out that in 1993 the National Narcotics Council requested and obtained from Inderena and the Health Ministry the corresponding authorizations to eradicate illicit crops by spraying with Glyphosate.

On the other hand, she stated that the management plan, described in article 1 of Decree 1753 of 1994, was the one that should be implemented to continue with the Eradication Programme, because that activity should develop actions to prevent, correct, mitigate or control possible environmental impacts resulting from the implementation of said programme and clarified that, given that eradications activities began since 31 January 1992, mitigation of their effects should be established, which should be carried out in the framework of the environmental management plan. She went on recalling all verifications that Glyphosate was subject to by institutions in charge of safeguarding people's health, such as the Health Ministry and Inderena. In virtue of the foregoing, she asked the Deputy Minister for the Environment to specify if the requirement was a management plan or if it was necessary to make an environmental impact assessment.

On this regard, Mr. Ernesto Guhl, Deputy Minister for the Environment, stated that he agreed that an Environmental Management Plan should be made, not an Environmental Impact Assessment, just like the National Narcotics Directorate had interpreted it.

**Disclaimer**: Some excerpts have been redacted in the original annex given the classified nature of the Minutes of the National Narcotics Council (pursuant to article 94 of Law 30 of 1986) and they do not deal with issues concerning the current case

# Annex 29

## Note 11430 from the Ministry of Justice and Law, National Narcotics Directorate (DNE) to the Ministry for the Environment enclosing the Environmental Management Plan for the Application of Glyphosate in the Eradication of Illicit Crops, 30 July 1998

*(Archives of the Colombian Foreign Ministry)*

REPUBLIC OF COLOMBIA

*Ministry of Justice and Law*
*National Narcotics Directorate*

11430

Santafé de Bogotá D.C.

GUILLERMO ACEVEDO MANTILLA
Deputy Director of Environmental Licenses
Ministry for the Environment
Bogotá. D.C.

Dear Mr. Acevedo:

I am pleased to submit your office the ENVIRONMENTAL MANAGEMENT PLAN FOR THE APPLICATION OF GLYPHOSATE IN THE ERADICATION OF ILLICIT CROPS, prepared by the consulting firm GEMSI LTDA., which was developed from December 1, 1997, and which includes a typical page on how content was structured and its final form.

This plan consists of 10 chapters containing background, project description, identification of reference areas, Environmental characterization, analysis of field testing, identification and assessment of environmental impact, environmental management plan, contingency plan for the program for the eradication of illicit crops by aerial spraying with glyphosate and the environmental audit area for the program for the eradication of illicit crops by aerial spraying with glyphosate.

Likewise, the aforementioned study includes annexes on: opinions and permits in connection with the use of the herbicide glyphosate, General weather information, maps, physical-chemical analysis, and photographic record.

Sincerely,

*[Signed]*
CARLOS ENRIQUE GALLEGO SILVA
General Secretary
*July 30/98]*

## Annex 30

### NOTE 16341 FROM THE MINISTRY OF JUSTICE AND LAW, NATIONAL NARCOTICS DIRECTORATE (DNE) TO THE MINISTRY FOR THE ENVIRONMENT ENCLOSING CHAPTER 7 OF THE ENVIRONMENTAL MANAGEMENT PLAN FOR THE APPLICATION OF GLYPHOSATE IN THE ERADICATION OF ILLICIT CROPS, 30 OCTOBER 1998

*(Archives of the Colombian Foreign Ministry)*

REPUBLIC OF COLOMBIA

*Ministry of Justice and Law*
*National Narcotics Directorate*

Santafe de Bogotá
30 October 1998

16341

Mr.
GUILLERMO ACEVEDO MANTILLA
Under Director Licenses
Ministry for the Environment
City

REF: Environmental Management Plan

Dear Mr. Acevedo:

In response to your request made in Note No 221-2-315 dated 2 October this year, for the corresponding purposes, I am enclosing the copies of Chapter 7 called: IDENTIFICATION AND ASSESSMENT OF ENVIRONMENTAL IMPACT of the aforementioned document.

Sincerely,

*[Signed]*
BEATRIZ PADILLA MEZA
Acting Director

Carrera 16 A NO. 79-08 Santafe de Bogota D.C.
Tel. 636 2139 Fax. 2578416 E-mail 104551.3473@composerve.com

## Annex 31

### NATIONAL NARCOTICS DIRECTORATE (DNE), ENVIRONMENTAL MANAGEMENT PLAN FOR THE APPLICATION OF GLYPHOSATE HERBICIDE IN THE ERADICATION OF ILLICIT CROPS WITH SUPPLEMENTARY INFORMATION, SUBMITTED BY THE DNE TO THE MINISTRY FOR THE ENVIRONMENT, 13 SEPTEMBER 2000

*(Archives of the Colombian Foreign Ministry, Table of contents; chapters 2, 3, 5; section 5.1., pp. 53 – 83; sections 7.1 and 7.2, pp. 127-131)*

# NATIONAL NARCOTICS DIRECTORATE

# -DNE-

SUPPLEMENTARY INFORMATION TO THE ENVIRONMENTAL MANAGEMENT PLAN FOR THE APPLICATION OF THE HERBICIDE GLYPHOSATE IN THE ERADICATION OF ILLICIT CROPS

*BOGOTA , SEPTEMBER 2000*

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

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**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**
[Chapter 2]

# 2. DETERMINATION OF FACTORS AND CRITERIA (ENVIRONMENTAL, SOCIO-ECONOMIC AND OPERATIONAL) CONSIDERED IN THE SELECTION OF THE REFERENCE ZONES

In order to determine factors and criteria (environmental, socio-economic and operational) considered in the selection of reference zones, it is important to re-emphasize the principles of selection of spraying areas in Colombia, in order to establish a reference framework that will allow analyses to be made from the point of view of the representative nature of the zones.

In other words, if a national reference framework is established for the illicit crop zones which are the object of spraying, a clear statement can be made of the representative nature of the reference zones.

## *2.1. CRITERIA FOR SELECTION OF THE AREAS FOR SPRAYING RESOLUTION 1/94 AND RESOLUTION 5/00, NATIONAL NARCOTICS COUNCIL.*

√ Detection of plots with industrial-type crops, through the analysis of satellite images and aerial photography. Estimation of the area of the illicit crop detected. Verification of the existence of illicit crops by overflying the areas, and determination of the area of the crop through the use of the SATLOC system[1] .

√ Integration of information about crops detected with the cartographic bases in the GIS. Location of crops with regards to population centres, protected areas and water bodies.

√ Programming of spraying work, in accordance with the characteristics of each plot verified.

√ Subsequently, at each antinarcotics police base, the execution of spraying is programmed in accordance with predominant weather conditions, the presence of armed groups, and guarantees for operation.

√ In areas in excess of 2 ha, the illicit crop must be a single one- coca-leaf (Erithroxylum coca) or poppy (Papaver somniferum), taking account of topographical considerations and closeness to human settlements.

√ Areas of illicit crops where it can be shown that there has been fragmentation or mixing with illicit crops, and forms of illicit crops used to evade the actions of the herbicide eradication program.[2] .

**Fragmented crop area:** an area of land divided by living or artificial barriers, with a sequence of lawful crops, subsistence crops, or native woodland, with illicit crops.

**Mixed crop area.** And illicit plant propagation area, which contains lawful and illicit crops intersparced.

√ Crops with of an industrial production nature, such as:

[1] Geopositioning system installed in each of the aircraft used in spraying
[2] As defined in Resolution 005 of August 11, 2000, National Narcotics Council

- ❖ Defined lines and uniform distribution of plants
- ❖ Continuous, fragmented or mixed areas with illicit crops, in areas larger than 2 ha.
- ❖ High density of planting. Distances for coca crops are 0.7-0.8 m between one plant and the next, which allows densities to be between 10,000 and 15,000 plants per hectare approximately, and for opium poppy, 0.3 m between one plant and the next and 0.8 m between the lines, for an approximate density of 45,000 plants per hectare.

√ Illicit crops located outside protected areas, including:

- ❖ Areas included in the National Natural Parks System
- ❖ Micro basins supplying municipal and rural area water supplies
- ❖ Consolidated suburban settlement areas

√ Crops where strategic ecosystems are being affected, and which meet the above conditions, show a new front of destruction of vegetation for the establishment of illicit crops.

√ Operational location, including the following criteria (distance from the operations based to the crop area, risk factors (activities of armed groups), predominant factors of climate, and the 100m buffer zone for water bodies.

Therefore, in the areas where spraying has been conducted with glyphosate in Colombia, using the criteria given above, the following reference zones were selected, using the environmental management plan used for the formulation of the environmental management plan

**Nucleus of Sierra Nevada de Santa Marta**. Palomino basin, Municipality of Santa Marta.

**Nucleus of Serranía de Perijá**. R. Magiria, tributary of R. Cesar. Municipalities of Manaure and Agustin Codazzi, Department of Cesar and Villanueva, Department of La Guajira.

**Nucleus of the Municipalities of Páez, Cauca and Iquira abnd Teruel**, (**Huila)**.

**Nucleus of the Municipalities of Chaparral and Rio Blanco**, Department of Tolima.

**Nucleus of La Gabarra,** Municipality of Tibú, Department of Norte de Santander.

**Nucleus of the Municipality of Puerto Rico**, Department of Meta.

**Nucleus of Caño Grande – La Lindosa**. Municipalities of Calamar and El Retorno, Department of Guaviare

## *2.2. DETERMINATION OF CRITERIA OF THE REPRESENTATIVE NATURE OF REFERENCE ZONES*

The selection of reference zones took into account the following criteria, considered decisive for initial evaluation.

1. The intention was to ensure that the reference zones were representative of the natural region in which they stand, with respect to flora, fauna, water resources and other environmental elements which are part of the ecosystem, and which may have been part of the activities of the establishment of illicit crops, and so, of the program for the eradication of illicit crops by spraying.

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

2. At the same time, the intention was to ensure that within the representative zones there were some which had not been the object of spraying (Sierra Nevada de Santa Marta, La Gabarra), in order to be able to make a comparative analysis between the zones already sprayed and those not sprayed, and this in the first instance allowed a determination as to whether there were differences with regard to one of the components of the environment which were sampled.

3. In operational terms, the intention was to ensure that the representative zones should offer the greatest possible security for taking the samples, that is, to determine the zone of influence and/or military action by the illegal armed groups.

4. Each of these zones has a high percentage of representative value with regard to the total area of illicit crops in the Department, and at national level, with the area percentages presented in the chart below, in accordance with the 2000 census data. Trends in the establishment of illicit crops in these representative zones have fluctuated with regard to those observed in 1998, when the formulation of the Environmental Management Plan began, since in the areas which have not been sprayed, such as Sierra Nevada de Santa Marta and La Gabarra at that time, the area of illicit crops has now tripled, and for the remaining representative zones, these values have markedly decreased, as can be seen in the information reported for the poppy crop in the departments of Tolima and Huila, from 1500 ha in 1997, to only 337 ha today (2000). Sources: Antinarcotics Police, US Department of State, or Environmental Audit cited by the EMP for the eradication of illicit crops, census of illicit crops for 2000)

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| REPRESENTATIVE ZONE | MUNICIPALITIES | PREDOMINANT ILLICIT CROP | TOTAL AREA OF ILLICIT CROP PER MUNICIPALITY (HA) | % OF TOTAL FOR DEPARTMENT | % OF TOTAL FOR COLOMBIA |
|---|---|---|---|---|---|
| 1 SIERRA NEVADA DE SANTA MARTA | RIOHACHA, SANTA MARTA | COCA | 760 | 100 | 1 |
| 2 SERRANIA DE PERIJA | MANAURE, AGUSTIN CODAZZI | POPPY | 832 | 33 | 1 |
| 3 PAEZ-IQUIRA-& TERUEL | IQUIRA & TERUEL | POPPY | 222 | 15.5 | 82 |
| | PAEZ | | | | 0.5 |
| 4 LA GABARRA | TIBU | COCA | 7373 | 95 | 7 |
| 5 CAÑO GRANDE-LA LINDOSA | CALAMAR | COCA | 982 | 33 | 3 |
| | EL RETORNO | | 1687 | | |
| 6 PUERTO RICO | PUERTO RICO | COCA | 806 | 28 | 1 |
| 7 CHAPARRAL-RIO BLANCO | CHAPARRAL | POPPY | 63 | 52 | 4 |
| | RIO BLANCO | | 45 | | |
| | | | | | |
| | | | | % REPRESENTATION, ILLICT CROPS, COLOMBIA | 22.5% |

Source: Map of Illicit Crops in Colombia 2000 Census, amended with the most recent data supplied by the Antinarcotics Police DIRAN

*Chart 1 Representative standing of illicit crops in the nuclei selected in terms of areas of crops of the same type at Municipal, Departmental and national levels.*

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An analysis of the figures reported in Chart 1 shows that the study was made in the most representative areas of the country with regard to concentration (continuous planting areas, higher density, that is, a larger number of plants per hectare), persistence and spread of illicit crops at the date of the analysis.

Likewise, for the selection of representative zones, an analysis of other variables, summarized in Chart 2, was made. It allows a clear definition to be made of the geographical location of nuclei, the predominant in the illicit crop, the presence of strategic ecosystems, existing environmental information, vegetation formations, existing hydrographic basins, nearby protected areas, and the presence of armed groups.

For the spatial location of illicit crop areas, and so, of spraying areas, we present the cartography of illicit crops by Province supplied by the Antinarcotics Police DIRAN, clearly showing the illicit crops by Province and their location with respect to the national Nature Park System. Likewise, we attach the illicit crop location map on a national scale, with an updated location of protected areas and National Natural Parks supplied to the DIRAN, by Special Administrative Unit of National Natural Parks Unit –UAESPNN- in July 2000.

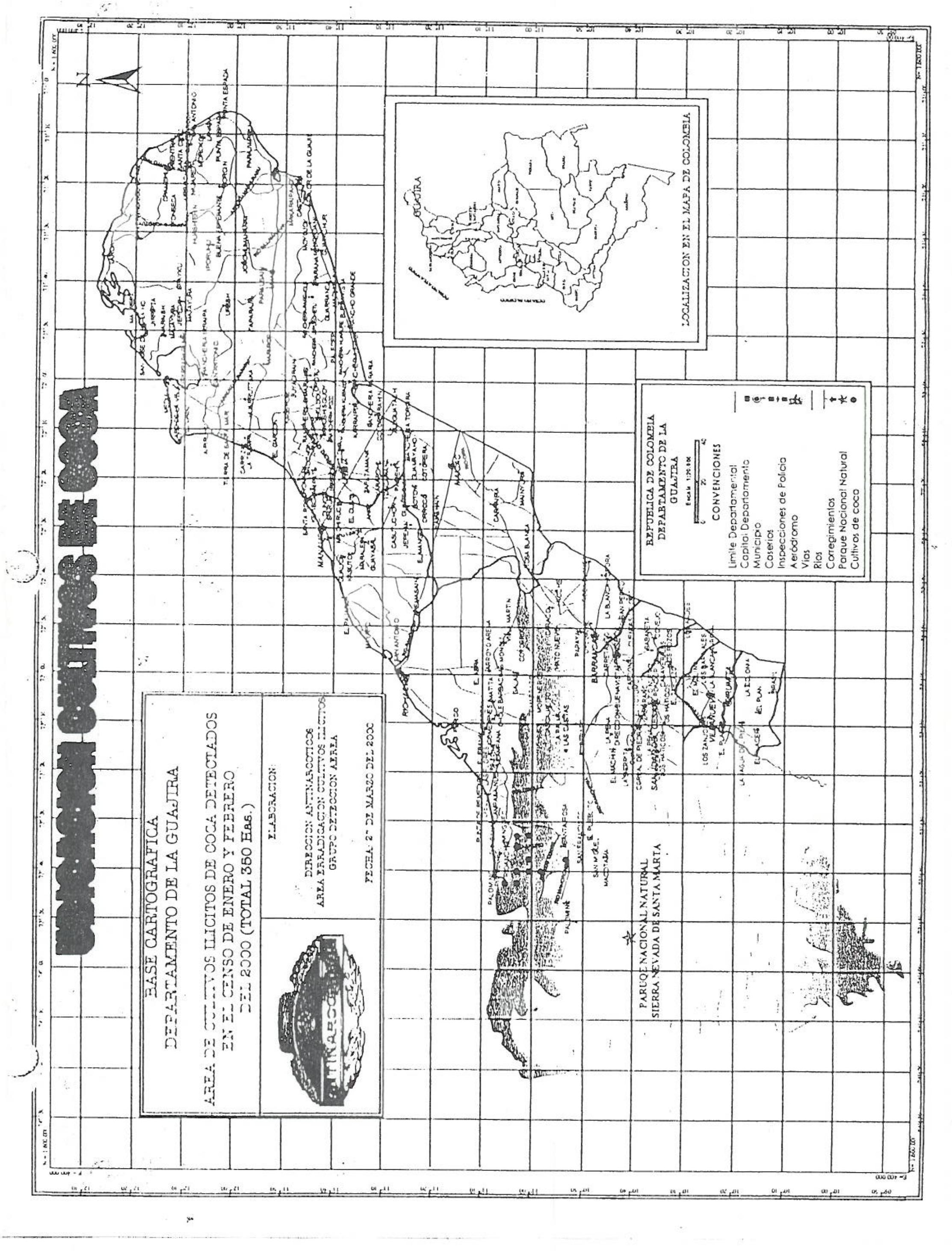
## Supplementary Information to the Environmental Management Plan for the eradication of illicit crops

| ZONE | REGION | PROVINCE | MUNICIPALITY | DOMINANT ILLICIT CROP | INFO AVAILABLE | VEGETATION FORMATION | BASINS | NEARBY PROTECTED AREAS | STRATEGIC ECOSYSTEMS | ARMED GROUPS PRESENT ? |
|---|---|---|---|---|---|---|---|---|---|---|
| SIERRA NEVADA DE SANTA MARTA | CARIBBEAN | GUAJIRA, MAGDALENA | Rioacha, Santa Marta | Coca | Sufficient | Be-Tt | Palomino basin between Magdalena and Guajira, affected by illicit coca in lower reaches because climate is warm and dry (dry tropical forest). The river marks the boundary between Santa Marta and Rioacha, Basin of the Don Diego, Buritica and Guachaga affected by illicit crops mainly in the middle and lower reaches, flowing directly into the sea, jurisdiction of Santa Marta, rural district of Don Diego | Sierra Nevada de Snata Marta | transition ecosystems destroyed between the lower part of the Sierra Nevada de Santa Marta, the middle and lower sections of the basins and to establish illicit crops. | Yes |
| SERRANIA DE PERIJÁ | | Cesar, Guajira | Agustin Codazzi, Villanueva | Poppy | Sufficient | bmh-PM, bmh-MB and bp-m or High Andean forest | Magdalena basin or Espiritu Santo tributary of the R. Cesar. The basin starts in the Serrania de Perijá and flows into the R Cesar. The main coca crops are in the upper part of the basin in the jurisdiction of Villanueva and Codazzi | Serranía de Perijá | High Andean forest and *paramo* ecosystems threatened by the establishment of illicit crops which in the long term will affect the strategic ecosystems such as the La Zapatosa marshes, also being a tributary of the R.Cesar. | Yes |
| PAEZ, IQUIRA & TERUEL | ANDEAN | Huila | Iquira, Teruel, Paez | Poppy | Sufficient | bmh-PM, bmh-MB | R. Paez and R. Iquira basins. The upper reaches are the worst affected by illicit crops in the jurisdiction of Paez (Cauca) and Iquira and Teruel (Huila) | Nevado del Huila Natural Park | High Andean forest, *paramo* ecosystems, innumerable water sources flowing down from this mountain range and being destroyed by the establishment of illicit crops | Yes |

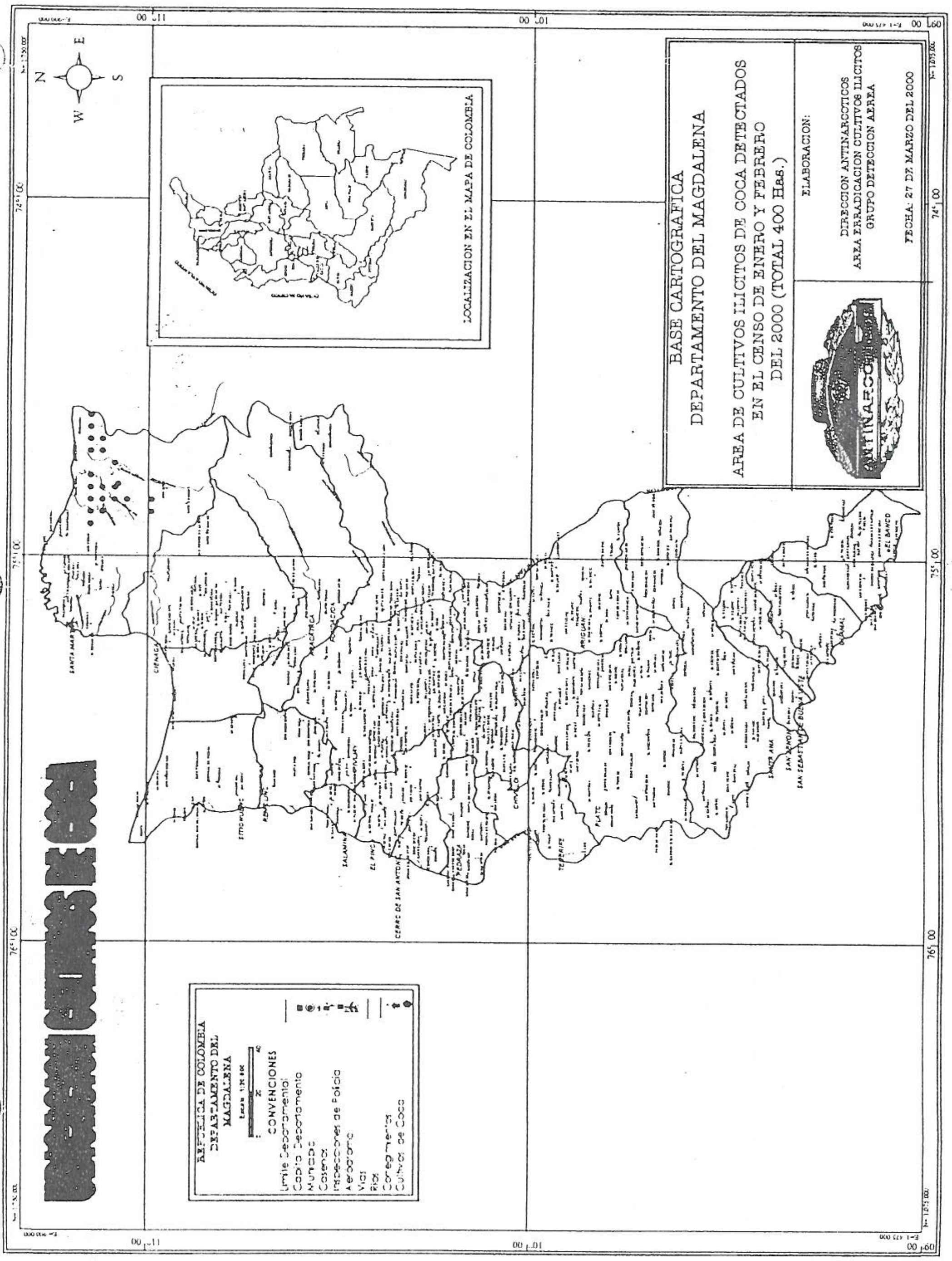
## Supplementary Information to the Environmental Management Plan for the eradication of illicit crops

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| CHAPARRAL-RIO BLANCO | ANDEAN | Tolima | Chaparral Rio Blanco | Poppy | Sufficient | bmh-PM and bmh-MB | R Amoya basin, tributary of R., Saldaña, jurisdiction of Municipalities Chaparral and Rio Blanco. Illicit crops mainly in the upper parts of the basin | Las Hermosas Nature Park | High Andean forest *paramo* ecosystems, innumerable water sources flowing down from this mountain range and being destroyed by the establishment of illicit crops | Yes |
| LA GABARRA | CATATUMBO | Norte de Santander | Tibú, RD Las Gabarra | Coca | Sufficient | bh-T, bmh-T, bmh-PM | Catatumbo basin, illicit crops in the middle reaches of the river. In general, illicit crops have spread along the middle and lower reaches of the river. | Catatumbo-Bari Nature Park | Coca leaf drops mainly in the middle and lower reaches of the R Catatumbo, which flows into L. Maracaibo, Venezuela. | Yes |
| CAÑO GRANDE-LA LINDOSA | AMAZONAS | Guaviare | Calamar | Coca | Sufficient | bmh-T | Unilla basin, tributary of the Vaupés, illicit crops along the river from upper to lower reaches. | Nukak-Maku Reserve, Chiribiquete Nature Park | Hundreds of hectares of bh-T and bmh-T being destroyed rapidly to make way for illicit crops. | Yes |
| PUERTO RIO | ORINOCO BASIN | Meta | Puerto Rico, El Retorno | Coca | Sufficient | Bh-Tt | Middle and lower R Ariari basin in Municipalities of Puerto lleras and Puerto Rico. Illicit crops develop mainly along the course of the river. | La Macarena Nature Park | Complete savannah ecosystems being destroyed and pastureland being turned in to illicit crops | Yes |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**



**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**



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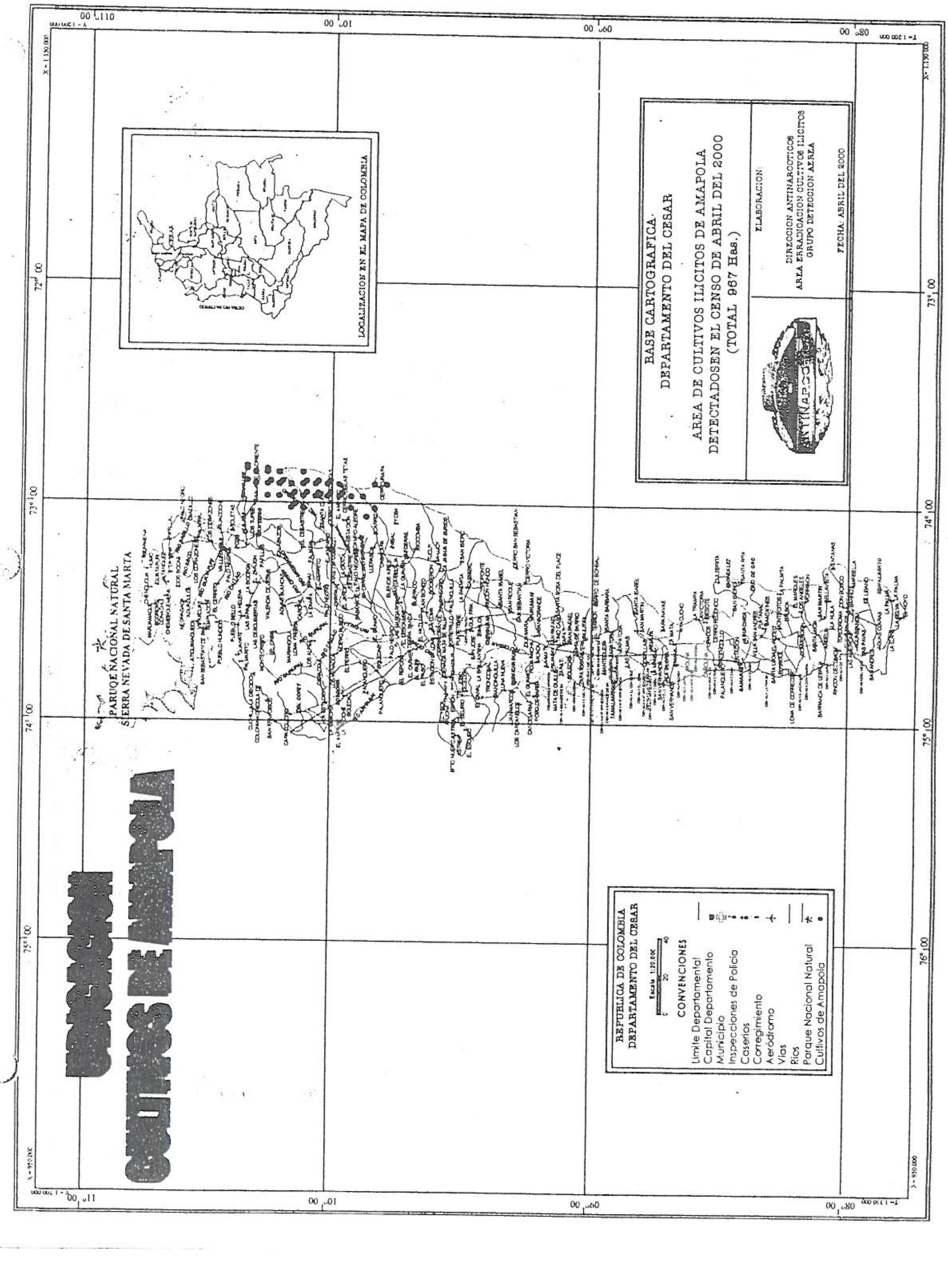

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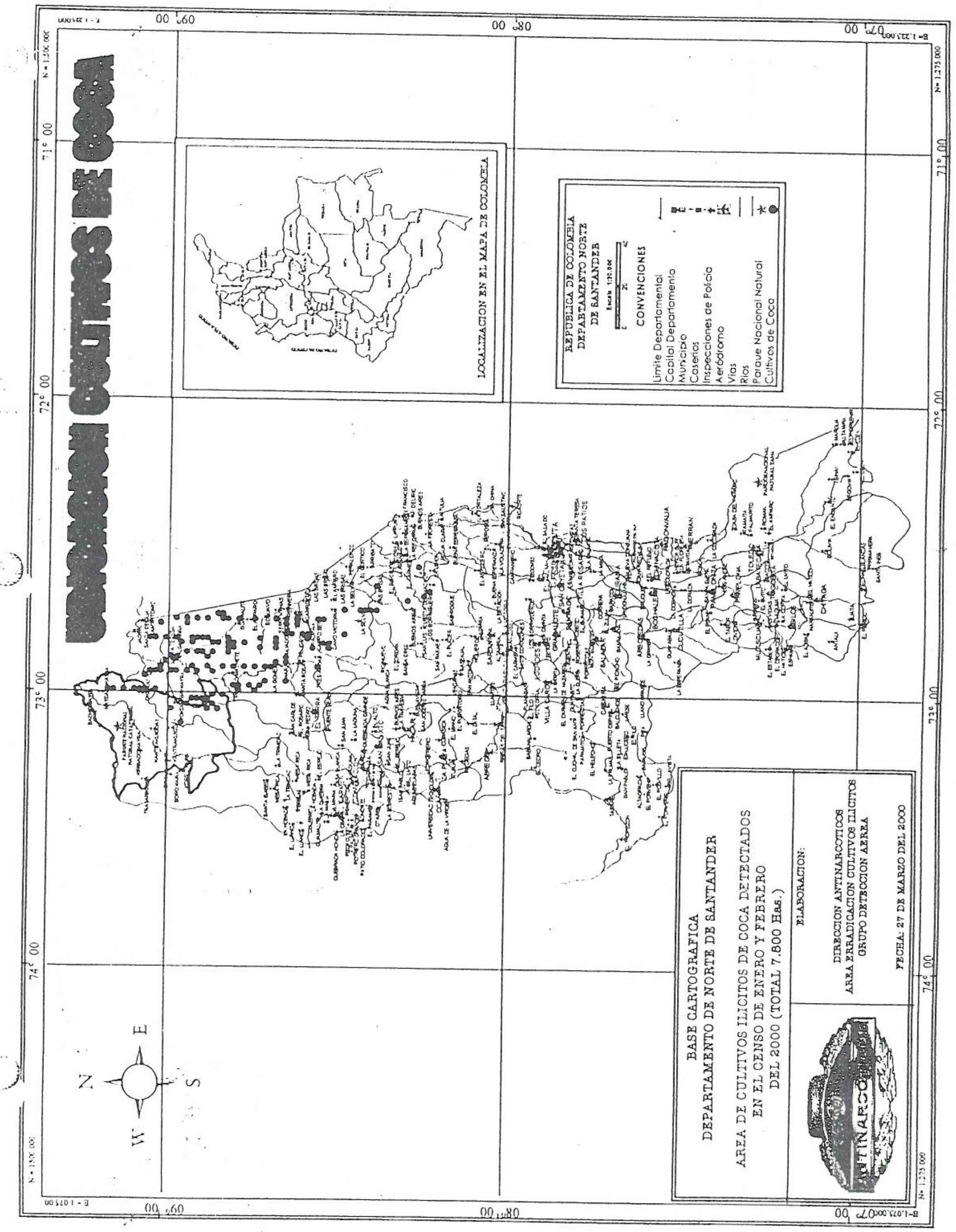

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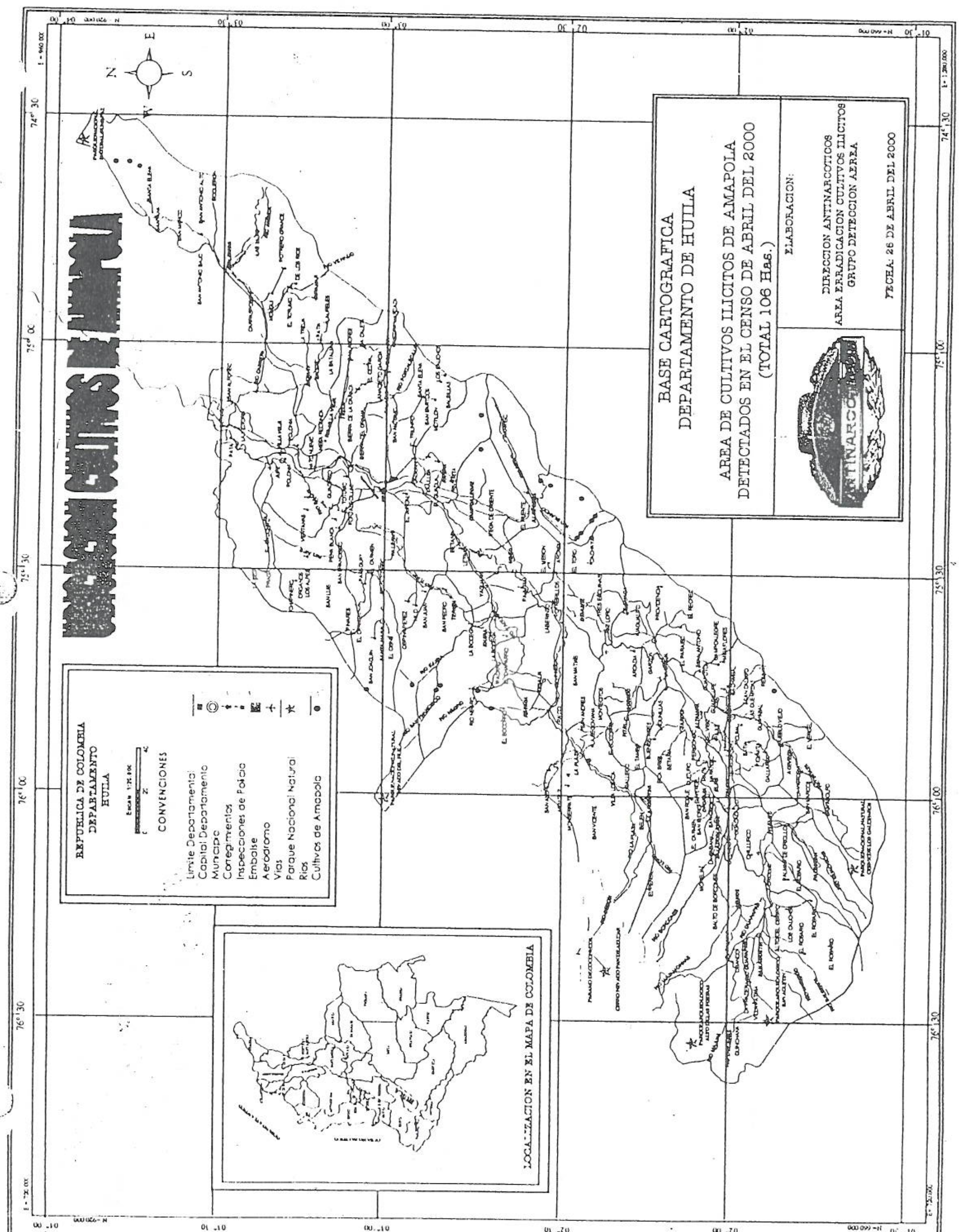

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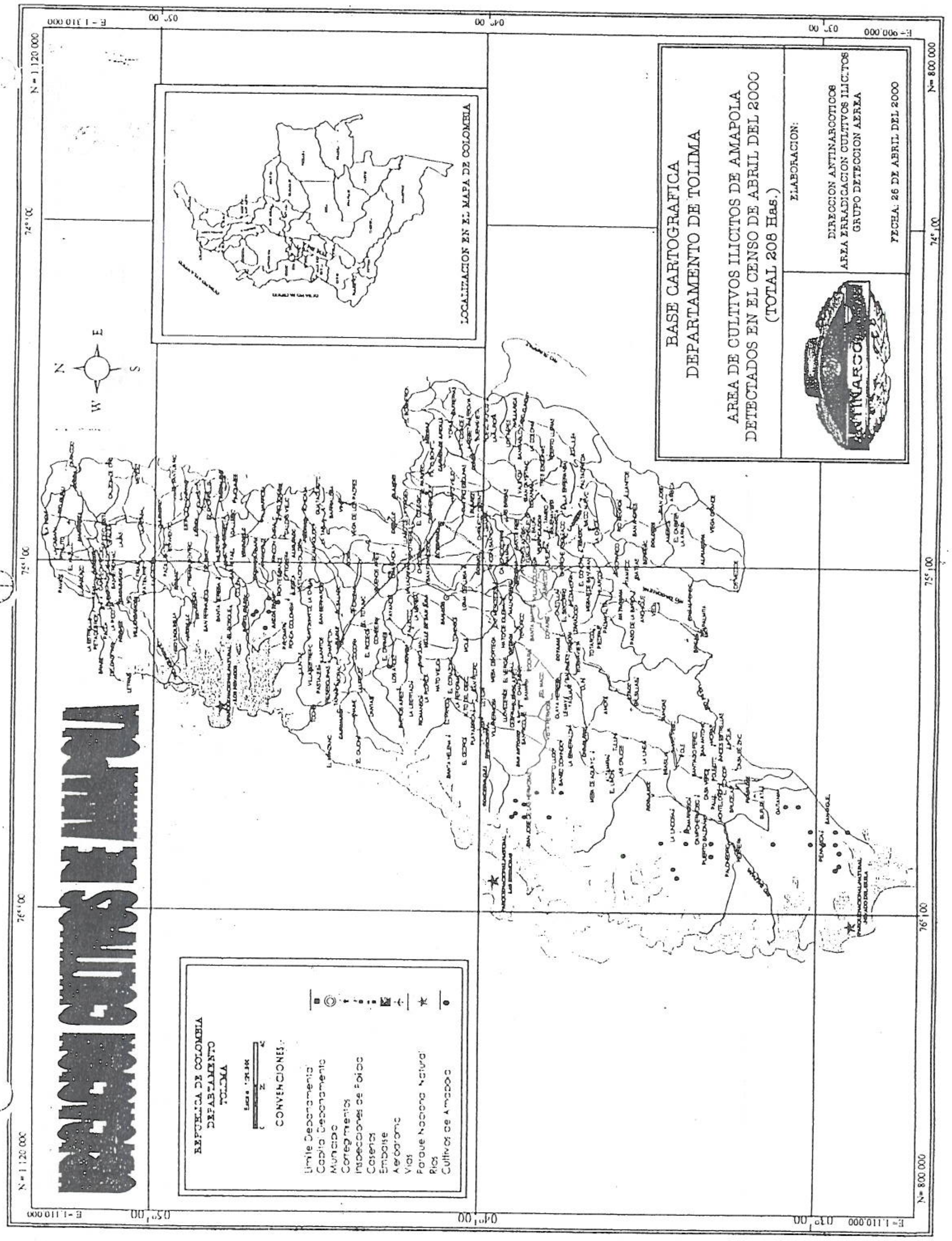

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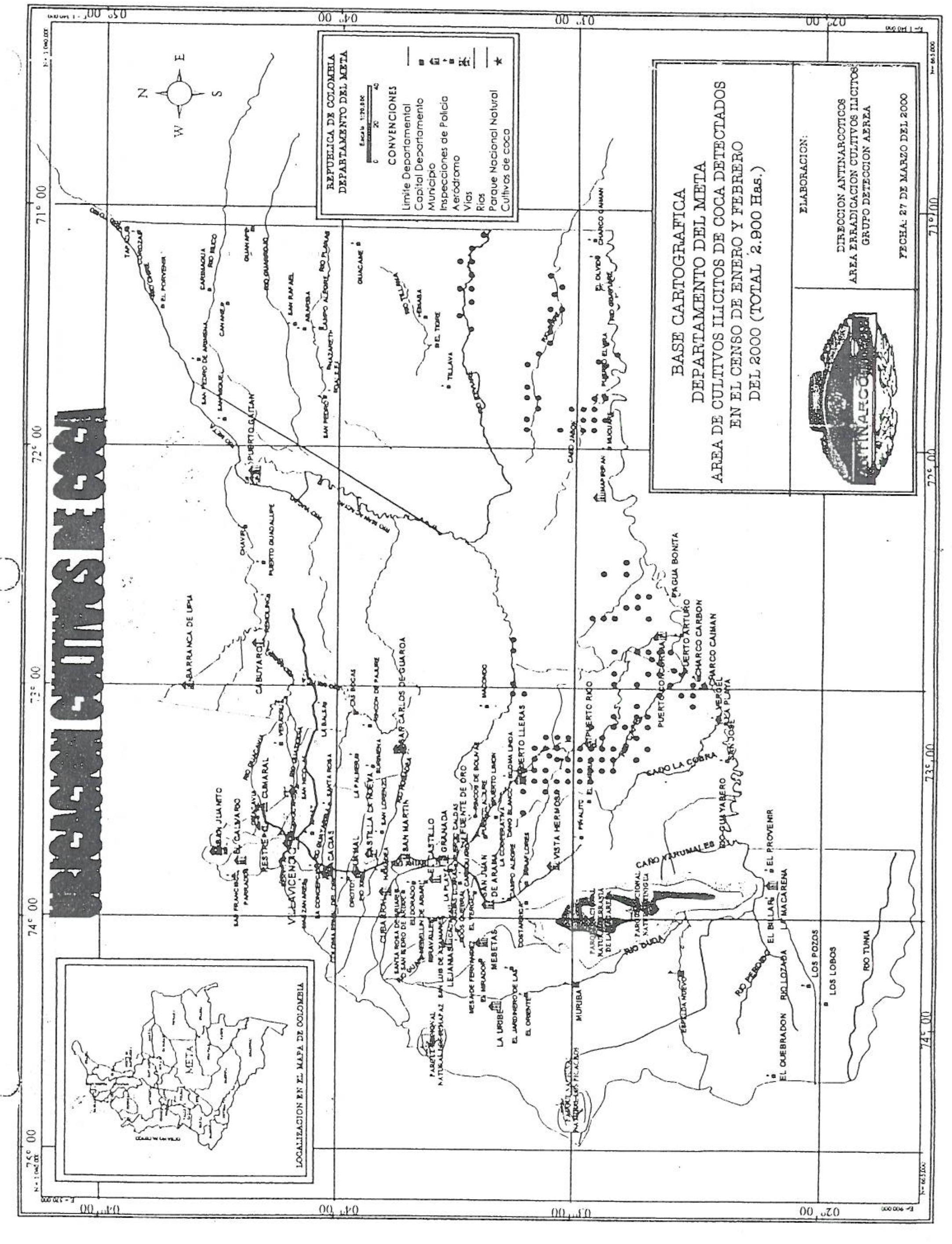

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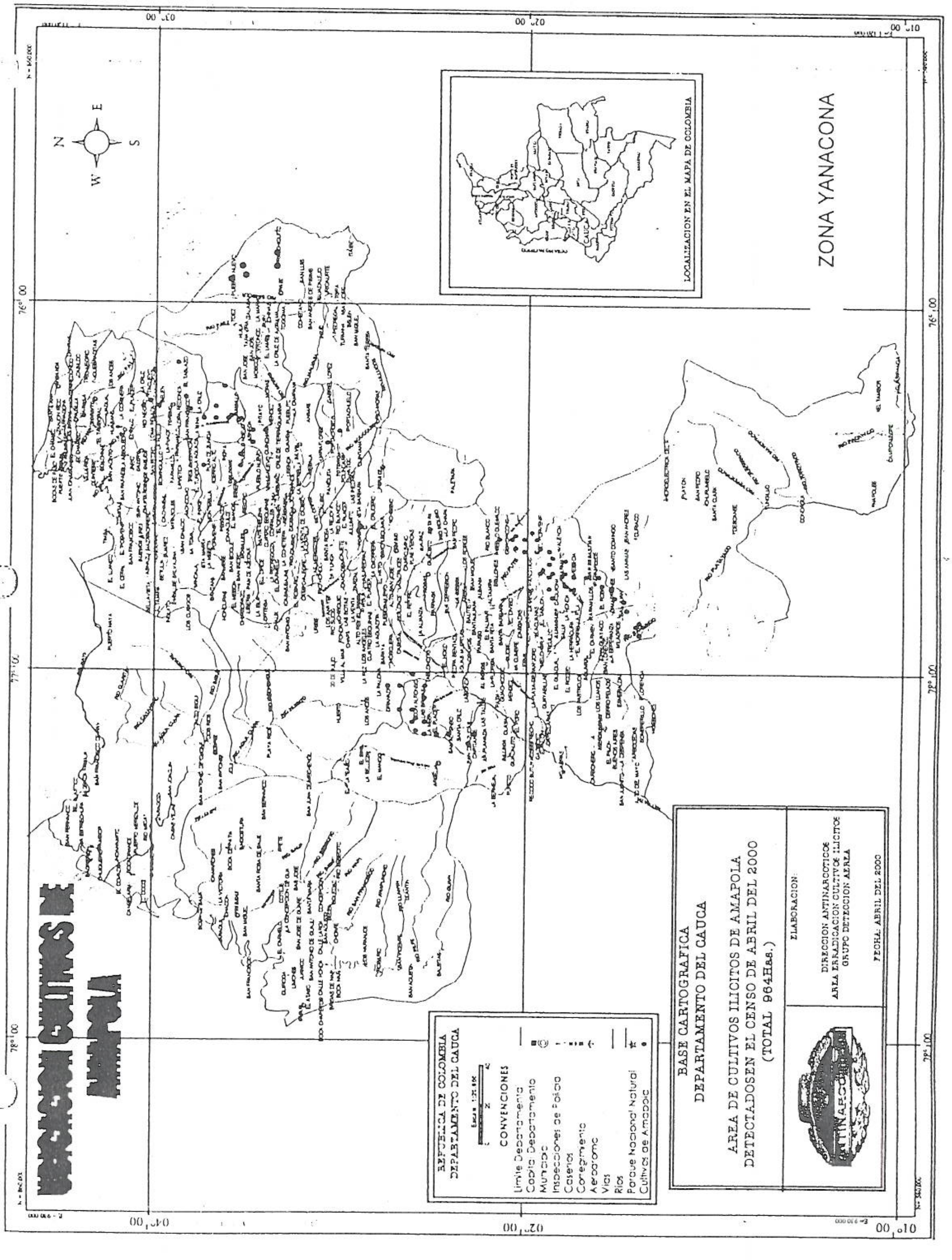

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**
[Chapter 3]

# 3. To design specific measures contained in the Program for the prevention, correction, mitigation and environmental compensation of the effects that may be generated by the application of glyphosate in the location of illicit crops in zones close to the National Natural Park System (modification of section 1.2 of Order 599 of December 1999, by Order 143 of March 2000).

For the development of this point, the limit of the protected areas was established in each of the nuclei, and the location of illicit crops in areas close to them was also determined, in order to define specific measures to be taken in those zones.

At the same time, and for each representative zone, a context was established for the development of illicit crops, both inside and outside protected areas, in order to set up programs which would help return the areas close to the protected areas to the transition areas between productive zones and protection zones, and to draw up proposals to discourage or eradicate illicit crops.

For this purpose, the base document was the "Environmental Management plan for the eradication of illicit crops", for the identification and environmental characterization of the nuclei object of the eradication program is pursued by DIRAN[3] and coordinated by DNE[4] .

This additional technical information was compiled by consultation at the documentation centre of UASEPNN[5] of the Ministry of Environment, and specialized information was taken by search from libraries and journal collections.

The analysis and processing of this information allowed special measures to be considered for the eradication of illicit crops in the Nature Parks areas and nearby zones.

Below is an analysis of the introduction of illicit crops into the nuclei object of the study, and particularly the introduction which affected buffer zones close to the protected areas.

## *3.1. DESCRIPTION OF THE ESTABLISHMENT OF ILLICIT CROPS IN ZONES CLOSE TO PROTECTED AREAS IN THE NATIONAL NATURAL PARK SYSTEM*

### 3.1.1. ANDEAN ZONE

#### 3.1.1.1. Chaparral-Rio Blanco (Tolima) nucleus. Influence on the Las Hermosas Natural Park (HER)

The Las Hermosas Natural Park, located between the Provinces of Valle del Cauca and Tolima on the Western range of the Andes has been affected by illicit crops, in the context of the Chaparral-Rio Blanco nucleus, particularly in the zone close to the limits of the Park located in the Province of Tolima, between the municipalities of Chaparral and Rio Blanco.

The main characteristic of Las Hermosas Park is its very humid *paramo*-type climate, which classifies it as a strategic ecosystem of vital importance since it supplies water to a number of human settlements both in Valle del Cauca and in Tolima, and indeed, a good part of an agro-industry established in Valle del Cauca depends on

[3] Antinarcotics Direction National Police
[4] National Narcotics Directorate
[5] The Administrative Unit of National Nature Parks System

water sources from the Park (Sarria and Londoño, 1991) [6]

Landholding in the properties close to the Park is characterized by possession (settlers), generally protected by deeds of sale, but the characteristics of landholding for the whole Park are not known. (Sarria and Londoño, 1991).

There is also no knowledge of the landholding of properties located in the buffer zone of the Las Hermosas Park; it is likely that the owners are wealthy, and have left the care of these lands in the hands of caretakers or tenants (Sarria and Londoño, 1991).

The main productive system of the Las Hermosas Park and its nearby areas is cattle-ranging, with a small presence of crop-farming, mainly potato, on small plots. Burning off his frequent in the dry season, and is used as a method for rejuvenating meadows, and making them palatable for cattle (Sarria and Londoño, 1991).

The climate conditions, relative inaccessibility, and the great distance from important urban centres all encourage illegal activities, in particular the growing of opium poppy in small areas, and in places with steep slopes, generating a fragmented landscape of *Paramo* vegetation, surrounded by man-made type matrix, is characterized by areas of pasture and opium poppy crops (EMP, 1999)[7].

The main limiting factors for the establishment of this productive system - both legal and illicit - are the strongly scarped relief, and the humid cold climate, typical in the region (EMP, 1999).

Based on the map "Location of illicit crops in Colombia, 2000 census", prepared by the DIRAN, it was possible to determine that the buffer zone of the Las Hermosas Park has been affected by opium poppy crops in the municipalities of Chaparral and Rio Blanco. In the Chaparral there are 63 ha planted, and in Rio Blanco, 45 ha.

This means is that the area of opium poppy crop in these two municipalities is equal to 52% of the total crop of total illicit crop areas in the entire Department of Tolima, and this in turn is equal to 4% of the total opium poppy crops grown in Colombia. According to the same map, and on the cartographic base map of the antinarcotics division[8], the location of the illicit opium poppy crop areas is outside the Park, that is, within the zones close to it, in the jurisdiction of the Department of Tolima.

### 3.1.1.2 Paez Iquira and Teruel Nucleus (Provinces of Huila and Cauca). Area of influence of the Nevado del Huila Natural Park (NH).

Nevado del Huila Natural Park contains a complex diversity of flora, typical of the high Andean forests, which is a mixture of tree and shrub vegetation, covered by thick layers of moss, lichen, orchids, philodendron, and anthurium, with a high degree of epiphytism, and a high concentration of water vapour in the environment, which make it a "natural water factory" (DIRAN and Environmental Audit , 1999) [9]

Based on the map "Location of illicit crops in Colombia, 2000 census", it has been possible to determine that in the municipality of Teruel (Department of Huila) there are 72 ha planted with opium poppy (6% of the Departmental total), and in the municipality of Iquira there are 150 ha (12.5% of the Department total). In the municipality of Paez (Department of Cauca) there are 15 ha (2% of the Departmental total).

This means that the area of the opium poppy crop in these municipalities is equivalent of 0.7% of total opium poppy crops in Colombia. However, these data are considered to be an underestimate, since when the illicit crop census was taken, spraying activities had already begun and it is probable that with the vegetative cycle of these

[6] Sarria S Stella and Londoño Janeth 1991 Parque Nacional Natural Las Hermosas. Monografía, Convenio Corporación Autónoma Regional del Cauca CVC y Corporación Autónoma Regional del Tolima CORTOLIMA. Co-ordinator Luis Fernando Gómez, Palmira, Valle del Cauca 169pp.
[7] GEMSI Ltda Environmental Management Plan for Eradication of Illicit Crops
[8] DIRAN Illicit Crop Eradication Division, Aerial Detection Group, Base Map for the Province of Tolima, April 2000 (1:20000)
[9] DIRAN and Environmental Audit for the Eradication of Illicit Crops 1999 Eradication, an environmentally sustainable policy. Bogota. 46 pp.

species, considered as short, the expansion of the areas has been recurrent.

According to the DIRAN base map[10], the location of the areas of illicit crops of opium poppy located both inside and outside the Nature Park (NH).

That is to say, the opium poppy crops in the jurisdiction of the Department of Tolima are in the areas close to the Park, while the crops located in the jurisdiction of the Departments of Huila and Cauca affect both the inside and outside of the Park.

[10] DIRAN Illicit Crop Eradication Division, Aerial Detection Group, Base Map for the Department of Tolima, Huila and Cauca, April 2000 (1:20000)

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**3.1.2. THE ORINOCO REGION**

## 3.1.2.1.The Puerto Rico (Meta) Nucleus. Influence on the areas of the La Macarena Natural Park (SMA)

La Macarena is a unique space due to its ecological and biogeographic characteristics, hosting a very high diversity of flora and fauna and a large number of endemic species, and it plays an important role as a Pleistocene refuge; it is a centre of species dispersion, as it contains habitats of reproduction or food for land and water migrant species. Under Law 52/1948, it was declared a Heritage of Mankind and an International Monument, which gives it both national and national importance (CORMACARENA 1995, CORMACARENA et. Al. 1997).

The process of human occupation of the La Macarena biological reserve, started by settler activity in the 1930s, meant that the area initially proposed as a reserve had to have about 70% of its surface withdrawn (Caicedo 19 5) [11] and that the Special Management area of La Macarena (AMEM), was declared, demarcated and zoned under its present name in 1989 (Legislative Decree 99/1989). The regime of the national Nature Park La Macarena was also set up in that year (CORMACARENA et al 1997)[12] .

The withdrawal of part of the former reserve has encouraged settlers to move into areas around Mesetas, Puerto Rico and Bocas del Ariari; and road infrastructure was generated, with consolidation of productive nuclei exercising strong pressure on the Nature Park (Avellaneda, 1989[13]. Today, the human settlements have tended to consolidate in the special management area AMEM, and new processes of certain settlement have decreased in numbers, due to the restrictions imposed by armed groups present in the area (CORMACARENA et al, 1997).

Human intervention in the special management area AMEM is mainly effected by the following practices (CORMACARENA et al 1997)

1. *Establishment of subsistence economies*, proper to founding settlers, who slash and burn, and introduce crops clearing the way to jungle areas.

2. *Extractive practices of forestry resources,* linked to national markets, mainly *pochota quinata*, Bombacaceae or cedar tree, which is extracted selectively in the buffer zone of the Macarena Park, and from inside of it. This extraction generally precedes establishment of the meadows for cattle raising. The wood extracted from this area is sold *in situ*, and some 50,000 pieces of cedar are estimated to have been disposed of in that manner in 1990.

3. *Coca-leaf crops*, generally the area for this is no larger than 3-4 ha per smallholding, in areas which were previously opened up and in which some trees are still standing.

4. *Cattle ranging.* This is a means of capitalization. This productive system is seen by settlers as a means of increasing the value of their property, and causes serious environmental problems in addition to the gradual loss of productivity and load-bearing capacity of the pastureland established.

5. *Opening up of communications*. Roads are used for the commerce of legal products (cattle and crops), and illicit crops alike (coca-leaf). However, they may generate the fragmentation of biological corridors between the Macarena, Tinigua and Los Picachos Parks.

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[11] Caicedo T. Hernan Basis to styructure an environmental management policy for the Sierra de la Macarena biological reserve, INDERNA, Villavicencio, Meta

[12] Corporación para el Desarrollo Sostenible del Área de Manejo Especial la Macarena CORMACARENA, Asociación para la Defensa de la Reserva de la Macarena ASOMACARENA and UAESPNN, 1997. Project for preservation and recovery of plateau zones in the National Natural Parks La Macarena and Tinigua La Macarena, Special Management Areas, Bogotá, 14pp.

[13] Avellaneda Mario 1989 Preliminary Study of Impact from Settlers on La Macarena Nationa Reserve and determination of current condition of tyhe natural system in altered áreas. Final Report. Universidad Nacional Bogotá.

Further, social, political and territorial control is exercised by the guerrilla group FARC, for whom it has been a "traditional" territory, and who in recent years have regulated the extraction of natural resources in the form of timber, wildlife and fish, and they have restricted the area planted with coca leaf crops (only 4 hectares per smallholding, for the sustenance of the family unit) (CORMACARENA et al, 1997).

La Macarena Nature Park (SMA) is influenced by the Puerto Rico nucleus, at the confluence of the River Guejar into the River Ariari , affecting the inside of the Nature Park and the buffer zone in the north eastern end of the Sierra La Macarena.

The municipality of Puerto Rico is considered to be a semi-urban settlement or area of unconsolidated settlement (CORMACARENA, 1995), and is the second largest producer of coca leaf in the Department, after Puerto Lleras.

According to the map "Location of illicit crops in Colombia 2000 Census", it can be established that there are 806 ha planted with coca leaf in the municipality of Puerto Rico, or 28% of total area with this crop in the Department of Meta, and equivalent to 1% of the total crop area in Colombia. According to the DIRAN base map[14], the location of the areas of illicit coca leaf crops are mainly outside La Macarena, that is, they are in its buffer zone, with only a small percentage inside the Park.

Coca leaf crops in La Macarena Nature Park (SMA) buffer zone are located mainly in the floodplains of the rivers Guejar, Ariari and Caño Cabra in the foothills of the Sierra La Macarena, and DIRAN (the Aerial Detection Group of the Antinarcotics Police) have classified them as medium density. At the same time, it has been determined that there are coca leaf crops in the Municipality of Vistahermosa and La Macarena, but since these are in the "cooling off" area assigned to the guerrilla groups, no quantification has been possible.

## 3.1.3. AMAZONIA

### 3.1.3.1. Caño Grande – La Lindosa (Guaviare) Nucleus. Influence on the Nukak Nature Reserve (RNN NUK)

The Nukak Nature Reserve (RNN-NUK), created by Resolution 122/1989, is located at the eastern end of the Department of Guaviare, between the rivers Inírida and Vaupés; it forms part of the Guyana Shield, which extends into Colombia in the Departments of Guainía, Vichada, Vaupés, Guaviare and Caquetá.

The Nature Park (NUK) is characterized by being an ecotone zone between the Orinoco Plains and the Amazon jungles, and therefore conserves fauna and flora species typical of both ecosystems, and adapted and endemic species for the region. These characteristics give it national importance as an area, in terms of diversity (IDEADE, at al 1996)[15]

The Reserve is mainly inhabited by indigenous communities, but settlement processes have brought subsistence farmers from other parts of the interior of Colombia, who have settled mainly in consolidated centres such as San Jose del Guaviare, and subsequently, moved out to their places of settlement

The distance and lack of infrastructure has encouraged the establishment of illicit crops, particularly coca leaf, which is produced generally with three production systems (IDEADE at Al 1906):

1. *Owner-sharecropper*. The owner of the land hands the process of coca production over to a Manager-caretaker, who is paid a percentage of the production

[14] DIRAN Illicit Crop Eradication Department, Aerial Detection Group, Base Map for the Department of Meta, March 2000 (1:20000)

[15] IDEADE, Universidad Javeriana, Instituto Alexander von Humboldt, UAESPNN, Government of France, Colciencias, FES, Governor of Guaviare and Guainía, Instituto Nacional de Salud 1996. Fieldwork in the Nukak Nature Reserve, Department of Guaviare.

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

2. *Rent.* The owner of the land pays rent to another settler in his coca-leaf plantation, and at the end of the production period, the other settler pays the owner a percentage of the total produced.

*3. Partnership.* The owner of the coca plantation becomes a partner of the process of production process and the extraction of the coca base. The owner puts up the land and the crop, and the partner supplies labour and materials. They then split the proceeds equally.

The *chagras* (clearings in the jungle, producing legal and illicit crops), may perform large contiguous zone, or zones separated by nearby or distant jungle corridors (IDEADE at al 1996).

The Nukak Nature Reserve (NUK) has been affected by the penetration of settlers and the medium-density establishment of the illicit crops, principally to the north-west and south-west, and high-density crops to the south, on the border with the Department of Vaupés. These crops are located on a strip along the main rivers and streams in the area, including Caño Grande in the jurisdiction of El Retorno, the river Unilla, in the jurisdiction of the municipality of Calamar, R. Vaupés (municipality of Miraflores, and the river Inírida (jurisdiction of Tomachipán- Puerto Paloma), and in general, along their banks at a distance of not more than 1.5 km from the water (SIMCI project, 1999).

According to the map "Location of illicit crops in Colombia, 2000 census", it has been determined that the Caño Grande nucleus affects the Nukak Nature Reserve in areas of jurisdiction of Municipalities of El Retorno and Calamar. In El Retorno there are 1687 ha planted with coca leaf, and in Calamar, 982 ha. This is equivalent to 32% of the total coca grown in the Department of Guaviare, and equivalent to 2.6% of the total crop area in Colombia. According to the same map, and to the DIRAN base map[16], the locations of the illicit crop areas for coca leaf plantation are principally to be found to the north, west and south of the Nature Reserve, both in the buffer zone and inside the Reserve. The individual plots are larger than 4 ha, and there are some with an area of more than 10 ha, surrounded by extensions of rough brachiaria pasture, other legal crops, or small amounts of woodland (IDEADE et al 1996).

The incidence of the establishment of illicit crops inside the Reserve has resulted in the slash-and- burn destruction of a large part of the original forest in this part of the country, selective exploitation of fine woods, principally for the construction of housing in the settlement at Tomachipan, the hunting of wild life (tapirs, boars, deer) and fishing. Given the dynamics of the population and the transitory presence of labourers for the coca leaf harvest, this impact causes serious problems in terms of the population of flora and fauna species, in addition to the displacement and de-culturalization of the indigenous tribes settled in the Reserve (IDEADE et al, 1996).

3.2. Influence on the Chiribiquete Nature Park (CHR)

This Nature Park is located at the south-western end of the Department of Guaviare and the north-eastern end of the Department of Caquetá. It is one of the few of the remaining important sections of the rocky chain belonging to the Guyana Shield, which rises up as a series of isolated geological formations through the surface of the Amazon Plains. This makes it an intense focus of speciation and enemies of flora and fauna, some yet to be discovered (Fundación Puerto Rastrojo 1992)[17].

The Precambrian and Mesozoic basement which covers almost all the Nature Park serves as "protection" for the establishment of illicit crops inside the Park, and the establishment of settler communities, however this important system is influenced in the south-western buffer area, by the dynamics of coca leaf production established in the municipality of Miraflores (which has 3866 ha of coca leaf, equal to 47% of the total area of the Department and 4% of the national total), on the banks of the River Vaupés and the Macaya river

[16] DIRAN Illicit Crop Eradication Department, Aerial Detection Group, Base Map for the Department of Guaviare, March 2000 (1:20000)
[17] Fundación Puerto Rastrojo 1992 Manejo y conservación del Parque Nacional Natural de Chiribiquete, 19pp.

floodplains.

### 3.1.4. CATATUMBO REGION

**3.1.4.1. La Gabarra (Norte de Santander) Nucleus. Area of influence of the Catatumbo-Bari Nature Park (CTB)**

The Catatumbo Nature Park (CTB) is in the extreme north of the Department of Norte de Santander, in the jurisdiction of the municipalities of El Carmen, Convención, Teorama, Tibú and El Tarra. The natural characteristics of the Park have been little studied, and there is an absence of detailed studies of flora and fauna, however, there is in particular the presence of hillside, Andean woodland, and foothill woodland . (EMP, 1999).

The initiation of oil production in the Catatumbo area since the 1970s has attracted processes of settlement which have slowly invaded the Reserve, with the subsequent loss of the lands of the indigenous communities and the exhaustion of natural resources, mainly forestry. Further, settlement processes have caused socio-economic transformation, forcible cultural, religious, political and language pressures, and there has been forced labour in the production of oil and coal, the influence of the guerrillas and the settlers: all this has brought about substantial changes in the indigenous communities (Rodriguez 1997)[18].

The settlers established in the area both inside the Park and in the nearby zones, have been engaged partly in the extension of the agricultural frontier, and partly in the establishment of illicit coca leaf crops, particularly in the Catatumbo, generating environmental and social problems (Rodriguez 1997).

The Baíi community derives part of its subsistence from crop farming and low intensity cattle ranging. Some of the indigenous community sell timber, particularly species such as *Cariniana pyriformis, Bomnbacopsis sp, Jacaranda copaia and Cordila alliodora*, amongst others, which the middlemen buy at extremely low price, and then resell in Cucuta. In addition to the problems proper to the community, there is the presence of three guerrilla groups, the drug traffickers, the timber cartel and common criminals, all generating a climate of instability and social insecurity, which have influenced welfare in the region (Rodriguez 1997).

La Gabarra nucleus affects the Catatumbo Park (CTB) due to the establishment of high-density coca leaf crops by the settlers inside the Park, and in the buffer zone mainly at the eastern end in the jurisdiction of the rural district of La Gabarra, municipality of Tibú. According to the map "Location of illicit crops in Colombia 2000 census", it has been established that the municipality of La Gabarra has 7373 ha planted with coca leaf, or 94.5% of the total area grown in the Department of Norte de Santander, and 7.1% of total for Colombia. According to the same map, and the Antinarcotics Police base map[19], the location of the areas of illicit coca-leaf crops affecting the Catatumbo Park are principally due to be found to the east, in the buffer zone and inside the park itself.

### 3.1.5. CARIBBEAN REGION

### 3.1.5.1. Sierra Nevada de Santa Marta (Magdalena) Palomino Basin Nucleus, affecting Sierra Nevada de Santa Marta Nature Park (SNS).

This Nature Park (SNS) forms part of the Sierra Nevada de Santa Marta Massif, declared by UNESCO as a Man and the Biosphere Reserve. It is an isolated formation, independent of the Andes Range of Mountains, with an area of 17,000 km², with all thermal floors and important vegetal formations of the tropics in the Americas, with great diversity of flora and fauna. During the Pleistocene, this mountainous island served as a refuge for a

[18] Rodriguez A. Olga 1997 Informe de gestión, Parque Nacional Natural Catatumbo-Bari, Bogotá
[19] DIRAN Illicit Crop Eradication Department, Aerial Detection Group, Base Map for the Department of Norte de Santander, March 2000 (1:20000)

number of species, of which 40-60% are endemic (Hernández, 1992, cited by Fundación Pro Sierra Nevada et al. 1997) [20].

The colonization of the Nature Park (SNS) began in the mid-1950s, with the establishment of a range of different human groups and the displacement of the local indigenous communities, to places higher up in the mountain. In particular, there is the "coffee belt" (a strip between 900-1500 m above sea level), started by subsistence farmers emigrating from the Andean zone. They produce coffee and subsistence crops to supply communities lower down, and exercise strong pressure on the natural resources, particularly fine wood and wood for fuel, and generate contamination due to the waste material from the coffee crop, which is thrown into streams. Another human group which occupied the lower levels of the Sierra were the subsistence farmers from the coast, who immigrated to the area after the banana and cotton crisis. They are mainly engaged in cattle ranging, with small areas of subsistence crops (Fundación pro Sierra Nevada de Santa Marta et al 1997).

The human intervention in the Palomino basin took place with the opening up of the Caribbean Highway (Troncal del Caribe), and marihuana crops which in 1986 arrived at 500 m above sea level. The limits of the Nature Park (PNN) which runs down to the sea between the Don Diego and Palomino rivers has been extensively colonized, has been subject to strong pressure by marihuana growers (Barbosa at al 1986) [21].

Poverty, and the marginal existence caused by state neglect has encouraged the substitution of the subsistence economy with marihuana, an activity which led to the rapid disappearance of woodland, with indiscriminate felling to make way for the crop, which in the 1980s produced what was known as the "*Bonanza marimbera*", strengthening new processes of colonization of the Nature Park (SNS) (Barbosa at al 1986).

Today, these crops are mixed with illicit low-density coca-leaf crops, mainly on the northern side of the Park, and inside it and in its buffer zone, mainly in the Palomino basin. In accordance with the map "Location of illicit crops in Colombia 2000 census" (SIMCI project), it could be established that this Nature Park, the Palomino basin, is affected by the coca leaf crops in the municipality of Rioacha, where there are 91 ha planted, and Santa Marta, which has 669 ha has planted, equal to 100% of the area grown in the Park, and in turn 1% of total crops in Colombia. According to that map, and the DIRAN base map[22], the location of the illicit coca leaf crops is mainly in the north of the Park, in the buffer zone and inside the park itself.

### 3.1.5.2. Serranía de Perijá Nucleus, Municipalities of Manaure and Agustín Codazzi (Cesar) an d Villanueva (La Guajira). Affecting the Forestry Reserve created by Law 2/1959.

The municipalities of Manaure and Agustin Codazzi are in the lower part of the Western watershed of the Serranía de Perijá and Serranía de Los Motilones in the Department of El Cesar. It should be noted that the Serrania de Los Motilones Forestry Reserve, created by Law 2/1959 has been nominal, and has not prevented the penetration by settlers, and even less, the extraction of natural resources.

The typical climate of Perijá is cold humid *páramo*, generally steep relief, which has favoured the establishment of illicit opium poppy crops on soils with slopes of more than 50° (DIRAN and Environmental Audit 1999).

According to the map "Location of illicit crops in Colombia 2000 census", it has been established that the Serranía de Perijá and particularly, the Los Motilones Forestry Reserve has been mainly affected by opium poppy crops in the Municipality of Manaure (239 ha) and Agustin Codazzi i (343 ha planted), this is equivalent

[20] Fundación Pro Sierra Nevada de Santa Marta and UAESPBB The Nature Conservancy 1997 Evaluación Ecológica Rápida, definición de áreas críticas para la conservación de la Sierra Nevada de Santa Marta, Bogotá
[21] Barbosa C, Rodriguez G and Avellaneda A, 1986. Precisión de los términos de referencias para estudios ambientales en la Sierra Nevada de Santa Marta afectada por cultivos de marihuana y fumigación con glifosato. Commission report, INDERENA Bogota 31pp.
[22] DIRAN Illicit Crop Eradication Department, Aerial Detection Group, Base Map for the Department of La Guajira, March 2000

to 61% of the total opium poppy crop in the Department of Cesar; and in the municipality of Villanueva there are 55 ha planted, equivalent to 36% of the total in the Department of La Guajira. These areas taken together are equivalent to 21% of the total area of crop in Colombia. According to the same map, the areas of illicit opium poppy crops are mainly to be found in the east of the forestry reserve.

## *3.2. Eradication of illicit crops in zones close to the bridge protected areas*

### 3.2.1. Measures of prevention

**1. Safety strip, for the spraying area**

According to Decree 1843/1991 Article 87 "Safety strip", it is stated that the application of pesticides and in rural areas will not be effected less than 10 m on the ground or 100 m in the air as a safety strip along or around watercourses or bodies of water, main roads, human and animal population or any other area requiring special protection.

Therefore, this principle will be applied to the nearby areas as defined in environmental legislation, in addition to measures in other current environmental legislation.

**2. Operational planning**

During the operational planning for the execution of the program for spraying illicit crops, the nuclei of illicit crops detected and verified will be superimposed on the cartographic base for protected areas, in order to plan spraying flights outside the limit of the protected area.

Given that the SATLOC system provides a precise geographical location of places where spraying is taking place during the operational program, the flight lines in the program will be superimposed on the map in order to ensure that spraying does not take place inside the project each protected area.

**3. Permanent exchange of inter- institutional information**

In the context of institutional and integration, efforts will be made to secure a permanent exchange of information with the UAESPNN administration in order to establish the dynamics of illicit crops inside the Nature Parks, and to adopt appropriate measures, whether for manual eradication by local consensus or by imposition. Given that the limitation of the establishment of illicit crops allows strategic ecosystems and nature reserves to be conserved.

At the same time, strategies will be considered jointly with the UAESPNN of strategies to be adopted in coordination with the National Police and the Municipalities, to discourage the advance of illicit crops into protected areas.

### 3.2.2. Formulation of specific programs

The Plan is set in the context of current environmental regulations, and within the illicit crop eradication program coordinated by the DNE. The criterion for development falls in the framework of investigation, and as a general objective, proposes activities providing new knowledge with regards to follow-up of potential impacts which may be generated with the eradication of illicit crops by air in zones close to protected areas.

### 3.2.2.1. Program: Monitoring of successional dynamics in vegetal communities in lots sprayed close to protected areas

**IDENTIFIED ENVIRONMENTAL IMPACT**

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

Potential effects generated on vegetation, caused by the eradication of coca leaf crops in Nature Park buffer zones

## TYPE OF MEASURE PROPOSED

Research

## OBJECTIVES

- To evaluate the impact caused on vegetation in the Nature Parks due to the eradication of illicit coca leaf and opium poppy crops in buffer zones and areas bordering the Nature Parks.
- To compile this information to identify future research work.
- To record changes occurring in vegetation due to the effect of the eradication of coca leaf and opium poppy crops.

## LOCATION

| REGION | NUCLEUS | PARKS | Location of buffer zones |
|---|---|---|---|
| Orinoco basin, Coca | Puerto Rico, Meta | Sierra de la Macarena | Buffer zone (NE edge) |
| Amazon basin, coca | Caño Grande-La Lindosa, Guaviare | Nukak | Buffer zone (N and SW edges) |
| Caribbean, Coca | Sierra Nevada de Santa Marta | Sierra Nevada de Santa Marta | Buffer zone (N end,) Palomino basin |
| Catatumbo, coca. | La Gabarra, Norte de Santander | Catatumbo-Bari | Buffer zone (E edge) |
| Andean, poppy | Iquira-Teruel-Páez, Chaparral – San Antonio | Nevado del Huila | Buffer zone. |

## JUSTIFICATION

The protected areas are affected by activities undertaken outside the boundaries, such as ecological processes, and physical, cultural and socio-economic changes.

The eradication of coca leaf and opium poppy crops in the Nature Park buffer zones and in the Nukak Nature Park (RNN) may affect vegetation inside those parks. There is a lack of knowledge directly related to this problem, and given that the protected areas have to be managed in a complementary fashion, and not in isolation from the dynamics of the ecology of the landscape, which involve the protected zone and its surroundings (Simonetti 1997).

The influence exerted by local communities close to the areas of natural forest in protected zones is a decisive factor when planning conservation strategy, especially addressed to the maintenance of gene flow supporting biodiversity in the Nature Parks.

Amongst the research efforts required, priorities must be observed in the identification and understanding of the effects of external factors arising from the matrix surrounding the Nature Parks (Sauders et al 1991), where situations are directly related to adjacent anthropic activity, and the attitude of the community to the natural area.

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

## METHODOLOGY

Taking as a basis the information supplied by the Rapid Ecological Assessment (REA), the general procedure consists of the following:

- Location of places which have been the object of the eradication of illicit crops in buffer zones and the detailed map locations prepared in the REA.

- Selection of sample areas

- The sample areas must meet certain minimum requirements, such as: that they must be located in a fringe of 1 km from the edge of the Park (that is, on the edge of the buffer zone), there must have must be facilities and access for data taking, and spraying activities must have been undertaken.

- The selection of sampling sites will be made in accordance with statistical procedures for random stratified sampling, taking account of the requirements mentioned.

- The area selected will be located on the ground with the help of a GPS, and will be demarcated for easy subsequent identification, for which purpose of the link will be formed with the Antinarcotics Police GIS.

- An experimental design will be used, to treat the area between the eradicated crop and the edge of the park, and where the control will be a nearby area which does not have this type of intervention (illicit crop), with related replicas.

- Each area selected will involve treatment and control, and a transect will be established with a suggested length of 100 m x 10 m wide (0.1 ha), in turn comprised of five rectangular plots of 20 m long by 10 m wide (Parde and Bouchon 1994, Prodan et al 1994).

- The composition of flora of all arboreal species with a diameter breast height of more than 10 cm will be recorded, implying a recording form and calipers (Prodan et al 1994, Parde and Bouchon 1994).

- The plots will then be subdivided into some concentric subplots of 10 m long by 5 m wide (Prodan et al 1994), which will be established to record saplings, small trees, shrubs and scrub (Gysel and Lyon, 1980, Zevallos and Matthei 1994).

- There will be an evaluation of 1) Composition and structure of vegetation, such as composition of fauna, frequency, abundance and dominance of species, 2) phytosanitary status, 3) ratio between area and wealth of species based on linear regression models (Gleason 1922, Arrhenius 1921), 4) species diversity indices, 5) effects of the influence of the surrounding matrix such as light intensity, relative humidity, temperature.

- Liu and Ashton (1999) have suggested that changes in variables such as the diametric structure and composition of species are good indicators to evaluate the impact of man on vegetal communities.

- A statistical comparison will be made of results of the plots inside and outside the Park, both in treatment and in the control transect. This comparison will enable the real impact of eradication to be established for illicit crop eradication in buffer zones, on vegetation inside the Nature Parks.

- It should be noted that the samples will be made regularly - twice a year and at least for five years - in order to establish a monitoring mechanism for the dynamics of vegetation over time. However, it is clarified that studies of this kind generally involve periods of more than five years (Laurence, 1991).

– Information compiled will be input into a custom-made database.

The analysis of partial results will be used as and when obtained to propose new research, and as a source of information for monitoring the dynamics of vegetal succession and the offer of flora in the Nature Parks; also, this will establish the capacity of resilience of these systems.

Likewise, the areas provided for in the project will act as pilot units for estimating subsequent environmental impact in similar ecological areas or other types of an impact not provided for in the short term.

**Total time for execution of the project: five years**

**TIMETABLE PROPOSED FOR THE FIRST TWO YEARS**

This includes activities for the first two years

Time (quarters)

| Activity | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Identification and selection of sample areas | X | | | | | | | |
| Preparation of maps, recording forms, field equipment, etc- | X | XXX | | | | | | |
| Set up field sampling units | | | XXX | XXX | | | | |
| Field sampling | | | | | X | X | X | X |
| Create and feed database | | | XXX | XXX | X | X | X | X |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**COST IN 2000 PESOS**

Description Amount Col$000

| | |
|---|---|
| COSTS YEAR 1 | |
| 2 Professionals, 1 field assistant | 84,000 |
| Mapping, database** | 30,000 |
| General information | 1,000 |
| Office materials | 3,000 |
| Field materials | 4,000 |
| Transport | 3,000 |
| Publications | 2,000 |
| SUBTOTAL YEAR 1 | 127,000 |
| COSTS YEAR 2 | |
| Professionals (4 months a year) | 48,000 |
| Perdiems (1 months a year) | 4,500 |
| Student degree papers (10) (2 per region) 4 months/year/4 years | 32,000 |
| Transport allowance per nucleus | 3,200 |
| SUBTOTAL YEAR 2 | 87,700 |
| TOTAL COST OF PROGRAM | 214,,700 |

** This item will be paid for by integration of the Program into the SIMCI system

**OPERATION OF THE PROGRAM**

The operation of the program will be undertaken in each of the area selected in the item of "Location", and results will be made public every six months, with regard to the results of sampling and analysis incorporated for each of the regions.

For the program to be implemented in parallel for each of the regions, with the development of a unified methodology, the intention will be to develop this research together with the development of graduate and undergraduate degree papers, coordinated by specialist professionals, and with ample recognition of the successional dynamics of vegetal communities.

The results obtained in the first year of research will be used to determine the successional dynamics in each region, and measures will be adopted as considered relevant with regard to the formulation of specific programs to encourage these processes of restoration of vegetal cover. At the same time, analysis will be made of the relationships between the results of the other programs formulated in the components of vegetation, soil, water, fauna and the social component.

The results of this program will be published every six months, and will be made available to national-order institutions which research into vegetation, educational institutions and NGOs, in order to form discussion groups for the results and to make joint proposals of measures to be adopted.

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**ENTITIES**
**Coordinating entity**; DNE, through its Regional Technical Units
**Support entities**: Ministry of the Environment, UAESPNN, universities, NGOs, research institutes (Alexander van von Humboldt, SINCHI, CONIF).

**CONDITIONS**

- Budget availability for entities engaged in the program
- Problems of public order in buffer zones, or in municipalities close to the Parks

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### 3.2.2.2. Program. Follow-up and monitoring of vegetal cover in areas which are the object of the eradication of illicit crops in zones close to protected areas through remote sensing. A vision of landscape ecology.

**ENVIRONMENTAL IMPACT IDENTIFIED**

- Temporary loss of vegetal cover
- Change in the use and vegetal cover in areas close to the Nature Parks systems

**TYPE OF MEASURE PROPOSED**
Research

**OBJECTIVES**

- To monitor changes in the landscape over time, occurring due to establishment-eradication dynamics of illegal crops, in areas close to the Nature Parks system (SPPN).
- To quantify the impact on areas close to the Nature Parks affected by the establishment-eradication of illicit crops over time.
- To determine areas in which special programs for rehabilitation and recovery of ecosystems affected by the dynamics of establishment-eradication of the illicit crops could be implemented.
- To protect and recover fragile systems of great strategic value to regional and national development.
- To consolidate special management areas in places made critical by the establishment and eradication of illicit crops.

**LOCATION**

| REGION | NUCLEUS | PARKS | Location of buffer zones |
|---|---|---|---|
| Orinoco basin, Coca | Puerto Rico, Meta | Sierra de la Macarena | Buffer zone (NE edge) |
| Amazon basin, coca | Caño Grande-La Lindosa, Guaviare | Nukak | Buffer zone (N and SW edges) |
| Caribbean, Coca | Sierra Nevada de Santa Marta | Sierra Nevada de Santa Marta | Buffer zone (N end,) Palomino basin |
| Catatumbo, coca. | La Gabarra, Norte de Santander | Catatumbo-Bari | Buffer zone (E edge) |
| Andean, poppy | Iquira-Teruel-Páez, Chaparral – San Antonio | Nevado del Huila | Buffer zone. |

**JUSTIFICATION**

The natural landscape cover is the result of complex series of interactions between climate, soil, water and biota (Fuentes 1989). The alteration of the landscape is due to natural phenomena (for example, volcanic eruption), and human activity (for example, introduction of crops into woodland areas, drastic changes in soil use), which modify the surroundings.

Formulation of alternative occupation in a given area, whether to propose cultural use, forestry, or conservation, requires knowledge of the biophysical and socioeconomic medium as close as possible to reality (Andrade 1994).

The ecology of the landscape is the theoretical and methodological framework which is most appropriate to for the integrated study of the landscape, which is determined overall, and not as simply the sum of its parts (Burrough 1986).

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

The external characteristics of landscape are those which determine and permit the recognition and differentiation within it, and principally composed of geo-forms and different types of cover (Foreman and Godron 1986).

Further, timeseries studies and analysis of the dynamics of changes in the landscape using comparisons of photographic records, theme-maps, or remote sensing images, have frequently been used to make comparisons of different types of soil or vegetal cover through the dynamics of time (Noss 1990, Ripple and Spies 1991, Fallas 1998).

In Colombia, the methods which come closest to this approach are the "Ecological Landscape Surveys", made by IGAC Rural Survey Unit and in IDEADE of the Javeriana University. Recently, the methods for landscape ecology have been used by the GIS-PAFC Project, developed by IGAC (Andrade 1994).

## METHODOLOGY

The general methodology proposed combines that used by the IGAC GIS-PAFC Project, which in turn is based on methodological guidance proposed by FAO, with some adjustments for application to the case of follow-up and monitoring of vegetal cover in target areas for illicit crop eradication in zones close to the Nature Parks system. The procedure is described below:

***Diagnosis***. This is based on the identification of the central problem with regard to the effects generated by illicit crops which are the object of spraying in Nature Park buffer zones. This diagnosis would be made with from the results obtained in a Rapid Ecological Assessment.

Formulation of specific and general objectives, which in turn allow the level of detail to be established, along with the volume of information required and inputs to be used. For this case, it is suggested that studies are made at reconnaissance level (working scale of 1:500,000 to 1:100,000, allowing the use of satellite image, radar and aerial photography images on a small scale 1: 60,000), or semi-detailed (working scale 1: 25,000-1:10,000, by the use of satellite radar images or aerial photography on medium scale between 1:20,000 and 1:40,000) (CIAF, 1981)

***Identification of indicators of variation of landscape dynamics,*** which will allow changes occurring over time to be measured and monitored. It is suggested that a competent group of professionals be formed which will approach the problem from different standpoints. The indicator will be the measurement of the effect on the descriptor element (part of the variable identified), as selected. Some indicators may be more relevant than others, and they should therefore be weighted, to give a better analysis the setting of priorities of variables to monitored, and the development of subsequent research or management (Montenegro, 1998).

Some indicators suggested to quantify the spatial heterogeneity and dynamics of spatial variation of landscape are (Ripple at al 1991, Forman 1995): 1) Variation of size of crop areas, and eradicated areas, 2) Changing shape of these units, 3) Spatial distribution and density of the same, 4) Abundance in the Nature Park buffer zones, 5) Spacing between areas, 6) Density and dispersion of the units.

The analysis of results will be made in the light of the application of statistical tests (parametric or otherwise, depending on the indicator), which will allow evaluations to be made with reliability criteria (level of significance of $\alpha$ = equals 0.05).

**Multi-temporal analysis.** Based on the use of remote sensing and GIS, and in accordance with the level of detail proposed in the formulation of objectives, it is proposed that specific monitoring studies be effected on the dynamics of vegetation in areas close to Nature Parks affected by the establishment of an illicit crops where the eradication program has been implemented, in order to 1) verify the rate of substitution of native woodland by crops; 2) evaluate the recovery rate of ecosystems once the crops have been eradicated; 3) monitor the ecological comportment of the landscape impacted (through the application of indicators); 4) evaluate the comportment (invasive or exclusive) of surrounding vegetation in the areas affected; 5) observe the growth of vegetation in buffer zones, etc. This, considering that the multiplicity of information which can be obtained through the use of instruments such as remote sensing and GIS.

The study of monitoring will be made through the through application and interpretation (visual or digital, depending on the sensor selected) of the indicators proposed and on images recorded in sequential time periods (six monthly, yearly). In addition, images may be selected from previous years so that retrospective studies can also be made. This will allow greater precision in the spatial quantification of dynamics which have occurred in the landscape in areas close to the Nature Parks.

Finally, the information recorded will provide important elements in the formulation of programs for recovery, management, rehabilitation and research at landscape level, which can be effected in these areas.

**TIMETABLE** **time in quarters**

| Activity | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Diagnosis | XXX | | | | | | |
| Selection and identification of indicators | XXX | | | | | | |
| Selection of sensor type, acquisition of material, interpretation | XXX | XXX | XXX | | | | |
| Multitemporal analysis of images and statistics of results | | | XX | XXX | XXX | XXX | |
| Preparation of reports, formulation of new programs | | | | | | XXX | XXX |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**TOTAL EXECUTION TIME**
**1 YEAR**

**COSTS**

| Description | Col$000 |
|---|---|
| for professionals (two forestry specialist GIS forestry engineers, one biologist and one geographical or land survey engineer with specialist studies in GIS) | 144,000 |
| Remote sensing and cartography | 7,000 |
| General information | 1,000 |
| Office materials | 4,000 |
| Field materials | 4,000 |
| Transport | 16,000 |
| Publications | 5,000 |
| Socialization of results | 5,000 |
| **TOTAL COST OF THE PROGRAMME** | **186,000** |

**ENTITIES**

**Coordinating entity:** DNE
**Support entities**: DIRAN, Ministry of the Environment, UAEESPNN, IGAC, universities, NGOs, Research institutes (Alexander from Humboldt, SINCHI, CONIF).

**CONDITIONS**

Budget availability of entities engaged in the program
Availability of equipment and qualified personnel in the agencies engaged.

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## 5. Assessment of Environmental Impacts of Eradication with Glyphosate in the Short, Mid, and Long Term

The assessment of environmental impacts resulting from spraying with Glyphosate herbicide in the different regions of the country requires not only contextualizing the program regarding the areas where illicit crops are established and beyond the identification of potential effects be it negative and / or positive and their evaluation, as well as the moment in which they occur in the short, mid or long term. It is also necessary to clearly determine what the mobility of the herbicide is in the natural settings where it is applied.

Therefore, the development of this aspect is aimed at determining what the gaps in existing information are , which, once solved with specific research programs, will allow to establish on solid ground the short, mid, and long term environmental impacts and the environmental measures that should be adopted depending on the nature of the impact and its characteristics.

Taking as start point the conditions of applications, it follows that:

**a. Spray mix:**

| | |
|---|---|
| Coca Crops | Commercial Glyphosate formulation: Roundup 10.4 liters / hectare, water 12.85 liters / hectare, and Cosmoflux 0.25 liters / hectare |
| Poppy Crops | Commercial Glyphosate formulation: Roundup 2.5 liters / hectare, water 47.25 liters / hectare, and Cosmoflux 0.25 liters / hectare |

**b. Application Conditions**:

**Flight altitude**: 15 to 20 meters depending on the topographic conditions
**Aircraft speed:** between 120 and 150 Miles / hour
**Mean volumetric diameter of droplets on foliage surface**: >250 micra

c. Weather conditions for application

| Weather condition | Coca crop | Poppy crop |
|---|---|---|
| Maximum wind speed for application | 6 knots | 4 knots |
| Relative humidity | > 75% | >85% |
| Temperature | <30 centigrade degrees | <13 centigrade degrees |
| Optimal application time | Between 6 and 10 a.m. | Between 6 and 9 a.m. |
| Topography | Flat to wavy | Mountainous to very mountainous |

Source: Antinarcotics Direction, Environmental Management Plan 1998.

These weather conditions for application are strictly observed in order to achieve the greatest efficacy in application.

**Location of plots with geographic coordinates**, each aircraft has a SATLOC unit system, which has been previously programmed according to satellite images available for plot location and with the prior reconnaissance over flight, which allows the pilot to release the herbicide with precise coordinates. Likewise, this system records the start and finish point of discharge; this length times the swath width allows to estimate with precision the amount of sprayed hectares.

**Growing stage of the illicit crop**

**Poppy crop**. The optimal application age is at one and four and a half months, because at this point, the plants have not reached their physiological maturity, therefore it cannot act as a dryer or accelerator of seeds production. To conduct spraying in that period, permanent monitoring of the areas by interpretation of satellite images and field verifications is carried out.

**Coca crop**. It is applied to foliage of plants between 2 and 4 months after planting. When the crop is more developed, it is conducted when the crop shows greater density, that is, when leaves have not been harvested. Taking into account that the planting density are as high as 90.000 per hectare, and leaves are tender due to continuing harvesting, it guarantees a greater effectiveness of the herbicide for eradication of the illicit crop.

**Frequency of application per plot of illicit crop**.

The aim of spraying is to considerably affect the illicit crop, in 70% at least, so that it is considered economically unfeasible, that is, production costs are higher than profits obtained from it.

Therefore, in each plot of illicit crop in average, 2 sprayings in different swaths are conducted with the purpose of considerably affecting its production.

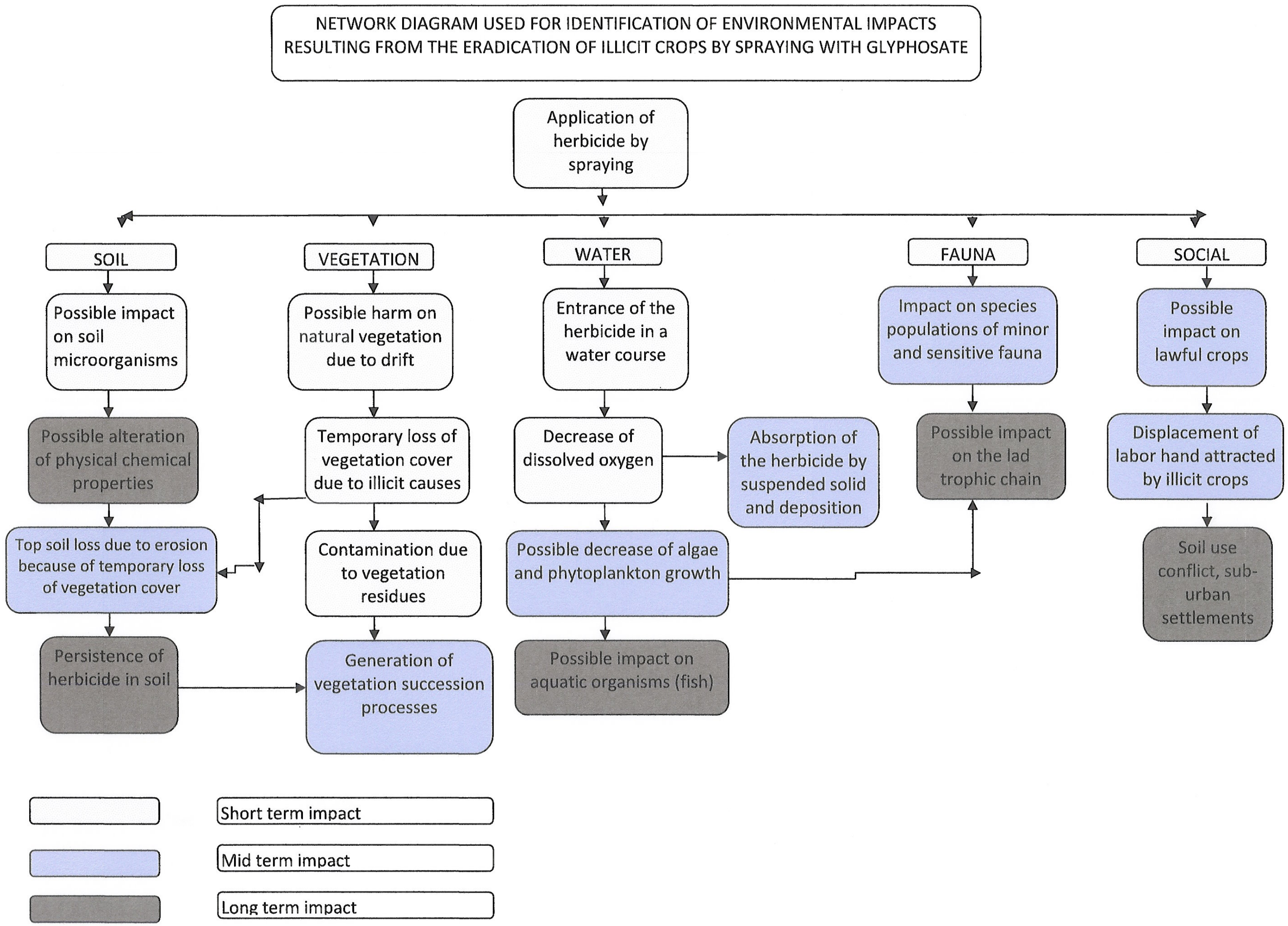
These applications are conducted a 1 year time period for security reasons and are carried out in different sectors of the plot in different swaths[23], which means that a same swath of the plot is sprayed twice.

It often happens that these applications are not necessary because growers abandon the illicit activity because they feel they have been spotted by the police.

23 The application swaths correspond to the aircraft swath (between 30 and 50 meters). Source DIRAN

With these specifications about the spraying activity, the network diagram was selected as the method for the Assessment of Environmental Impacts of Eradication with Glyphosate in the short, mid, and long term because it integrates the causes of impacts and their effects through interrelations existing between causal actions and environmental elements that receive the impact.

The diagram shown below allows to clearly establish what the potential effects resulting from the application of herbicide for eradication of illicit crops are and it also allows to identify the information lack that needs to be solved to estimate these impacts and propose environmental measures according to them.


NETWORK DIAGRAM USED FOR IDENTIFICATION OF ENVIRONMENTAL IMPACTS RESULTING FROM THE ERADICATION OF ILLICIT CROPS BY SPRAYING WITH GLYPHOSATE
Application of herbicide by spraying
SOIL
Possible impact on soil microorganisms
Possible alteration of physical chemical properties
Top soil loss due to erosion because of temporary loss of vegetation cover
Persistence of herbicide in soil
VEGETATION
Possible harm on natural vegetation due to drift
Temporary loss of vegetation cover due to illicit causes
Contamination due to vegetation residues
Generation of vegetation succession processes
WATER
Entrance of the herbicide in a water course
Decrease of dissolved oxygen
Absorption of the herbicide by suspended solid and deposition
Possible decrease of algae and phytoplankton growth
Possible impact on aquatic organisms (fish)
FAUNA
Impact on species populations of minor and sensitive fauna
Possible impact on the lad trophic chain
SOCIAL
Possible impact on lawful crops
Displacement of labor hand attracted by illicit crops
Soil use conflict, sub-urban settlements
Short term impact
Mid term impact
Long term impact

In the first level we start from the assumption that the introduction of a chemical substance generates a modification of the environmental element and that such an effect is considered negative to the extent that there is contamination

In other words, there is contamination of an environmental element when the limits in which this element is able to degrade external substances (contaminant) are exceeded and these substances cause a change in its dynamics. The modification that this substance causes will depend on the amount that enters the environmental element, the time it remains in it, and the frequency of its entrance.

Thus, it is considered essential to start research programs which, included in the environmental management Plan, become mitigation Programs that monitor the ecosystems to determine if there are changes in its interrelation and start investigating their causes.

It is important to point out that these programs will be coordinated by the National Narcotics Directorate and for its implementation will count on research agreements with national entities, universities, and international organizations.

Taking as start point the assumption that there will be contamination of the environmental elements, the need for research programs is then reached.

However, if the results from the Verification Processes of the Program for the Eradication of Illicit Crops in Colombia are analyzed, which are presented below as photographic records and the field samplings done within the Environmental Management Plan performed in1998, it can be observed that there is no evidence of the environmental effects previously described and that, therefore, the Environmental Management Plan must be oriented towards prevention and control measures that guarantee the correct application of the herbicide in each of the country zones.

Bringing these two considerations together is summarized in developing structured researches that include systematic samplings in every region target of the management Plan and that they are carried out in the lab and field.

These researches will allow to know with certainty the environmental effects on each component and to determine its magnitude and intensity in order to propose the concrete environmental measures to revert, compensate or correct them.

In order to relate the environmental impacts from the program for the eradication of illicit crops by spraying with the reports of the environmental audit, a series of photographic images have been selected from the plots that were sprayed at different dates and that upon carrying out the eradication verification at different time intervals after spraying, it is observed that that there is an efficient recovery of vegetation covers.

## 5.1. Analysis of verification images of eradication of illicit crops

Images of fumigated illicit crops were taken at various times since 1995, with different lapses of time in days after spraying and in different crops (coca-leaf and opium-poppy).

It should be appreciated that the range of information that can be extracted from these image and the figures of the Environmental Audit is very wide. The following can be observed from these images:

That, given the size of the plots chosen for eradication, it is unlikely that nearby vegetation would be affected due to the effects of drift.

The processes of natural regeneration are rapid, indicating that persistence in the soil is moderate because the high density of the illicit crop prevents any significant quantity from reaching it, and the biomass is deposited in the illicit crop. These considerations are the result of observations made by the eradication verification commission, formed by the environmental audit, NAS officers from the US Embassy and active members of DIRAN.

The photographs also show that the effects on nearby native vegetation, and specifically lawful crops (plantain and maize) are minimal evidenced by partial yellowing of the foliage, though this not threaten survival.

The analysis of the vegetation close to the sprayed plots allows information to be extracted in relation to the adaptive strategies of plants there with regard to extreme conditions to which they are subjected. The analysis of these symmorphies is made at the point of potential ill-effects on vegetation due to spraying with glyphosate.

There follows an account of the images included, arranged in order of time elapsed since spraying.

The attached images correspond to those of reports of the inter-institutional verification committee for the eradication of illicit crops.

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**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

LIST OF IMAGES SUPPLIED BY THE INTER-INBSTITUTIONAL VERIFICATION COMMITTEES FOR THE ERADICATION OF ILLICIT CROPS.

| LOCATION. | TIME ELAPSED AFTER SPRAYING |
|---|---|
| MUNICIPALITY OF CHAPARRAL | NOT SPRAYED |
| MUNICIPALITY OF MAPIRIPAN | NOT SPRAYED |
| MUNICIPIO DE SAN ANTONIO | 8DAYS |
| M!UNICIPALITY OF PLANADAS –TOLIMA | 5 DAYS |
| DEPARTMENT OF HUILA | 8 DAYS |
| IQü iRA (RIO l\:EGRO) | 10 DAYS |
| C.AÑO GRANDE (EL RETOR.NO) | 40 DAYS |
| SANJOSE DELGUAVIARE | 45DAYS |
| RIOBLANCO –TOLIMA | 53 DAYS |
| RIOBLANCO-TOLIMA | 53 DAYS |
| CHAPARRAL-TOLIMA | 61 DAYS |
| CHAPARRAL –TOLIMA | 62DAYS |
| SAN JOSE DEL GUAVIARE | 70 DAYS |
| RIOBLANCO TOLIMA | 77DAYS |
| CHAPARRAL-TOLIMA | 86DAYS |
| CHAPARRAL-TOLIMA | 86 DAYS |
| SAN JOSE DEL GUAVIARE | 90-120 DAYS |
| EL RETORNO-CANO GRANDE (GUAVIARE) | 125 DAYS |
| MIRAFLOR.ES (GUAVIAR.E) | 133 DAYS |
| SAN JOSE DEL GUAVIARE | 139 DAYS |
| SAN JOSE DEL GUAVIARE | 180 DAYS |
| MIRAFLOR.ES- GUAVIARE | 227 DAYS |
| EL RETORNO | 232 DAYS |
| EL RETORNO | 284 DAYS |
| SAN ANTONIO-CHAPARRAL | 360 DAYS |
| SECTOR EL RETORNO | 12 MONTHS |
| RIO BLANCO | 12-14 MONTHS |
| Si\N JOSE DEL GUAVIARE | 14MONTHS |
| RIO BLANCO | 2YEARS |

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**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| | |
|---|---|
| PHOTO No.: VA 21 | **ROLL:** RVA 118 |
| LOCATION **N** 03º 49' 12,0" **w** 75° 38' 28.4" Chaparral | |
| VERIFICATION DATE: Feb. 13/96 | **TIME SINCE SPRAYING** |
| COMMENTS - Large plot being cleared for future planting of opium poppy. Over 20 ha.<br>- Note the "criminal" destruction of the Andean jungle | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| | |
|---|---|
| PHOTO No.: VC 9 | **ROLL:** RVC 112 |
| LOCATION **N** 02° 52' 06" **W** 72° 03' 02.3" Mapiripan | |
| VERIFICATION DATE: | **TIME SINCE SPRAYING** |
| COMMENTS - The Plot prior to spraying<br>- Note in photo VC 7 the effects of aerial spraying with glyphosate | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| | |
|---|---|
| PHOTO No.: VA 08 | **ROLL:** RVA 118 |
| LOCATION **N** 03° 52' 18.3" **W** 75° 38' 18.3" San Antonio | |
| VERIFICATION DATE: Feb. 13/96 | **TIME SINCE SPRAYING** ± 8 days |
| COMMENTS - Plot sprayed not more tan 10 days before | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

## PLOT Nº 7

| | |
|---|---|
| PHOTO No.: VA 15 | **ROLL:** RVA 138 |
| LOCATION **N** 02° 58.240' **W** 75° 46.480' PLANADAS – TOLIMA | |
| VERIFICATION DATE: 27/02/97 | **TIME SINCE SPRAYING** 5 days |
| COMMENTS - Note the plot only a few days after glyphosate spraying<br>- Note that the plants have a yellowish tinge, indicating certain death (100% control). | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| | |
|---|---|
| PHOTO No.: VA 13 | **ROLL:** RVA 91 |
| LOCATION **N** 03° 16.46' **W** 74° 40.25' COLOMBIA (HUILA) | |
| VERIFICATION DATE: June 22 de 1995 | **TIME SINCE SPRAYING** 8 days |
| COMMENTS - Police officer trying to tear out a maize plant<br>- Note that the dosage of 2,5L/Ha of glyphosate affected the opium poppy-plants; maize plants between them only slightly affected<br>- No effect on surrounding vegetation | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| | |
|---|---|
| PHOTO No.: VA 36 | **ROLL:** RVA 118 |
| LOCATION **N** 02° 46' 04.6" **W** 75° 45' 41.2" Iquira (Rio Negro) | |
| VERIFICATION DATE: Feb. 13/96 | **TIME SINCE SPRAYING** ± 1O days |
| COMMENTS - Sprayed with glyphosate about 10 days ago. Not the effectiveness of the herbicide which has killed almost 100% of the crop | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

## PLOT 11


| | |
|---|---|
| PHOTO No.: VC 1 | **ROLL:** RVC 129 |
| LOCATION **N** 02° 16.414' **W** 72° 24.512' Caño Grande (El Retorno) | |
| VERIFICATION DATE: Dic. 11 de 1996 | **TIME SINCE SPRAYING** ± 40 days |

COMMENTS

- In (A). note the plot of ±3 ha of coca
- Area around Caño Pava and Caño Grande.
- This plot was not part of the simple selected but was visited in the company of the JIFE-UNDCP Observer to see the results of aerial spraying with glyphosate after 40 days.
- No damage or negative environmental impact on nearby shrubs and trees

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| | |
|---|---|
| PHOTO No.: VC 26 | **ROLL:** RVC 105 |
| LOCATION **N** 02° 32' 25.3" **W** 72° 27' 52.4" San Jose del Guaviare | |
| VERIFICATION DATE: Nov. 29, 1995 | **TIME SINCE SPRAYING** ± 45 days |
| COMMENTS - Surrounding trees minimally affected by glyphosate spraying<br>- Tons of biomass destroyed to make way for illicit coca-leaf crops.<br>- Yarumo and balso are the species most susceptible to glyphosate. They recover in a few months after slight loss of foliage. | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**PLOT 4**


| | |
|---|---|
| PHOTO No.: VC 36A | **ROLL:** RVA 137 |
| LOCATION **N** 03° 27'550" **W** 75° 45' 190" Rio Blanco | |
| VERIFICATION DATE: 27/02/97 | **TIME SINCE SPRAYING** ± 53 days |
| COMMENTS | - Destruction – slash-and burn and deforestation – are common practices in illicit crops.<br>- (1) note the total destruction of opium poppy..<br>- (2) See newly planted poppy, not more than 30 - 45 days. |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**PLOT 4**

| PHOTO No.: VA 35 | **ROLL:** RVA 137 |
|---|---|
| LOCATION **N** 03° 27'550" **W** 75° 45' 190" Rio Blanco – Tolima | |
| VERIFICATION DATE: 27/02/97 | **TIME SINCE SPRAYING** ± 53 days |
| COMMENTS - Note the maize crop (1) unaffected, but the poppy plants are eradicated.<br>- Note that the trend in the establishment of illicit crops is to look for areas of higher ground (over 2.500 m). | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**PLOT 4**

| | |
|---|---|
| PHOTO No.: VA 15A | **ROLL:** RVA 132 |
| LOCATION **N** 03° 41.82' **W** 75° 42.03" Chaparral Tolima | |
| VERIFICATION DATE: DEC 18 1996 | **TIME SINCE SPRAYING** 61 days |
| COMMENTS - Note the excellent application of glyphosate spraying.<br>- Efficiency is 100%. Plot of 20 – 25 ha.<br>- Note the insensitivity of the drug crop growers in destroying invaluable High Andean Woodland systems. | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| | |
|---|---|
| PHOTO No.: VA 8 | **ROLL:** RVA 132 |
| LOCATION **N** 03° 41.98' **W** 75° 41.03" Chaparral Tolima | |
| VERIFICATION DATE: DEC 17 1996 | **TIME SINCE SPRAYING** 62 days |
| COMMENTS - Plot of 6 - 10 ha.<br>- Note spraying efficiency of 80% - 90%<br>- Note the phenomenon of serious erosion caused by deforestation<br>on steep slopes (1 ). | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| | |
|---|---|
| PHOTO No.: VC 5 | **ROLL:** RVC 105 |
| LOCATION **N** 02° 29' 04.6" **W** 72° 26' 41.5" San Jose del Guaviare | |
| VERIFICATION DATE: Nov. 29 de 1995 | **TIME SINCE SPRAYING** ± 70 days |

COMMENTS - Palms are another species that quickly invade abandoned land. 1, after spraying.

- The coca crop disappeared after aerial spraying with glyphosate and the effects on surrounding vegetation are nil, 2.

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**PLOT 2**


| | |
|---|---|
| PHOTO No.: VA 31 | **ROLL:** RVA 137 |
| LOCATION **N** 03° 27.100' **W** 75° 50.600' | |
| VERIFICATION DATE: 27/02/97 | **TIME SINCE SPRAYING** ± 77 days |

COMMENTS - Plot in Rioblanco - Tolima.

- Note the track of the aircraft (1), which was effective in eradicating the illicit poppy crops.
- Note that the areas eradicated are used for cattle ranging, an activity inappropriate for this type of soil and physiography
- In (2) plots sprayed in previous years are now in the process of natural regeneration or restoration

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| | |
|---|---|
| PHOTO No.: VA 27 | **ROLL:** RVA 137 |
| LOCATION **N** 03° 39.380' **W** 75° 39.300' | |
| VERIFICATION DATE: 27/02/97 | **TIME SINCE SPRAYING** ± 86 days |
| COMMENTS - Plot in Chaparral - Tolima, towards San José de Las Hermosas.<br>- Note that 90% of the area planted with opium poppy was eradicated.<br>- Note that the natural forest was not affected by aerial spraying. | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**


| | |
|---|---|
| PHOTO No.: VA 29 | **ROLL:** RVA 137 |
| LOCATION **N** 03° 39.380' **W** 75° 39.300' Chaparral | |
| VERIFICATION DATE: 27/02/97 | **TIME SINCE SPRAYING** ± 86 days |
| COMMENTS - Note that the trees are not affected by aerial spraying with glyphosate<br>- Note in (1) a small area of opium-poppy not sprayed but abandoned because, no doubt, its small size was not economically viable | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

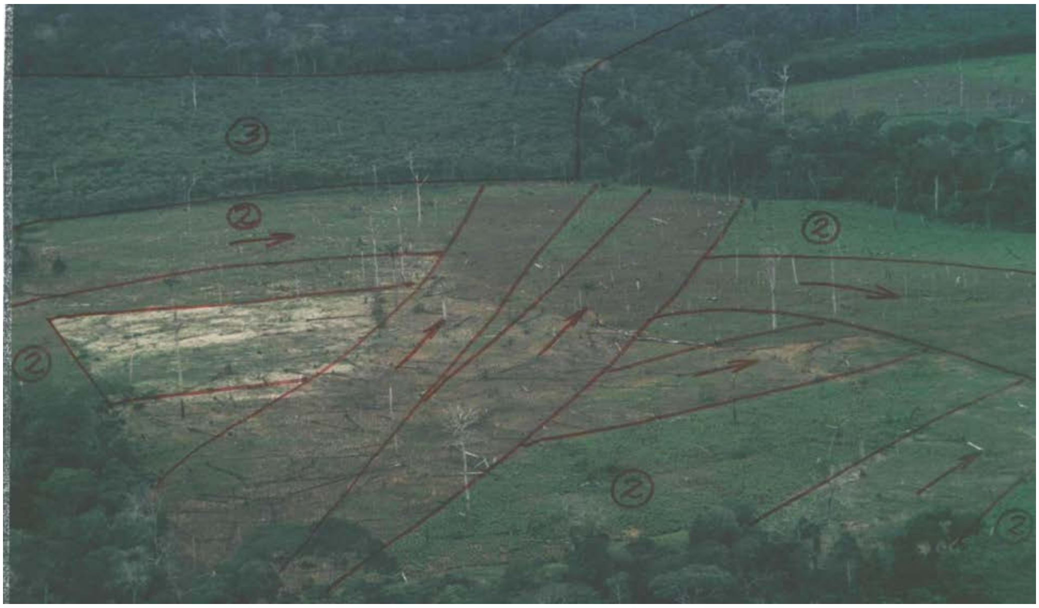
| | |
|---|---|
| PHOTO No.: VC 33 | **ROLL:** RVC 104 |
| LOCATION **N** 02° 24' 41.4" **W** 72° 31' 09.9" San Jose del Guaviare | |
| VERIFICATION DATE: Nov. 29 1995 | **TIME SINCE SPRAYING** ± 90 – 120 days |
| COMMENTS - Natural restoration is excellent and vegetation on the edge of the plot shows no signs of negative effects from spraying 1.<br>- In 2 note the ecological crime of the destruction of nature, large trees, palms etc. | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**PLOT 2**

| | |
|---|---|
| PHOTO No.: VC 20 | **ROLL:** RVC 137 |
| LOCATION **N** 02° 16.609' **W** 72° 33.530' | |
| VERIFICATION DATE: 26/02/97 | **TIME SINCE SPRAYING** 128 days |
| COMMENTS - Note completely necrotic (dead tissue) logs and branches. | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**




| | |
|---|---|
| PHOTO No.: VC 31 | **ROLL:** RVC 129 |
| LOCATION **N** 01° 26.64' **W** 71° 52.76' Miraflores (Guaviare) | |
| VERIFICATION DATE: Dic. 12 1996 | **TIME SINCE SPRAYING** 125 days |

COMMENTS

- Plot size: 30 - 50 ha.
- Effectiveness of spraying: 80%-90%.
- Note the track of the aircraft. Here, the coca is completely dead and out of production (1).
- In (2) the coca continues, but in a bad state.
- In (3),natural regeneration secondary succession (rapid-growth species) e.g. yagrumo, balsa tree, etc.

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**


| PHOTO No.: VC 8A | **ROLL:** RVC 121 |
|---|---|
| LOCATION **N** 02° 47' 00.2" **W** 72° 05' 45.8" San Jose del Guaviare | |
| VERIFICATION DATE: Nov. 29 1995 | **TIME SINCE SPRAYING** ± 90 – 120 days |
| COMMENTS - Note the size of the coca plot, abandoned after spraying with glyphosate<br>- Totally dead coca-plants (1).<br>- Note the invasion of yagrumo (2), shrubs and grasses<br>- An overflight determined that crops sprayed had been eradicated | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| | |
|---|---|
| PHOTO No.: VC 8 | **ROLL:** RVC 105 |
| LOCATION **N** 02° 30' 11.2" **W** 72° 27' 38.0" San Jose del Guaviare | |
| VERIFICATION DATE: Nov. 29 1995 | **TIME SINCE SPRAYING** ± 180 days |
| COMMENTS<br>- NAS personnel in Colombia took part in the verification.<br>- This plot was completely eradicated. The picture shows very encouraging natural regeneration of forest | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**PLOT 1**

| | |
|---|---|
| PHOTO No.: VC 10 | **ROLL:** RVC 137 |
| LOCATION **N** 01° 24.230' **W** 71° 58.703' Miraflores - Guaviare | |
| VERIFICATION DATE: 26/02/97 | **TIME SINCE SPRAYING** 227 days |
| COMMENTS | - Plot sprayed 08/07/96 in the area of Miraflores, size about 15-20 ha.<br>- USDA/ARS estimate that at least 90% of the plot had been eradicated.<br>- Note the invasion of natural vegetation (grasses and herbaceous). Note that some plants had non-productive leaves and the stems are completely necrotic (dead) |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**PLOT 3**

| | |
|---|---|
| PHOTO No.: VC 34A | **ROLL:** RVC 121 |
| LOCATION **N** 02° 07' 45.8" **W** 72° 10' 01.3" El Retorno | |
| VERIFICATION DATE: May 06, 1996 | **TIME SINCE SPRAYING** ± 232 days |
| COMMENTS Note the process of succession after the eradication of coca.<br>Invasion of gramineous species (1).<br>Invasion of heliophytes (Balsa, Yagrumo) (2).<br>Succession of shrubs (3). | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

**PLOT 2**


| | |
|---|---|
| PHOTO No.: VC 30A | **ROLL:** RVC 121 |
| LOCATION **N** 02°14' 06.1" **W** 72° 03' 40.2" El Retorno | |
| VERIFICATION DATE: May 06, 1996 | **TIME SINCE SPRAYING** ± 284 days |
| COMMENTS - Note totally eradicated plots (1) now again invaded by native vegetation<br>- Shrubs and trees are the best evidence that the plot was abandoned<br>- Distances calculated by GPS Between A- B = 479 m. Between C- D = 333m. | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| | |
|---|---|
| PHOTO No.: VA 04 | **ROLL:** RVA 118 |
| LOCATION Tolima-Sector de San Antonio-Chaparral N 03" 57' 22,8" W 75 n 32' 48,8" | |
| VERIFICATION DATE: Feb. 13/96 | **TIME SINCE SPRAYING** ± 360 days |
| COMMENTS Process of natural restoration of plots sprayed a year ago. | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| PHOTO No.: VC 23 | **ROLL:** RVA 104 |
|---|---|
| LOCATION **N** 02" 21' 29.2" **W** 72" 32' 13.0" Sector El Retorno | |
| VERIFICATION DATE: Nov 29 1995 | **TIME SINCE SPRAYING** 12 MONTHS |
| COMMENTS - The large spreads of coca near El Retorno have disappeared due to the Eradication Program.<br>- Plot invaded by natural vegetation… Excellent restoration<br>- No clinical cases attributable to glyphosate application have been reported | |

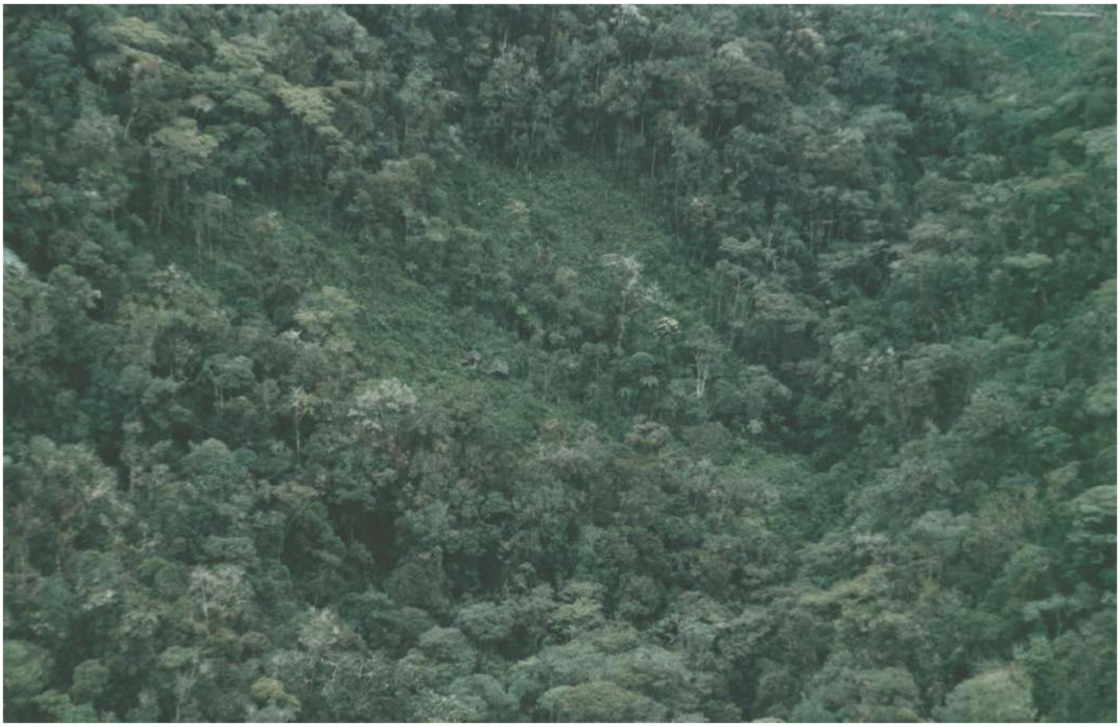
**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**


| | |
|---|---|
| PHOTO No.: VA 30 | **ROLL:** RVA 118 |
| LOCATION **N** 03" 34' 40.2" **W** 75” 48' 04.4" Rio Blanco | |
| VERIFICATION DATE: Feb 13/96 | **TIME SINCE SPRAYING** 12 – 14 MONTHS |
| COMMENTS - Large plot with opium-poppy 1, more tan 6 ha.<br>- Plot sprayed about a year ago 2. Note the process of natural regeneration. | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

| | |
|---|---|
| PHOTO No.: VC 17 | **ROLL:** RVC 105 |
| LOCATION **N** 02" 30' 47.5" **W** 72” 27' 26.7" San Jose del Guaviare | |
| VERIFICATION DATE: Nov 29 1995 | **TIME SINCE SPRAYING** ± 14 MONTHS |
| COMMENTS - Note the excellent succession of plants: heliconia, balsa, yagrumo, grass, palms, etc., in coca crops abandoned after spraying 1.<br>- The few surviving species of coca are eliminated by the dynamic process of succession. | |

**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**



| | |
|---|---|
| PHOTO No.: VA 25 | **ROLL:** RVA 118 |
| LOCATION **N** 03" 39' 50.0" **W** 75" 42' 06.6" Rio Blanco | |
| VERIFICATION DATE: Feb 13/96 | **TIME SINCE SPRAYING** ± 2 Years |
| COMMENTS - Plots sprayed about 2 years ago. Note the abandoned houses<br>Note the good degree of natural restoration. | |

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**Supplementary Information to the Environmental Management Plan for the eradication of illicit crops**

…

7.1 Herbicides displacement in soils

LETEY and FARMER (1.994) state that displacement of an herbicide in soil may occur as a result of diffusive and mass flow phenomena

**Diffusion** is the process by which matter is transported as a result of random molecular movement caused by the thermal energy of molecules. It causes a uniform distribution inside the system. It occurs in movement network of high to low concentrations. **Mass flow** occurs as a result of external forces. Displacement of Glyphosate will occur, then, as a result of water current or particles in soil, which combine with the pesticide molecules.

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STIKLER, KNAKE, and HINESTRY (1.969), cited by the former authors, found that the effectiveness of an herbicide depends on the water contents in soil. Some herbicides become more effective as water contents in soil increases. This effectiveness is attributed to water contents present in the displacement of the diffusion process.

To date, different models have been developed to describe the mass flow of chemical products through the water and soil profiles. All of them have to do with water flow and, especially, its velocity. The most important parameter in the absorption coefficient between the herbicide and soil. For instance, the herbicide with a high absorption coefficient will be relatively immobile in soil.

Based upon researches carried out, there is an inverse order between displacement and absorption and an inverse relation between absorption and lixiviation.

Likewise, there more modern evidence of the inverse relation between absorption and displacement of herbicides through soil due to water. As the content of **organic matter** increases, depth of lixiviation decreases. Similarly, as organic matter content increases, pesticides absorption coefficient increases. On the other hand, in very “heavy soils”, with increase of clay content the absorption coefficient increases and pesticides mobility decreases.

WEED and WEBER (1.994) point out that bio-activity (organic matter), displacement, and persistence of pesticides in soil depend greatly on the interaction of the pesticide molecules with the absorption of the complex soil. Absorption reduces concentration in the soil solution, thus, part of the pesticide is removed from power center. The effect depends on the nature of the absorbed molecule, on the absorbing surface, the soil chemistry, and the form of bio-influence.

On the other hand, RILEY and EAGLE (1.994) mention that inactivation processes, adsorption, lixiviation, volatilization, up-taking by plants the soil granulometry, and residues of herbicides are the most important items in displacement of the herbicide in soil.

- **Inactivation**. Herbicides may be lost in soil when physically removed as a result of molecular exchange or degradation (physical mechanism of transport or elimination)

- **Adsorption**. Herbicides distribute in soil, according to the solid, liquid or gaseous phases. Although it is very important to acknowledge that there is not a true thermodynamic balance in soil, it is described by the absorption coefficient because the concentration of herbicides in soils controls the biological profitability and its mobility. Organic matter of soils and the pH influence the herbicide adsorption.

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- **Degradation**. Decomposition is the most effective process to eliminate herbicides in soil. Photochemical degradation of herbicides may be important on the plants’ surface, particularly when they have been incorporated into the soil. The main degradation mechanism is chemical and biological. Many of the herbicides containing chemical groups, which are susceptible to hydrolysis, in aqueous solution, and with similar pH may be different under aerobic or anaerobic conditions. Although chemical degradation occurs, the microorganisms are involved in some later stages, which lead the herbicide to mineralization of carbon dioxide ($CO_2$).

- **Lixiviation**. The concentration of a chemical product affects its lixiviation for the draining through the soil pores. A strong absorption, soil aggregates, with a high amount of micro pores, tend to significantly reduce the gravitational movement of the soil profile. In practice, the least mobile residues are found confined in the first centimeters of the soil profile, some more mobile ones are found up to a meter below the surface.

- **Volatilization**. The incorporation of herbicides into soil, the use of granulated formulations, soil humidity, and light rain, after application, help displacement of herbicides in soil and reduce volatilization as well as adsorption.

7.2 Reports on research on the effects of Glyphosate herbicide on tropical soils.

Now, other researches found on herbicide displacement in soil and that are part of a wide range of researches reported in the Environmental Management Plan, Chapter III, pages 34 and 35, Chapter Vi, pages 17 – 21, and Chapter VII, pages 36 – 48.

Thus (WILLIS, 1.994), concludes that the toxicity of herbicides in soil depends on the proportion of the component in the soil solution, in relation with that absorbed by the soil colloids, properties vary with water contents and weather factors.

According to the Environmental Management Plan for the Eradication of Illicit Crops, “the molecular degradation seems to occur in a relatively short period of time in tropical soils. There is a lot of information on the subject, but to the effect, it is enough to make reference to one of the most in-depth researches prepared by the researcher C.S. …

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… Helling, engaged in the Research Services of the United States Department of Agriculture”

“Data by C.S. Helling (1.997) from the researches made Environmental Dissipation of Glyphosate and other herbicides in soils experimentally treated in certain regions of Panama and Peru, with substantially higher doses than the ones required for weed control, show that no residues of the parent product or its main metabolite, the Aminomethylphosphonic acid (AMPA) were not detected in soil samples taken 1,5 and 3 months after applying treatments on coca crops"

According to MONSANTO (1.972b) and cited in the Environmental Management Plan for the Eradication of Illicit Crops, the Glyphosate degradation rate in soils "seems to be quick". The fact is that the Aminomethylphosphonic acid AMPA is more persistent than Glyphosate; in which amounts of AMPA 111 days after application, rates were 10 to 17% of the amount initially applied.

With regard to the mean life of parent product in soil (AMPA), i.e., the time [*sic*] required for half of the product applied to metabolize or disappear may range between 3 and 141 days (Environmental Management Plan for the Eradication of Illicit Crops.)

CLAES (1.998) mentions that Glyphosate is a persistent herbicide. Tests carried out by Monsanto (company that manufactures Glyphosate-based products) showed that up to 140 days were necessary for half the amount of the product applied to decompose or disappear.

However, "there are authors that state that usually the biocide effect is very short in tropical soils because the molecule is susceptible to degrade rapidly and can break and transform into components such as CO2, water, certain nitrogen fraction, and some phosphates; all this due mainly to microorganisms action". (Environmental Management Plan for the Eradication of Illicit Crops).

The same author mentions that 2the high persistence of the parent molecule only occurs in ecosystems with temperatures below the freezing point, such as some regions in Canada, where, besides low temperatures, there is also an almost complete reduction of microorganisms activities, responsible for decomposition of the parent molecule.

MENDOZA et al (1.999) made *in vitro* tests to determine the toxic effect of herbicides Glyphosate and paraquat on the nitrification process on sandy loam soil (pH: 5,8, moisture: 13,05%), in the village of Rio Frio, Magdalena. A reduction in nitrification and an increase in the delay period were observed as concentrations increased. However, with high doses of commercial Glyphosate (100 and 1000 ppm of Round Up) and commercial paraquat (1000 ppp of Gramaxone) there was inhibition of nitrification.

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Both standard and commercial paraquat, at 10 and 100 ppm, caused slight disturbance on nitrification, which returned to relative normality after 30 days.

Similarly, a significant difference was observed between commercial Glyphosate (maximum nitrate concentration) and standard Glyphosate at a concentration of 1000 ppm, which suggests that adjuvants in the commercial product contribute to increase the toxic effect of the herbicide.

These data reported based on in vitro tests are of interest to develop pesticides use techniques that allow for the recovery of microbial populations for soil fertility.

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…

## Annex 32

### NOTE N° 24171 FROM THE NATIONAL NARCOTICS DIRECTORATE (DNE) TO THE MINISTRY FOR THE ENVIRONMENT, 8 AUGUST 2001

*(Archives of the Colombian Foreign Ministry)*

REPUBLIC OF COLOMBIA

Ministry of Justice and Law
National Narcotics Directorate

Bogota, D.C.

ASE 24171

Mr.
JUAN MAYR MALDONADO
Minister for the Environment
City

Dear Mr. Minister:

In compliance with your Order 516 dated July 2001 issued by that Ministry, I am submitting the progress report of the liabilities set upon this Directorate according to Resolution No. 0341, following the order established in the chart outlined, as a minute, after the follow-up meeting on the work carried out by the National Narcotics Directorate, last July 23.

In order to comply with the terms set out in the Resolution, I would appreciate it if the comments on the report are submitted by August 22.

Sincerely,

[Signed]
GABRIEL MERCHAN BENAVIDES
DIRECTOR

# Annex 33

**NOTE N° 32280 FROM THE NATIONAL NARCOTICS DIRECTORATE (DNE) TO THE MINISTRY FOR THE ENVIRONMENT ENCLOSING THE ENVIRONMENTAL MANAGEMENT PLAN (EMP) OF THE PROGRAM FOR THE ERADICATION OF ILLICIT CROPS BY AERIAL SPRAYING WITH GLYPHOSATE (PECIG), 6 NOVEMBER 2001**

*(Archives of the Colombian Foreign Ministry)*

REPUBLIC OF COLOMBIA

*Ministry of Justice and Law*
*National Narcotics Directorate*

Bogotá, 6 Nov. 2001 32280

Mr.
JUAN MAYR MALDONADO
Ministry for the Environment
Bogotá

Dear Mr. Minister:

It is my pleasure to submit the Environmental Management Plan for the Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate, within the submissions time period set out by Resolution 0341 issued by that Ministry.

Likewise, I am sending the progress status of compliance with Resolution 0341.

I will be awaiting for your Ministry's comments in order to make the corresponding adjustments; nevertheless, the Directorate has started the necessary arrangements to implement it.

Truly yours,

*[Signed]*
GABRIEL MERCHAN BENAVIDES
Director

Enclosures: Environmental Management Plan for the PECIG
Annexes of the Environmental Management Plan
CD of the Environmental Management Plan for the PECIG
Second progress report of Resolution 0341 with 2 CD's containing characterizations made by DIRAN during 2001.

GGE

# ENVIRONMENTAL MANAGEMENT PLAN OF THE PROGRAM FOR THE ERADICATION OF ILLICIT CROPS BY AERIAL SPRAYING WITH GLYPHOSATE (PECIG)

## MAIN VOLUME

## BOGOTA, NOVEMBER 2000

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## INTRODUCTION

This Environmental Management Plan (EMP) has been prepared according to the regulations provided for in Decree 1753, 1994 and the requirements included in Resolution 0341, 2001 issued by the Ministry of the Environment to the National Narcotics Directorate (DNE).

The mentioned Plan includes five chapters and an Executive Summary:

. Chapter 1 comprises an introduction to the EMP with a general description of the objectives, sites of the illicit crops, justification for the Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate – PECIG -, legal framework, background and institutional structure.

. Chapter 2 includes a description of the Program, its stages of development, the characterization of glyphosate as herbicide, application method, equipment and materials used and the institutional and operational organization to execute same.

. Chapter 3 describes the general baseline of the Program comprised by the general physical, biotic and socioeconomic conditions of the coca and poppy areas and the socioeconomic and environmental impact created by the illicit crops, the stage within which PECIG control activities are performed.

. Chapter 4 includes an assessment of the environmental impacts created by the eradication of illicit crops by aerial spraying with glyphosate, particularly on soil, water, vegetation, fauna, health of the human population exposed to it and agriculture and livestock production.

. Finally, as a result of the above, Chapter 5 shows the Environmental Management Plan as such, encompassing a set of preventive, corrective, mitigation and compensation measures of the impacts generated.

According to the regulations in force, although an environmental management plan must be focused on the measures to be applied for the control of impacts of a certain activity or project, it has been deemed convenient to give this EMP a similar structure as that of a regular Environmental Impact Study, due to the high sensitivity existing around the subject of aerial spraying of the illicit crops with glyphosate.

It must be observed, however, that this is the framework of an Environmental Management Plan at a national level and coverage, developed to encompass the eradication of illicit crop activities through aerial spraying with glyphosate in all the areas where they are found, now or in the future. Thus, and due to the illicit nature of these crops, the detailed environmental characterization of the areas to be sprayed is considered to be the object of the immediate stage prior to the spraying operation in order to determine, in real time, the environmental and socioeconomic conditions to be taken into account during the spraying process.

**[Page 4]**

## EXECUTIVE SUMMARY

The purpose of the Environmental Management Plan (EMP) is to establish the actions which will be used by the entities responsible for the Program of Eradication of Illicit Crops through Aerial Spraying with the Glyphosate Herbicide – PECIG – in order to prevent, mitigate, control, compensate and correct the eventual negative environmental effects or impacts caused by the program, including follow-up, assessment, monitoring and contingency plans. The Plan has been set up according to the provisions of the Ministry of the Environment by decrees and resolutions issued on the matter, specifically Resolution 0341/2001 in aspects related to an environmental management plan, and provisions issued by the National Narcotics Council on the eradication of illicit crops. The purpose of the application of the EMP is not only to control the environmental impacts of the Aerial Spraying with Glyphosate Program but to reduce the great impact generated by the illicit crops to the Colombian ecosystems, such as deforestation, erosion, water pollution, migration of population and effects over indigenous people and cultures, amongst others.

Twenty four provinces in the country are the main coca crop areas, although 74.3% of those areas belong to the provinces of Putumayo, Caquetá, Guaviare and Meta. Poppy crops are found mainly in the provinces of Cauca, Nariño, Tolima and Huila (72.6%). Notwithstanding the mentioned illicit crops distribution, the Program for Eradication of Illicit Crops by Aerial Spraying with the Glyphosate Herbicide will take place only in those areas where the crops are considered industrial, such as was determined by the National Narcotics Council's Resolution 0005 of August 11/2000.

In general, the areas chosen for coca cultivation are located in hot, humid and very humid climates, flat to uneven land, soils with low or very low potential for traditional agricultural activities and high drainage density, with a great number of rivers and streams with permanent flow due to abundant rainfall.

Therefore, coca crops are located in humid to very humid tropical forests (equatorial evergreen forests or ombrophilous forests) frequently intervened and, in some cases, **felled** almost in their entirety, such as that at Serranía San Lucas in southern Bolivar, among others. These forests have a great variety of flora and fauna and also several endemic factors and endangered species. On the other hand, poppy crops are situated in potential Andean and high Andean forest areas of great relevance due to their biodiversity and the interest existing in water conservation, the sources of which are used for rural and urban waterworks. There are protected areas to be affected or which are affected by illicit crops mainly in the areas of PECIG, but not to be sprayed, according to Decree 1843/1991, included and geo-referenced in the SATLOC system, which alerts the aircrafts when they are approaching such areas.

In general, from the socioeconomic viewpoint, coca crops are situated in low populated areas, characterized by extreme poverty levels and no utilities, with economy based on extractive activities and with no economic infrastructure to develop traditional economic activities, or with a low coverage level (roads, electricity, others). On the other hand, poppy crops are carried out in a relatively higher population density but, in any case, lower in comparison to the middle levels of the country and with extreme poverty and lack of utilities as well; traditional farmers, with a low-coverage level in economic infrastructure to carry out traditional economic activities. Indigenous population is present in almost all the illicit crops areas, particularly in the Meta-Guaviare-Vaupes, Choco, Caqueta-Putumayo and Cordoba sites, although the larger indigenous population is found in the areas influenced by poppy crops (Chaparral-Iquira-Paez-Teruel).

From the environmental point of view, a very important characteristic is that generally coca crops are not located inside the forests but in open areas with grasses and traditional crops which is a sign that these are situated more in consolidated colonized areas or in the process of consolidation.

If the problem of illicit crops is to be analyzed as a whole, in the light of the legal regulations in force in Colombia which consider them to be a crime, of the international commitments of the country regarding the production and control of the narcotic traffic and of the huge environmental and socio-cultural impacts which the drug traffic development has caused and continues to cause, specifically in the most fragile ecosystems in Colombia, such as humid forests, tropical rainforests and the Andean forests, it could be considered that the eradication of illicit crops by aerial spraying with glyphosate is a measure to mitigate the environmental impact caused by those crops.

PECIG is a Governmental strategy, supported by national and international policy, and technical, economical, social, environmental and regional development reasons, amongst others:

- Colombian Government policy, with specific plans and programs designed and executed by each successive government.
- Coca, poppy and marihuana crops with more than 20 plants are considered by Colombian law (among others, Law 30/1986) as a crime that has to be sought after at the sites where they are located.
- They are part of accords and treaties signed by Colombia at a multilateral level (United Nations) and at a bilateral level.
- During recent years, satellite detection techniques have allowed larger illicit crop areas to be identified, mainly in southern Colombia where physical and socio-economic conditions have encouraged it. To overcome this situation, the Government has carried out essential actions in operation for the organization of methodologies to identify and monitor permanently the dynamics of the crops, develop operations to destroy industrial-type illicit crops and, as a long-standing strategy, an alternate development in order to reduce the participation of target population in unlawful activities.
- The entry of illicit crops in several regions of Colombia has wreaked havoc in the traditional economy and has fostered migratory processes and increased the intensity of violent actions since it has become a source of financing for several and numerous groups of illegal armed forces.
- The illegal drug-trafficking industry is at present the largest factor in environmental degradation in Colombia, not only due to the deforestation of areas of extensive tropical rainforest and Andean forest of these plantations, but also due to contamination of the ecosystems as a result of the large volumes of pesticides and chemical ingredients used on the inadequate removal of waste, activities which are performed without any control. In view of the above, the environmental impact caused by the eradication of the illicit crops using aerial spraying with glyphosate is just a minimal part of the impact caused by the different activities of the drug traffickers, which conceals the real environmental problem generated by this industry, besides the social, economic and health impact created by the illicit crops activity.
- According to studies conducted in recent years, it has been established that to have one hectare of coca, farmers must destroy 4ha of forest and for one of opium-poppy, 2.5ha of Andean forest[1].
- Burning down forests and woods means the destruction of 380 tons of biomass per hectare, that is, an accumulated total of 152 million tons of biomass, which turn into ashes, $CO^2$ and sediments[2].
- Destruction of these ecosystems severely harms the ecological homeostasis, which in the Amazon is determined by the great diversity of

[1] Parra L.E., 1997, Impacto ambiental en los cultivos ilícitos en Colombia. Rev. Coloquio No. 3, pp 69-107
[2] Parra L.E., 1997, ibid

flora, unique in the Planet – between 96 and 120 tree species per hectare – an unknown number of minor species, aside from micro-flora and micro-fauna with an infinite genetic potential[3].

- Frequently, illicit crops such as poppy and coca are located in ecosystems of an incalculable environmental value, those being the largest gene-banks worldwide, with a vital ecological importance due to their capacity to regulate $CO^2$ and keep the emissions to the atmosphere stabilized.
- Available technical reports show that 98.7% of farmers use pesticides and fungicides for plague and disease control; 92.5% use chemical fertilizers and 95.5% controls the competition of other plants with herbicides, in quantities such as to constitute an additional factor of imbalance of the fragile ecosystems of the Amazon and Orinoco regions, Pacific platform and high Andean areas (Uribe S., 1999).
- Along with the degradation of the forest ecosystems, there are changes in the habitat of the indigenous population still living in the forests, thus creating a loss of cultural diversity, a process which is increased by the incoming settlers and coca leave pickers in search for quick fortune, which leads to the loss of cultural identity of the indigenous communities who come in contact with them.
- Since a large amount of the crops are considered industrial, and due to the difficulty in accessing the sites by land or water or due to public disturbances, they cannot be eradicated manually; therefore it is necessary to eradicate them by aerial spraying with the herbicide.

Regarding this situation, the Program of Eradication of Illicit Crops by Aerial Spraying with Glyphosate – PECIG – in general causes a low environmental impact, a situation closely related to the following facts:

- Through the disincentive and targeting of the main factor of this environmental problem, which constitutes the growth of illicit crops, PECIG seeks to stop the deforestation process of the Colombian humid rainforest and high Andean forests.
- During this process, aerial spraying of the illicit crops may cause some impacts on the neighboring forests to such crops, but those impacts are not highly important as this EMP confirms. Moreover, in such cases where there are impacts, they shall be duly compensated by the environmental authorities.
- International scientific literature and local experience show that the use of glyphosate in lawful crops quickly degrades in soil and water, is not bio-

[3] Parra L.E., 1997, ibid

accumulating and the concentrations it may reach in the food chains as a result of spraying are lower than the limits established by the local and international authorities to be able to cause any significant harm over the land and water fauna and on human health. The US EPA (Environmental Protection Agency of the United States) has accepted, based on available research, that glyphosate is not a carcinogenic, oncogenic or teratogenic agent, nor does it cause any delayed neurotoxicity in humans and animals.

- The environmental management to be given to the Program excludes the areas of the Natural National Parks System, water bodies, human settlements and economic areas of interest as well as buffer strips of land regarding the same elements and mulched areas other than illicit crops. Likewise, it has a series of operating procedures to reduce the impacts caused by the same aerial spray to a minimum and to the handling of the herbicide at the base of operations, as well as all other elements or activities susceptible to create environmental impacts.

The main negative impacts are those caused on the lawful crops, due to the fact that they were inserted into or associated with illicit crops as a strategy of the coca-leaf and opium-poppy growers, and over the forests in the same situation. Nevertheless, the importance of these impacts has been deemed as low, given the operational technical specifications and the safety measures of the anti-narcotic bases. Likewise, it is important to note that there is a possibility of attacks on the bases and aircraft by the illegal armed groups.

On the other hand, the Program will undoubtedly have positive impacts, particularly due to disincentive in deforestation in order to establish illegal crops and pollution generated by all the drug traffic industry responsible for contamination due to not yet tested pesticides in those areas.

The proposed Environmental Management Plan includes thirteen (13) specific programs, distributed as follows:

- *Prevention programs:* Handling of spraying operations; handling of glyphosate at the operational bases; handling of fuel, vehicles, equipment and transportation of glyphosate and handling of solid residues.
- *Mitigation programs:* Handling of residual waters; inspection, verification and control of spraying operations; research in demonstrative and representative plots and environmental monitoring.
- *Social feasibility programs:* Social administration and compensation; educational communication and integral safety at the operational bases.
- *General programs:* Environmental administration: Contingency Plans.

Total annual cost of the environmental activities amounts to COP603.942.000 per base and COP4.227.594.000 per year for the foreseen 7 main bases, that is COP67.792 per hectare. This cost represents 5.8% of the spraying cost per hectare for coca and 6.3% for poppy.

**[CHAPTER 1]**

## 1. GENERAL ASPECTS OF THE PROGRAM

### 1.1 GENERAL OBJECTIVE

The purpose of the Environmental Management Plan is to establish the actions to be applied by the authorities in charge of carrying out the Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate – PECIG -, in order to prevent, mitigate, control, compensate and correct the possible negative environmental effects or impacts caused by the Program, including follow-up, assessment, monitoring and contingency plans.

### 1.2 SPECIFIC OBJECTIVES

- Identification and brief description of the environmental resources and values which may be affected by the proposed project under the existing conditions.
- Description of the effects PECIG may have over environmental resources and values.
- Description of the specific manner by which the EMP aims to minimize adverse effects and maximize the positive effects.

In order to achieve these objectives, the report starts with general knowledge of the present conditions – physical, biotic, socioeconomic and cultural – of the areas in which the Eradication Program is to be applied, as well as the characteristics of the aerial spraying of herbicide process emphasizing those susceptible to create environmental impacts.

Based on the knowledge of the environmental conditions and on the characteristics of the project, there is an assessment phase to answer these four basic questions:

- What are the expected changes as a result of PECIG? It is the identification of impacts or determining the possibility of interaction between the project and the environmental conditions of the area.
- What would be the scope of changes? The prediction of the expected magnitude of impacts, or the quantification of same in physical, biological, economic, social terms or others, according to their nature.

- Are the changes important? It is the assessment or the determination of the real importance of each impact facing the present situation, to the expectations of the population or to the existing legislation or to other relevant parameters.
- What is to be done to manage or control changes? It is the determination of the necessary mitigation measures for those impacts which are significant during the assessment.

This process is repetitive until the measures that show that the project is feasible are found from the environmental point of view. In the chapter regarding the assessment of impacts, the four previous stages were presented in a unified and synthetic manner, seeking to emphasize the real significant impacts of the project, although they were completely considered in the analysis.

For operational purposes, impact assessment has been organized according to the affected area, thus, impacts on the physical, biotic and socioeconomic-cultural media.

Each impact has been graded according to the following criteria:

* Character: direct, indirect

* Sense: negative, positive

* Probability of its occurrence: sure, probable, unlikely

* Duration: long or residual term, medium term, short term

* Reversibility

* Real importance: insignificant or worthless (0), very low (1), low (2), medium (3), high (4), very high (5)

Impacts are summarized and shown in synthesis in the reduced matrix of the environmental impact of PECIG (see Fig. 4.3 in chapter 4).

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**1.3 BACKGROUND**

The Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate – PECIG – for many years has been an official Colombian Governmental policy, has been recorded in the drug plans prepared by the relevant authorities and involves the institutions for its implementation with the least social impact and without significantly harming the environment.

For approximately three decades, illicit marihuana (*Cannabis sativa),* coca *(Erythroxylum coca var. Coca, E. Coca var., Ipadu and E. Novogranatense var. novogranatense)* and poppy *(papaver sonmiferum)* crops activities have been established and, thus, processing and traffic of narcotics derived from these plants have been developed.

Due to this situation, the National Government was committed to eradicate the illicit crops at the different bio-geographic regions of the country, including private properties, reservations, natural forests and parks, taking into consideration social, political, economic, legal, environmental and health aspects in an attempt to solve the problem once and for all.

Law 30, 1986 determines a procedure for the destruction of illicit plantations and specifically assigns to the Consejo Nacional de Estupefacientes – CNE (National Narcotics Council) the mission of "*arranging for the destruction of the marihuana and coca crops and other plantations from which substances producing dependence may be extracted, using the most appropriate methods, with a prior favorable concept of the entities in charge of looking after the health of the population and the preservation and balance of the country's ecosystem".* To this effect, this Entity issued Resolution 0001/94 through which the eradication of illicit crops in Colombian territory is authorized and the relevant procedures are established.

Through Decree-Law No. 423, 1987, Article 2 and Resolution 0001/94, the action of repression of the criminal conducts related to illicit crops was assigned to the Anti-Narcotics Police. This action to eradicate is to be implemented following criteria of responsibility and environmental control, where prevention, mitigation, correction and compensation of the eventual impacts caused by the eradication on the natural and bio-physical environment as well as the socio-economic factors must necessarily be considered.

The Program for the Eradication of Illicit Crops has developed the processes detailed below to determine the use of Glyphosate during the aerial spraying of illicit crops.

The Colombian Government has been using the aerial spraying method as a highly efficient and effective mechanism for the elimination of illicit crops since 1984, without prejudice of the ongoing plans, social agreements for voluntary eradication with the participation of local communities. Thus, from 1988, the ruling Government considered convenient to involve the environmental variable in the application of the mentioned method, by petition of the INDERENA (National Institute for Natural Renewable Resources and the Environment). Based on this decision, several studies were carried out tending to environmentally characterize the illicit crop areas and to establish environmental administration methods.

It is clear from past studies that the decision to recommend Glyphosate was due to a systematic and scientific procedure which considered the most advisable environmental and toxicological risk variables, as elements guiding the criteria for its selection, to date.

In the beginning of 1994 a Scientific and Technical Agreement between the National Narcotics Directorate (DNE), the United States Department of Agriculture (USDA-ARS) and the Programming Office of the Narcotics Affairs Section (NAS) of the Embassy of the United States in Colombia was entered into with the purpose of carrying out tests for "*Control, Estimate and Environmental Impact of Illicit Coca Crops";* those tests were performed in San Jose del Guaviare.

In December 1996, the final considerations of the report on the Legal and Technical Aspects for Eradication of Illicit Crops were presented to the National Narcotics Council, by which it is established that according to health and ecological studies, aerial spraying with Glyphosate carried out subject to technical parameters was not harmful either to human health nor to the environment.

Moreover, actions towards developing environmental measures have been taken, among which the following could be mentioned: the incorporation of environmental prevention programs and campaigns, seminars which have been held with different regional entities on the effects of the Eradication Program, the setting up of protocols and operational procedures allowing for prevention and minimizing possible impacts on areas which are not the objective of the Program, the determination and geographical references of those sites where the Program is not in operation such as: National Parks, Alternative Development Projects, Eradication Agreements, etc. as well as permanent surveillance on the sprayed areas.

All these decisions, at the time, have been judicially and legally justified by the

**[Page 11]**

National Narcotics Council - NNC, based on, among others, Law 30, 1986, Law 99,1993, Decree 2811/74, Decree 1753/94, Decree 1843/91 and Resolutions 0001/94 and 0005/2000 from the NNC.

PECIG has displayed a set of technical actions which have allowed the National Narcotics Council to take the decision to authorize the activities of eradication of illicit crops.

Thus, in compliance with the recent environmental regulations it was necessary to prepare the “Environmental Management Plan to Eradicate Illicit Crops” according to Law 99, 1993 and its regulatory Decree 1753, 1994 through which titles VIII and XII of Law 99, 1993 on environmental licenses are partially regulated, and where Article 38 indicates a “transition regime for projects, works or activities which, according to regulations in force before the issuance of this Decree, have obtained the environmental permits, licenses and authorizations required. These activities may continue but the environmental relevant authority through motivated decision may demand the presentation of environmental management, recovery or restoration plans”.

Likewise, the Colombian Government signed an Environmental Audit contract under which work has been proceeding since March 1992, the date on which the eradication of illicit poppy crops program was established.

Since 1992, the Colombian Government has formulated the National Plans to Combat Drugs, facing different areas of intervention, the product of analysis of the structural causes and of associated factors, as well as the identified fields of action by different planning efforts and gathered experiences. Its approach has an integral character where processes and strategies are united towards minimizing the possibilities of individuals or social groups to be linked to any of the practices related to the different manifestations of the drug problem, and repressive measures to combat the industrial-type crops, narcotics processing, traffic and distribution.

Within the framework of the National Plan to Combat Drugs 1998-2002, the following strategic objectives were designed:

1. ***Alternative development***, oriented towards reducing the participation of the affected population by the illicit crops as means of livelihood and towards the construction of social and economic licit alternatives, generating favorable conditions for the peace process in Colombia.
2. ***Reducing supply,*** directed at fighting illegal planting of seeds causing addiction, drug production, trafficking and distribution, as well as infrastructure supporting the illegal drug business.

3. ***Judicial and institutional strengthening,*** tending to strengthen judicial and operative instruments of the State's institutions in order to fight the narcotic drug organization and the different manifestations of the drug problem.
4. ***Reducing demand,*** with the purpose of controlling the use of illicit drugs, the growing trend to improperly use legal drugs and offer treatment alternatives, rehabilitation and social reinsertion to drug addicts.
5. ***Environmental management,*** designed to foster ecological conservation and sustainable integral development in regions of illicit crops and high-relapse risk.
6. ***International policy,*** through which Colombia's leadership role before the international community may be strengthened in order to consolidate, at a global and hemispheric level, the principles of shared responsibility, integrality and balance, and fostering cooperation on this matter.

Within this context, those actions planned to prevent and control this problem are the response to an unified internal policy and to international principles framed within the United Nations Convention Against Illicit Traffic in Narcotic Drugs and Psychotropic Substances, the Anti-Drug Strategy in the Hemisphere and the Global Action Plan approved at the United Nations General Assembly, indicating in one of its sections "the importance to combine repressive measures with alternative development programs".

Legal follow-up to the aerial spraying with pesticides, and the activity of cultivating, processing and distributing drugs producing addiction was established as a crime through Law 30, 1986 or National Narcotics Statute. The National Narcotics Council, through Resolution 0001, 1994, authorized for control aerial spraying with Glyphosate as an effective mechanism to eradicate illicit crops, as long as it was carried out with due technical conditions and under strict control procedures.

According to the strategic purposes indicated, a series of goals to achieve the above was foreseen and institutional responsibilities for its execution were assigned. The National Narcotics Council is the entity responsible for the development of the plan through the National Narcotics Directorate as the entity responsible for coordinating the execution of the policies planned by the Government on this matter. At a regional level, the relevant Sectional Narcotics Councils must be on the alert at provincial and municipal levels to assume the policies, strategic purposes and goals planned at a national level.

In the ***National Plan to Combat Drugs*** currently in force, it is important to highlight its objectives since they reflect the policies and experiences gathered in the country for several years to fight this problem. Its main purpose is to progressively and systematically reduce the causes and manifestations of the drug problem based on the principles of **integrality, co-responsibility, consensus, autonomy, multi-laterality and social content.**

*The Environmental Administration of PECIG*

Within the development of the strategic purpose of the ENVIRONMENTAL ADMINISTRATION of the National Plan to Combat Drugs, the National Narcotics Directorate has been coordinating the development of goals, actions and activities indicated in the Strategic Plan designed for four years and in the Operative Plans which are established yearly, through Administrative Units with the participation of several central state entities.

The purpose of the Strategic Plan 1998-2002, established jointly between the Ministry of the Environment, the Special Administrative Unit of Natural National Parks, the National Plan for Alternative Development,

The National Police – Anti-Narcotics Directorate -, the Ministry of Agriculture and Rural Development and the Agustin Codazzi Geographical Institute, is to "…foster ecological conservation and sustainable integral development in the regions of illicit crops and with high incidence risks". Moreover, this Strategic Objective has three goals which deal directly with this problem from different points of view. The goals established for this inter-institutional group are as follows:

"**Goal 1.** To protect, restore and monitor the fragile areas such as national parks, strategic ecosystems, natural reserves and critical environmental areas affected by illicit crops and its joint activities.

**Actions:**

- To strengthen surveillance, monitoring and follow-up systems to protected and environmentally important areas.
- To foster the elimination of illicit crops at the National System of Natural Parks through manual eradication actions, preferably agreed on.
- To promote programs and projects for the restoration of Natural National Parks areas, buffer and environmentally important areas affected by illicit crops.
- To increase the capacity of local intervention in territorial ordinance to incorporate alternative development and management of environmentally important areas in municipalities with problems of illicit crops.

- To incorporate within the environmental and rural education the component of the environmental, social and economic impact generated by the illicit crops.

**Goal 2.** To carry out those actions to reduce the impacts in the environment derived from the application of the program of eradication of illicit crops with glyphosate.

**Goal 3.** Handling and appropriate disposal of narcotics and chemical substances seized.

**Actions:**

- To develop a research project to handle and dispose of residues of seized chemical substances towards the formulation of a protocol to manage this problem.
- To train the workers of State entities in handling and final disposal of chemical substances, taking into account the safety of the involved agent as well as the protection of the environment.
- To adapt facilities for the warehousing and technical destruction of chemical substances and narcotics seized with the purpose of minimizing the danger that this substances may represent for the community and the environment.

During 1999 several activities were established in the Operating Plan of the Environmental Administration Unit tending to comply with the above actions. A coordinating process began between the National Park Unit, the DNE, the Eradication of Illicit Crops Directorate of the Narcotics Police (DIRAN) and the Environmental Audit under contract through DNE with the purpose of exchanging information related to the intervention in national parks. Thus, monitoring in these regions shall be easier, not only regarding the implementation of illicit crops, but on the effects derived from them as well, such as displacement of population towards those areas, among others".

On the other hand, the action of eradication of illicit crops with aerial spraying of Glyphosate is considered an activity in a transition regime, according to Article 38 of Decree 1753, 1994, and that is the reason why the Ministry of the Environment demanded from the National Narcotics Directorate – DNE – the presentation of an environmental management plan for such activity.

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Given that carrying out of the preventive measures imposed by the ministerial resolution must have an appropriate design and that the continuation of the

Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate Herbicide – because it is a decision of the National Government – must have a tool to allow it to prevent, correct, mitigate and compensate the impacts caused by such an activity, the National Narcotics Directorate – DNE – has decided to prepare this ENVIRONMENTAL MANAGEMENT PLAN, collecting the preventive measures imposed by the Ministry and designing new measures tending to guarantee an integral environmental administration to the Program, with the purpose that all the participating institutions have a common environmental action framework.

On presenting this management plan to the Ministry of the Environment, the DNE considers that it has all necessary elements for its design and implementation according to the provisions of Law 99, 1993 and its Regulatory Decree 1753, 1994, and that the demands contained in Resolution 0341/2001 regarding impact assessment, characterization of the areas to be sprayed and research on the representative plots are more appropriate for the follow-up and monitoring stage than for the design of the EMP as such.

As a consequence, this EPM does not have aspects of Resolution 0341/2001 which are part of the purpose of other different programs or instances or stages, such as cartography and environmental characterization of the areas of the eradication program in the 1:25.000 scale (article 5, subparagraphs a and b), of the impact assessment based on a long period of observation (art. 2), which should be part of the normal environmental follow-up and monitoring stages of the Program, or that requires the prior existence of an environmental management plan under which to act, as would be the case of international environmental audit, among others (articles 3,8,9,10,11 and 12).

## 1.4 LOCATION AND APPROACHES

According to recent statistics, main coca and poppy crop areas are those indicated in Chart 1.1 and Fig. 1.1. Main areas of coca crops are found in 24 provinces of the country, although 74.3% of the cultivated area is found in Putumayo, Caqueta, Guaviare and Meta. Poppy crop are mainly in Cauca, Nariño, Tolima and Huila (782.6%)[4]. Notwithstanding the previous distribution of illicit crops, the Program of Eradication by Aerial Spraying with Glyphosate shall only be carried out in those areas where crops are considered industrial, such as those determined in the National Narcotics Council's Resolution 0005 of August 11, 2000.

[4] Census August 2000. SIMCI Project.

In general terms, and with very few exceptions, the crop areas are far away from communicating roads and their access is mainly done via rivers (such as Putumayo, Caqueta, Guaviare) or by air.

**[Page 15]**

**CHART 1.1**

**LOCALIZATION OF ILLICIT CROP AREAS OBJECT OF THE PROGRAM**

| PROVINCE | CULTIVATED COCA AREA FOR THE YEAR 2000 (Ha)1 | CULTIVATED POPPY AREA FOR THE YEAR 2000 (Ha)2 |
|---|---|---|
| Antioquia | 2.547 | |
| Arauca | 978 | |
| Bolivar | 5.960 | |
| Boyaca | 322 | |
| Caqueta | 26.603 | |
| Cauca | 4.576 | 2000 |
| Cesar | 779 | 700 |
| Cundinamarca | 66 | |
| Cordoba | 117 | |
| Guainia | 853 | |
| Guajira | 321 | 200 |
| Guaviare | 17.619 | |
| Huila | | 1.000 |
| Magdalena | 200 | |
| Meta | 11.123 | |
| Nariño | 9.343 | 1.500 |
| Norte de Santander | 6.280 | |
| Putumayo | 66.022 | |
| Santander | 2.826 | |
| Tolima | | 800 |
| Valle del Cauca | 76 | |
| Vaupes | 1.493 | |
| Vichada | 4.935 | |
| Choco | 250 | |
| TOTAL | 163.289 | 6.200 |

**Sources: 1 Census August 2000 by satellite images. SIMCI Project. 2 Anti-Narcotics Police – verification through aerial reconnaissance.**

1.3JUSTIFICATION OF THE PROGRAM

The Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate Herbicide – PECIG is justified due to the following reasons:

**National and International**

- The eradication of illicit crops is a Colombian Government policy, which has been realized with specific plans and programs designed and carried out by the ongoing governments. Since it is a State policy, the decision to aerially spray comes from the highest political authority established to that effect, such as is the National Narcotics Council.

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- The Colombian laws (Law 30, 1986, among others) consider coca, poppy and marihuana crops as a crime should they surpass the amount of 20 plants, and must be persecuted in the sites where they are found. The above mentioned independently from transportation, processing and distribution.
- The eradication of illicit crops is part of covenants and treaties signed by Colombia at a multilateral level (United Nations) and at a bilateral level, particularly those commitments acquired in the *United Nations Convention Against Illicit Traffic in Narcotic Drugs and Psychotropic Substances* signed in Vienna in 1988, the *Anti-Drug Strategy in the Hemisphere* and the *Global Action Plan* approved during a special meeting of the United Nations General Assembly in June 1998.

**Regional and Economic**

- The Colombian Government is aware of the growing trend the coca plantations have had during the past years, mainly in the southern part of the country where physical and socioeconomic conditions have favored its introduction. Facing this situation, integral actions have been introduced, articulating the development of methodologies to permanently indentify and monitor the dynamics of the illicit crops in the national territory; the development of destruction operations of commercial illicit crops under technical parameters minimizing the environmental impact and, as a long-lasting strategy, alternative development leading towards the reduction of participants of the target population in unlawful activities through regional and local construction of social and economic and lawful and sustainable processes.

- The aerial spraying actions with glyphosate are duly carried out under technical conditions and strict control procedures because of the considerable increase of illicit plantations, its location in difficult-to-access geographical areas for governmental control and the presence of unlawful organizations in the areas.

From 37.500 hectares detected in 1991 by intelligence and reconnaissance, in the year 2000 (by satellite images) 163.289 hectares were discovered, mainly in the provinces of Putumayo (40.4%), Guaviare (11%), Caqueta (16%) and Meta (7%). It is to be noted that for the year 2000, 37 satellite images were used and 45% of the national territory was interpreted, with 80% reliability.

- During recent years, poppy crops have been stable with an average of 6.600 cultivated hectares. Concentration of crops was located in the provinces of Huila, Cauca, Nariño, Tolima and Serrania del Perija (Cesar-La Guajira).
- The introduction of these illicit crops in several of the regions of Colombia has disrupted its traditional economy and has created migratory processes and increased the intensity of violent phenomena since it has been a source of financing for several and numerous illegal armed groups.
- It is usual that there is a price increase in the essential consumption products of a family and the generation of luxury products as staples (satellite dishes, cars and others)…

**[Page 17]**

…in those regions where illicit crops are found.

**Environmental**

- Perhaps, currently, the illicit drugs industry is the greatest factor of environmental degradation in Colombia, not only through deforestation of vast areas of tropical rainforests and Andean forests used for cultivation, but by contamination of ecosystems caused by the large amounts of pesticides and chemical ingredients used and by inadequate waste removal; both activities which are carried out without any control.
- The environmental impact caused by the eradication of illicit crops through aerial spraying with glyphosate is just a minimal part of the impact caused by the different illegal drug traffic activities, which conceals the real environmental problem caused by this mentioned industry.
- It has been established that in order to prepare one hectare of coca-leaf, growers must destroy four (4) hectares of forest, and for one of opium poppy, two and a half (2.5) hectares of Andean forest, according to the study of Environmental Impact of Illicit Crops (Parra L.E., 1997).
- In accordance with the same document, burning of forests and woods means the destruction of 380 tons of biomass per hectare, which implies an accumulated total of 152 million tons of biomass which turn into ashes, $CO^2$ and sediments.
- The destruction of these ecosystems severely alters the ecological homeostasis which, in case of the Amazon region, is determined by the great flora diversity –

unique in the planet – between 96 and 120 tree species per hectare – an unknown number of minor species, besides micro-flora and micro-fauna with an inestimable genetic potential (Parra L.E., ibid).

- Frequently, poppy as well as coca illicit crops are situated in incalculable environmental value ecosystems, characterized by being the greatest genebanks in the planet, due to the presence of biotic communities (fauna and flora) that in many cases are unique and exclusive of these regions. Thus the Amazon plain, for example, chosen for coca cultivation, has a vital ecological importance due to its capacity to regulate $CO^2$ and keep the balance of emissions to the atmosphere. Moreover, the Amazon-Orinoco regions represents for humanity, and particularly for Colombia, an environmental bank, characterized by its large biodiversity. Equal situation exists with the Andean forests which are affected by the cultivation of poppy crops, which, according to the Institute of Hydrology, Meteorology and Environmental Studies - IDEAM (Instituo de Hidrología, Meteorología y Estudios Ambientales), occupy 9,134,270 hectares corresponding to 8% of the national territory.
- Two of the most important *hotspots (*Priority Terrestrial Eco-regions) of the planet are found in Colombia, that is the Tropical Andes and the Bio-geographic Choco, the first of which shows at present a high level of illicit crops and the second is in the initial affectation process.
- It is not an exaggeration to say that an average of one in ten plant or animal species in the world are found within Colombia's borders, in a territory not surpassing 0.77% of the landmasses in the world (McNeely, et al, 1990), according to several biodiversity reports.
- In a report prepared for the DNE (Uribe, 2000) it was confirmed that 98.7% of cultivators use insecticides and fungicides for plague and disease control, 92.5% uses chemical fertilizers and 95.5 controls other plants with herbicides. On the other hand, research from Instituto SINCHI (1) (Amazon Institute for Scientific Research) shows that producers of staple food crops, are meticulous in carrying out cultural labors in their illicit plantations, as well as weeding and chemically controlling insects and plagues.
- Taking into account that in the implementation of a coca cultivation producers generally use 6 Paraquat gallons (Gramoxone) for the first crop and a gallon in the following two crops; 2 liters of Dinitroanilines (Waxal) in each crop, 240 cubic centimeters of Carbamates (Furadan) in each of the three crops of the first year, 12 Kg of Urea and 12 Kg of triple 15 (chemical fertilizer), ***we could infer*** that in the census taken of coca crops between 1999 and 2000 the following agrochemical quantities were used (Bernal H., 2001):

**ESTIMATES OF USE OF AGROCHEMICAL SUBSTANCES BETWEEN 1999 AND 2000**

| AGROCHEMICAL | 1999 | 2000 | TOTAL |
|---|---|---|---|
| Paraquat* (gal) | 640.476 | 653.156 | 1.293.632 |
| Dinitroanilines *lt | 1.280.952 | 1.306.312 | 2.587.264 |
| Carbamates *lt | 153.714 | 156.757 | 310.471 |
| Urea Kg | 1.280.952 | 1.306.312 | 1.587.264 |
| Triple 15 Kg | 2.561.904 | 2.612.624 | 5.174.528 |

Source: Estimates: Hernando Bernal C. Strategic and Research Sub-directorate office – DNE

The above reasons plainly justify the efforts of the Colombian Government to combat illicit crops by any legal means within reach.

**Institutional**

(1) Oscar H. Arcvila, Adriana Rodriguez, 1997. Estudio de caso de la propducción de coca en el departamento del Guaviare (case study of coca production in Guaviare). Instituto Amazonico de Investifaciones Cientificas SINCHI.
* According to URIBE, 1999, SINCHI 1997 and the States security bodies, those most used, in their order are are Paraquat, Wax Up and Furadan.

* Because the eradication program is a commitment of the Colombian Government, the environmental management plan demands an inter-institutional coordination at a national, regional and local level, as well as from the organized communities around the objectives of prevention, mitigation and compensation of the environmental impacts generated by aerial spraying with glyphosate.

**Cultural**

- In parallel to the degradation of wooden ecosystems, there is a change of habitat for the indigenous communities still living in the forests, thus generating the loss of cultural diversity. This process is increased with the arrival of settlers and coca leave pickers, quick fortune-seekers, which leads to a loss of cultural identity of the indigenous communities entering in contact with them.
- It is to be expected that, as in the above case, the eradication of illegal crops may stop the cultural diversity loss and forced adaptation to other cultures by the indigenous communities.

**Technical**

- A great amount of the crops, due to their industrial size and by the difficulties for land and fluvial access or because of public order problems, they cannot be eradicated by hand, so it is necessary to eradicate by aerial spraying with the herbicide.

*The opposition of some sectors of society*

Some NGOs and sectors of society have expressed their opposition to aerial spraying with glyphosate because they are not aware of the implemented technique during the spraying operations, asserting that they are carried out indiscriminately and ignoring technical parameters of aerial spraying. In this same manner, it is stated that glyphosate spraying is a very important factor in the destruction of the Amazon and Andean forests and the native fauna, as well as food crops of the farmers and that the health of the population of the sprayed areas would be seriously affected.

In fact, existing evidence does not allow for proving the veracity of those asseverations or hypotheses; therefore, it is necessary that the information allowing for a rational idea on the real scope of such impacts be supplied through environmental verification, follow-up and monitoring foreseen in this Environmental Management Plan.

**1.5 LEGAL FRAMEWORK**

This plan is framed within the land use regulations regarding environmental, occupational health and professional risks matters, on narcotics control and use of herbicides, such as they appear in Chart No. 1.2 Likewise, international conventions signed by Colombia in reference to narcotics production and traffic have been taken into account.

## CHART No. 1.2

## LEGAL FRAMEWORK

| REGULATION | SUBJECT |
|---|---|
| **ENVIROMENTAL REGULATIONS** | |
| Resolution 0341, 2001 | From the Ministry of the Environment, through which the EMP is not approved for the Program of Eradication of Illicit Crops and imposes preventive measures |
| Decree 321, 1999 | From the Ministry of the Environment on the National Contingency Plan |
| Law 430, 1998 | Harmful residues |
| Resolution 415, 1998 | Through which management of used oils is established |
| Decree 1521, 1998 | From the Ministry of the Environment on transportation of liquid fuels |
| Resolution 0372, 1998 | From the Ministry of the Environment, ruling on retributive rates tariffs |
| Law 373, 1997 | Through which the program for the efficient use of water and saving it |
| Decree 901, 1997 | Through which the retributive rates are regulated due to the direct or indirect water use as receptor of point discharges |
| Decree 1791, 1996 | Ministry of the Environment on forestry exploitation |
| Decree 2107, 1995 | From the Ministry of the Environment, partially amending Decree 948/95 and contains the protection and control of air quality regulation |
| Decree 948, 1995 | From the Ministry of the Environment through which the prevention and control of atmospheric pollution is regulated |
| Decree 1753, 1994 | From the Ministry of the Environment on the regulations on environmental licenses |
| Resolution 000189, 1994 | From the Ministry of the Environment to prevent harmful residues from entering the country |
| Law 142, 1994 | Through which the public utilities |

| | |
|---|---|
| | regime and other provisions are established |
| Law 134, 1994 | Through which regulations on citizen participation mechanisms are established |
| Law 99, 1993 | Through which the Ministry of the Environment is created, the public sector in charge of Administration and Conservation of the Environment and the Renewable Natural Resources is rearranged, the National Environmental System SINA is organized and other provisions are dictated |
| Law 67, 1993 | Through which the United Nations Convention against Illicit Traffic in Narcotic Drugs and Psychotropic Substances is approved |
| Political Constitution, 1991 | Setting of general regulations on environmental rights and obligations |
| Decree 0919, 1989 | Through which the National System for Prevention and Relief of Disasters is organized and other provisions are dictated |
| Decree 1594, 1984 | Regulation for the use of water and liquid residues |
| Decree 2206, 1983 | Chapter XVI on surveillance, control and sanctions of Decree 02, 1982 on atmospheric emissions is substituted |
| Decree 2105, 1983 | Water supply is regulated |
| Decree 2104, 1983 | Regulatory of Law 09, 1979 on solid residues |
| Decree 02, 1982 | Regulatory of Law 09, 1979 on air |
| Law 09, 1979 | Health regulations are dictated (National Health Code) |
| Decree 1715, 1978 | Partially regulated Decree 2811, 1974 and Law 154, 1976 regarding landscape protection |
| Decree 1608, 1978 | Regulatory of Decree 2811/734 on wild fauna |
| Decree 1541, 1978 | Regulatory or Decree Law 2811/74 on non-maritime waters |
| Decree 622, 1977 | Through which Chapter V, Title II, Part XIII of Book II of Legislative Decree 2811/74 on “Natural National Parks, Law 23/73 and Law 2/1959 is partially |

| | |
|---|---|
| | regulated |
| Law 154, 1976 | On landscape preservation |
| Decree 877, 1976 | Determines protected forestry reserve areas |
| Decree 2811, 1974 | Through which the Natural Resources and Environmental Protection Code is dictated |
| Law 23, 1973 | Through which extraordinary faculties are granted to the President of the Republic in order to issue the Natural Resources and Environmental Protection Code and other provisions are dictated |
| Law 2, 1959 | Through which some forestry reserve zones are determined |
| **HEALTH** | **REGULATIONS** |
| Resolution 0026, 1996 | From the Ministry of Health through which an operating Sanitary License is issued to eradicate illicit crops |
| Decree 1771/94 | From the Ministry of Labor and Social Security, through which Decree 1295/94 is partially regulated |
| Decree 1295/94 | From the Ministry of Labor and Social Security through which organization and administration of the General Professional Risks is established |
| Decree 1843/1991 | Through which Law 09/79 regarding handling and use of pesticides is regulated |
| Resolution 1792/1990 | From the Ministry of Labor and Social Security through which permissible limit values are established for occupational exposure to noise |
| Resolution 2013, 1986 | From the Ministry of Labor and Social Security, regulates the organization and operation of the Medicine, Health and Industrial Safety committees at the working place |
| Decree 1594, 1984 | Through which Title I of Law 09/79 is partially regulated, as well as Chapter II of Title VI – Part III – Book II and Title III – Part III – Book I of Decree 2811/74 regarding use of water and liquid residues |
| Resolution 8321; 1983 | Through which regulations to comply with limits of sound and assurance of |

| | |
|---|---|
| | noise control are dictated |
| Decree 02, 1982 | Through which Title I of Law 09/79 and Decree 2811/74 regarding atmospheric emissions (technical part) are regulated |
| Resolution 2400, 1979 | From the Ministry of Labor and Social Security on provisions regarding housing, hygiene and safety in the workplace |
| **ON THE ERADICATION OF** | **ILICIT CROPS (PECI)** |
| Resolution 0017, 2001 | From the National Narcotics Council to attend to the complaints due to damages presumably caused by glyphosate spraying |
| Resolution 005, 2000 | From the National Narcotics Council, amending Resolution No. 001, 1994 on the authorization for the destruction of illicit crops in the country |
| Resolution 0017, 2001 | From the National Narcotics Council to attend to complaints due to damages presumably caused by glyphosate spraying |
| Resolution 001, February 1994 | The National narcotics Council extends and specifies the authorizations granted to the Anti-Narcotics Division of the National Police for the eradication and destruction of illicit crops in the country through the relevant means established to that effect |
| **MINISTRY OF** | **ECONOMIC DEVELOPMENT** |
| Resolution 1096, 2000 | Through which the regulation for drinking water and basic sanitation RAS is adopted |
| Resolution 822, 1998 | Through which the regulations for drinking water and basic sanitation is dictated |
| Decree 605, 1996 | Through which Law 142, 1994 is regulated regarding rendering of public utilities for waste disposal |
| **AGRONOMICAL** | **REGULATIONS** |
| Resolution 1098, 1996 | From ICA (Colombian Agriculture and Livestock Institute), through which guides on the application of pesticides are established |
| Resolution 3079, 1995 | From ICA, through which regulations |

| | |
|---|---|
| | on the industry, commerce and the application of bio-ingredients and similar products, mulch and fertilizers, soil conditioners and similar products, chemical pesticides, physiological regulators, agricultural coadjuvants and similar products |
| **INTERNATIONAL** | **REGULATIONS** |
| Vienna Convention 1988 | United Nations Convention against Illicit Traffic in Narcotic Drugs and Psychotropic Substances |
| United Nations General Assembly | Anti-Drug Strategy in the Hemisphere and the Global Action Plan |

### 1.6 ORGANIZATIONAL STRUCTURE

The following organizational structure is in charge of executing the Program for Eradication of Illicit Crops By Aerial Spraying with the Pesticide Glyphosate – PECIG:

The National Narcotics Council is in charge of the political guidance of the program

- The National Narcotics Directorate – DNE - is in charge of the national coordination of the program
- The Anti-Narcotics Directorate of the National Police (DIRAN) is in charge of the operational execution. The eradication actions are carried out from nine Operational Bases distributed in the main illicit crops areas. These actions are developed based in operational plans established by DIRAN.
- For follow-up and control, DNE has an Environmental Audit
- For advisory matters, the Program has the support of the Inter-institutional Technical Committee made up by several State entities.
-

**[CHAPTER 2]**

## 2. PROGRAM DESCRIPTION AND ANALYSIS

According to the legislation in force, the National Narcotics Council authorizes the National Police – Anti-Narcotics Division to develop the Program of Eradication of Illicit Crops, an activity which is entrenched in the drug policy of each Government.

### 2.1 OBJECTIVE

To develop the Program for the eradication of Illicit Crops taking into account aspects of social, political, economic, legal, environmental and health matters, with the purpose of carrying it out in a controlled manner from the operational and environmental point of view.

## 2.2 SCOPE

The Eradication Program is carried out in regions where the presence of illicit crops is identified taking into account their differential character, that is, for extensive or industrial crops. The Program for the Eradication of Illicit Crops does not operate in environmentally sensitive areas, in populated areas, in parks and natural reserves, in waterworks and water bodies.

## 2.3 STAGES OF THE PROGRAM FOR THE ERADICATION OF ILLICIT CROPS

Spraying of illicit crops with Glyphosate is planned and carried out through three very distinct phases:

- Detection
- Spraying
- Verification

### 2.3.1 Detection process

Its purpose is to identify, characterize and space out the illicit crops affected areas and determine the exclusion zones of the program.

Interpretation of satellite images SPOT/LANDSAT/IKONOS type, processed by the Integrated Project for Monitoring Illicit Crops –SIMCI - **with alert mechanisms for the exclusion zones.** As a complement, the following software for satellite recording and interpretation analysis is used: ILWIS, ERDAS, PCE, ILLISYS.

- When the existence of illicit crops has been detected, verification flights are scheduled for each of the areas in which the nuclei to be visited are located, or to quantify in cartography from the Agustin Codazzi Geographic Institute –IGAC –at a 5:500.000 to 1:400.000, or in processed satellite images by the Integrated Project for Monitoring Illicit Crops in a scale of 1:50.000 or 1:30.000.
- From cartography and satellite images, the observers perform the following activities:

  º Selection of a representative area from the nuclei

° Verification of the location of the plots: coordinates, site, township and municipality and identification of natural boundaries.
° Estimates of surface of illicit crops plots.
° Approximate density of the crops
° Type of local cover
° Verification of the high risk zones and exclusion zones, such as human settlements, water bodies, waterworks, indigenous reservations, natural parks and productive projects, among others.

- Aerial photographs and filming of the areas, which are analyzed by the Anti-Narcotics Police before the operations.
- Reconnaissance of industrial and farming nuclei. Methodology for the reconnaissance of each of the nuclei (groups of plots with areas of more than 2 hectares) is carried out by using radials with a distance between them of two (2) nautical miles (when there is coverage by satellite images), and three (3) nautical miles (when there is no coverage of satellite images, but of cartography). 95% is the coverage of each coca zone or region.
  *EXAMPLE OF A SATELLITE IMAGE PRESENTING DENSITY OF ILLICIT CROPS (picture)*

(inside) SIG CONSULTATION – SCOPE IN HIGH DENSITY AREAS IN COCA CULTIVATION – PUTUMAYO

Coca crops less than 3 Has. – Coca crops between 3 and 10 Has. – Coca crops between 10 and 30 Has. – Coca Crops between 30 and 50 Has. - Coca crops between 50 and 100 Has. – Crops larger than 100 Has.

**2.3.1.1 Characterization of the areas to be sprayed**

* In complement, the location of illicit crops and exclusion zones developed in the previous point, the National Police – Anti-Narcotics Directorate – collects all relevant information to carry out research of the areas to be sprayed. According to the provisions of Resolution 0005, 2000, information and cartography are requested from the following institutions:

° Ministry of the Interior (indigenous reserves)

° Offices of Agriculture Secretariats

° National Plan for Alternative Development

° Social Solidarity Network

° Offices of Health Secretariats

º Governors

º Mayors

º Regional Autonomous Corporations

º ICA Agencies

º Offices of the Secretaries to Governors

º Provincial Directorates of Health and Secretariats

º Universities

º Institute of Hydrology, Meteorology and Environmental Studies – IDEAM

º Instituto Geográfico Agustin Codazzi

º National Statistics Administrative Department

- Available information is collected, analyzed and assessed by DIRAN, jointly with DNE. Subsequently the exclusion zones where PECIG is not applied are geo-referenced.
- DNE and DIRAN with the available information, determine the potential risks relating to health, the environment and agricultural and livestock activities in the areas to be sprayed.
- Characterizations of the areas to be sprayed are presented by the DNE to the Technical Inter-institutional Committee for its recommendations.

**2.3.1.2 Appraisal of collected information**

Once the previous stages have been completed, DNE and DIRAN analyze the information evaluating the following parameters:

º Incidence of illicit crops in the region (comparative analysis of data of illicit crops established at present with those of previous satellite images)

º Ecosystems that are affected with the establishment of illicit crops

º Analysis of on the socio-economic and specialized information and determination of populated areas

ºAnalysis of the bodies of waterclose to the nuclei

º Analysis of the areas of National Natural Parks

º Determination of actions by illegal armed groups º Intelligence information

**2.3.1.3 Determining and spacing out the buffer strips**

Buffer strips are established with the purpose of providing protection to each of the environmental elements to be potentially affected by the spraying actions.

For the operation of the Program the provisions of Article 87 of Decree 1843, 1991 is taken into account in regards to “the application of the pesticide in rural areas may not be carried out in less than 10 meters in land and 100 meters from air for areas with water bodies, roads or human and animal population or any other requiring special protection”. In addition, buffer strips were established for other environmentally sensitive areas, which are presented in Chart No. 2.6.

With the purpose of determining with precision the buffer strips, reports are to be prepared to allow for assessment of those already established taking into account the operation of flights in conditions that are not normal such as those in areas of armed conflict. Additionally, the Verification, Inspection and Control Process shall be the mechanism which allows for follow-up on the functionality of the established strips.

**2.3.2 Spraying process**

**2.3.2.1 Planning operation (by each Operational Base of DIRAN)**

**2.3.2.1.1 Gathering of operational information**

- The vertical superposition of the gathered information in the previous phase, allows for determining by cartography the areas of operation which are situated through exact geographical coordinates.
- The armed conflict situation in the area subject to be sprayed: identification of subversive groups operating in each region, number of gang, number of men, areas of operation and influence, intelligence information.
- Quantification of raw material to be used according to the dosage of application of the pesticide and the area to be eradicated.

**2.3.2.1.2 Planning and control**

*Meetings to plan the operation*

The Commander of the aerial spraying base holds a daily meeting with the commander of the company, pilots of fixed and rotating wings, technical personnel and artillerymen to comprehensively analyze the spraying procedure.

*EXAMPLE OF A SATELLITE IMAGE WHERE WATER BODIES ARE SHOWN*

(Inside) “Details of coca plots at different distances from water bodies-

CA: Water bodies – ZU: Urban zones – Crops located less than 100 M from flowing water – Crops located between 100 and 1000 M from flowing water – Crops located at more than 1000 M from flowing water”

This process evaluates a set of alternatives to develop the operation and establishes the necessary parameters for compliance of the mission, by reviewing and analyzing the following aspects:

- Information obtained in the detection stage, starting of guiding operational analysis as is the geographical localization and physiographic setting of the illicit crops nuclei, meteorological factors, areas of illicit crops and those of exclusion in order to start the schedules of the number of mission.
- Determination of the mode of operation. Each one of the analyzed parameters shall determine how to carry out spraying using methods developed according to adverse safety conditions with which the program operates and the types of crops. The methods may be briefly described as follows:

(Picture at left) Parallel or by lines method This method allows for spraying an illicit crop lot simultaneously by a fleet of aircraft flying in formation. It is used in plots considered industrial or commercial.

Traditional, or “racecourse”. This method consists of spraying over the illicit crop using one aircraft which flies over the lot be sequenced, using parallel flight lines. Use of this method is mainly carried out in plots with small and scattered areas between 2 and 3 hectares.

**2.3.2.1.3 Coordination of Intelligence Operations**

Intelligence operations are coordinated with the armed forces (Army, Air Force, Navy) and other safety entities with the purpose of learning about recent movement of subversive groups, number of men and weapons at the programmed area of operations. Likewise, land support is requested in case it is needed.

*Example of integration of photographic files and satellite images*

*(Inside)* VERIFICATION OF COVERAGE – PHOTOGRAPHIC AND SATELLITE IMAGES FILES – 4 PICTURES

**2.3.2.1.4 Definition of the organization of the operation**

The organizational moment, human conditions of those who are to participate in the operation, number of officers, deputy officers, agents, executive level and civil personnel is evaluated at this point. Duties and responsibilities are assigned as well as number of aircraft, commander of the mission, observers, operational area, time of flight, known threats, friendly forces, height of pesticide release, autonomy in the aircraft flights, leaders and changes in leader, hostile fire procedures, SAR (Search and Rescue Procedure), survival equipment, etc.

For each operational area previously indicated, a provisional procedure for search and rescue (SAR) is prepared, with aspects such as possible unexpected actions, wounded and aircraft failures. Likewise, in this same phase, the final operational analysis is carried out, with the distance from the fumigation base to the nuclei to be eradicated, alternate chemical material and fuel supply sites for autonomy reasons in the flight of the aircrafts.

Working and flight plans are prepared with the indicated coordinates and the personnel is advised on the targets (nuclei) to be sprayed. To develop each operation, two alternatives or flight plans are proposed.

- Programming of logistic resources supporting each mission

In this phase there is preparation of human, technological and of required material resources for the performance of each operation.

- Human resources

In this phase, the number of pilots to be used for the operation and the number of existing pilots in the facilities to be employed in the mission and the military personnel assigned.

In this phase moreover, an activity takes place for the information of pilots and others taking part of the mission where data obtained in the previous detection phase is given. In addition, a review of the safety regulation protocols and checking lists to be developed in each operation takes place as well.

- Materials and equipment to be used

During this phase the equipment to be used in each mission is programmed.

º 1:5000.000; 1:50.000 and 1:30.000 scale planimetric maps

º SATLOC software for precision on discharge

º GPS

º Filming equipment

º Photographic cameras

º Operational protocols forms

º One (1) Caravan aircraft for personnel or ambulance and reconnaissance services transportation

º One (1) S.A.R. helicopter on stand-by

º One (1) helicopter to support on stand-by

º Anti-narcotic bases for logistic support

**2.3.2.1.5 Coordination with state entities to accompany the spraying operation**

During this phase coordination in carried out with the national and provincial authorities, Environmental Audit, Delegate Attorney's Office for the Environment and other entities of state control required in order to be part of the inter-institutional team foreseen in Resolution 0005/00 and who will accompany the spraying process, verifying compliance with the parameters to guarantee that the areas that are not included as illicit crops do not suffer any damage.

**2.3.2.1.6 Assessment of potential operational risk**

Assessment of potential risk for the operation of the program for the eradication of illicit crops by aerial spraying pretends to identify areas in which the accidents of the operation may have important effects of the environment. That is why the places where the discharges are to take place in case of eventual incidents occur should be geographically indicated.

The above must allow for indications of the measures to be taken in case of an accident and the components of the environment to which the efforts should be directed; likewise, it is a tool to plan de program and implement the measures to improve efficiency and optimize the operation.

Taking into account the program's characteristics, it is necessary to consider two different scenarios, when evaluating potential risks. In the first one, the activities are performed under favorable public order conditions. The second one considers potential risks for the operation under adverse public order conditions.

For the two scenarios, potentially dangerous events are assessed and the same are graded according to the implications it would cause in the environment.

Subsequently, the threats are assessed and graded regarding the probability of dangerous events to be present and likewise, an evaluation of the components of the environment which may present more susceptibility to identified dangers and its vulnerability is carried out. Finally, the information is integrated and the risk levels are identified for the areas subject to evaluation.

The proposed methodology is expounded in the contingency plan.

**2.3.2.2 Development of the Operation (in charge by each Operational Base of DIRAN)**

This phase requires exact knowledge of the site of illicit crops, exclusion zones and buffer strips carried out previously through aerial detection, satellite information, aerial reconnaissance, intelligence reports, characterization studies on the social, cultural, epidemiological, health, economic and environmental surroundings and potential risks to carry out spraying in an optimal manner in the environmental, technical and operational aspects.

Records of application of glyphosate for the program are approved by ICA the relevant entity.

The parameters to be taken into account in the operation have been formulated under the environmental, aeronautic and aerial safety regulations in force and applicable to the program. The parameters to be strictly complied with in the program are:

- Buffer strips to water bodies, populated center, nearby vegetation and the national parks system areas.
- Compliance of the Protocol of operation (height of flight, velocity of the aircraft and spraying equipment) and climatic conditions.

**2.3.3.5.1 Follow-up satellite system for precision of the operation**

The program for the Eradication of Illicit Crops must have a satellite follow-up system (currently the SATLOC System), installed in the spraying aircraft so that the operation may be carried out with precision, bearing in mind the geographical coordinates determined in the first detection phase. Later, through recording of all and each of the spraying operations with the relevant routes, geographic registration of the areas to be applied and the amount of glyphosate discharged per minute, an exact verification of the geographical site where the operations were carried out and the amount of areas sprayed shall be obtained, to the effect of verification in case any claims are formulated.

**2.3.2.5.2 Protocols for the Program’s Operation**

Setting up of the operational parameters is the product of the different field tests to guarantee the program's effectiveness, which leads to not only environmental but economic benefits. The effectiveness of the application under these operational parameters was guaranteed by ICA according to the concept issued the same day to the Ministry of the Environment on the visit to the anti-narcotics base Larandia on August 3 and 4, 2000 and during the complementation of the Management Plan in September 2000.

Each one of the parameters is the maximum range covering the operation, adding a safety factor in order to guarantee the precision of the application. However, to obtain greater efficiency in the operation and a reduction of the flight times, operational tests at the anti-narcotics bases are carried out to establish in each region the best possible conditions for application, such as the aeronautic parameters as well as the meteorological conditions according to the climatic phenomena of each region. Chart No. 2.4 shows in detail each one of the operational parameters taken into account. Chart 2.5 shows the dosages of application and the volumes of discharge by hectare adopted by the program (refer to the following sub-chapter).

**2.3.2.5.3 Execution of the action plan**

**Procedure**

- The pre-flight operations by the aeronautical maintenance personnel from the Aviation Area are started, consisting in preparing the machines.

- Fifteen minutes later an aerial reconnaissance of the area is carried out to determine the atmospheric conditions (temperature, direction and speed of the wind and relative humidity). Should the conditions allow for it, the reconnaissance aircraft confirms the operation and then the chemical materials used for spraying are prepared.
  (*Two pictures*)
- Subsequently, the safety operational group for the convoy helicopters is embarked determining the departure order and arrival to the target; the personnel selected during the planning phase goes into these helicopters. Likewise, among these there is a representative of the Environmental Audit, a delegate from the Public Ministry or an officer from the Attorney General's Office and, eventually, an officer from the Ministry of the Environment and from the Ombudsman, and other casual observers. In the SAR helicopter (search and rescue) a specialist paramedic in aid and recovery is present. Likewise, a Hughes 530F helicopter also embarks the purpose of which is to give safety and support in case of descent, accident or incident.

(*One picture)*

- Departure of aircraft towards the spraying nuclei directed by the leading pilot of the aircraft and the leader commander of the helicopters. On arrival to the target (lot), according to orders, the area to be worked over is to be maintained; the helicopters are positioned at the tactical height over the lot to ensure the area to be sprayed.
- Spraying of the illicit crops is carried out with T-65 or OV-10D aircraft, keeping the helicopters as convoys for immediate security. After the aircraft passes, the team goes back to the base of operations. This maneuver is carried out inversely to the first one, being coordinated in advance and with communication to the last aircraft ending its task.

**2.3.2.5.4 Results of the Operation**

Once the operation ends, minutes of the operation are prepared with indications of place, hour, number of hectares, geographical coordinates, names of the civil authorities, pilots who participated and notes of any incident, in order to carry out the contingency plan or mitigation of damage.

To analyze the information, there is a data card installed inside the aircraft and once the spraying operation ends, the data is downloaded en the matrix computer where the routes, traces and coordinates covered by the aircraft are visualized (SATLOC or Del Norte Program). Data generated by the program is incorporated to a Geographical Information System, the purpose of which is to situate, through geographical coordinates, the cartographic location of the nuclei affected by the illicit crops.

Minutes of the operation have filming or photographic records and the graphic records of the Satellite Follow-Up System (recording software and electronic signals system). Likewise, formats of the operation are developed where the hours of departure and arrival, ingredients used, incidents in the aircraft and any other relevant data and actions in the operation are recorded. In this document, the formats used for the operation are attached.

It is important to highlight that the minutes, formats and records of the Satellite Follow-Up System (SATLOC or DELNORTE) are extremely important to find out the results of the spraying operations, to verify the relevance of the formulated claims and the adjustment of possible errors committed.

Regarding the environmental results, they are carried out during the Inspection, Verification and Control program for the spraying operations.

#### 2.3.2.5.5 Post-flight operations

* The number of hectares of illicit crops sprayed with information on the area, analyzing the SATLOC system, the amount of agricultural ingredients used in the operation (Glyphosate and surfactants), the number of aircrafts used, the number of flight hours and the technical parameters with which the operation was carried out is determined.

* A spraying polygram for illicit crops is prepared and is immediately forwarded to the anti-narcotics communications office.

* The spraying orders by the judicial research unit is prepared with the signature of all who took part in the spraying operation over the illicit crops.

* Reports, photographic records, activity registration with all information received and the immediate forwarding of the polygrams to the Anti-Narcotics Division.

* Systemized statistics is made on detection, spraying and verification activities carried out at the jurisdiction.

Attached are the models of polygrams on spraying of illicit crops and the minutes on application of glyphosate in coca or poppy plantations which are completed on the same day of the operation.

### 2.3.3 Verification process

- Once the Satellite Follow-up System report (flight lines of each of the aircrafts, spraying lines) is analyzed, it is determined if the operation was carried out in the indicated areas though the Geographical Information System, satellite information and the fixed alert system.
- Compliance in the technical parameters of the model is assessed regarding the exclusion zones and the buffer strips. Should these established parameters not be complied with, relevant actions are taken according to the provisions of the contingency, verification, inspection and control plan.
- A final report is prepared with the results of the operation, with what was previously indicated.
  - Participants of the verification activities
  - Minutes and polygrams
  - Methodology of the process
  - Results of the operation
  - Recommendations
  - Photographic records of the sample plots and nuclei

This report shall be prepared by operation, that is, daily and sent to the Commander of the DIRAN based and the DNE. In the base, as well as in the offices of DIRAN and DNE in Bogota, the reports must be available for consultation by the environmental authorities.

Progressively during the execution of the action strategy, reconnaissance operations and result assessment are carried out through air verification and field work as well as in inter-institutional meetings to evaluate the results which will allow for the responsible and representatives of the committed institutions to analyze the dynamics and behavior of the areas where the Program has been operating, in order to guarantee in this manner that possible errors in this process be adjusted and corrected.

Card No 6 of the EMP has a detailed description of the inspection, verification and control of the spraying operations procedure, including the environmental aspects. In this card, the indicators to evaluate the efficacy and efficiency of PECIG are established in the technical aspects of spraying and its relation to the destruction of illicit crops as well as in the environmental aspects. On the other hand, the Monitoring Program of the EMP includes the permanent carrying out of SIMCI (Integral Monitoring of Illicit Crops System), through which a follow-up process through satellite is made of the annual evolution of the illicit crops by municipality, province and nuclei. Chart No. 2.1 depicts the main actions, responsible entities and indicators of the evaluation.

**CHART. 2.1**

**EVALUATION OF THE PROGRAM FOR THE ERADICATION OF ILLICIT CROPS**

| ACTION | RESPONSIBLE | INDICATOR |
|---|---|---|
| Identification, characterization and specialization of the areas affected by illicit crops and exclusion zones | Anti-Narcotics Police<br>National Narcotics Directorate<br>Environmental Audit<br>Institutions from which information is requested according to the provisions of Res. 0005.<br>Alternate National Development Plan(PNDA) | Report on characterization of the areas subject to spraying.<br><br>Geo-reference of the areas with illicit crops and exclusion zones |

| | | |
|---|---|---|
| | Social Solidarity Network | |
| Planning and decision on spraying operations | National Narcotics Council | Operative programs |
| Developing spraying operations applications under technical parameters in accordance with operating and environmental regulations set up in the Environmental Management Plan | Anti-Narcotics Police Environmental Audit | Technical and environmental parameters and operative protocols approved by the program |
| Development of a **Satellite Follow-up System** installed in the spraying aircrafts in order to guarantee that the operation is carried out with precision | Anti-Narcotics Police | There is a **Satellite Follow-up System** when the operation of the program starts |

**MODEL OF POLYGRAM OF SPRAYNIG ON ILLICIT CROPS**

**NATIONAL POLICE**

**ANTI-NARCOTICS DIVISION**

POLYGRAM NO. ___________ DATE ________

FROM _________________

TO __________________

TEXT:

SPRAYED HECTARES ________________

**COORDINATES JURISDICTION MUNICIPALITY PROVINCE**

N. W.

N. W.

PARTICIPATING AIRCRAFT IN SPRAYING

PNC PILOT FUMIGATED AREA (Has)

CONVOY AIRCRAFT INTERVENING IN OPERATION

PNC PILOT

| *GLYPHOSATE DEPOSIT | ADJUTANT DEPOSIT | GLYPHOSATE USED | ADJUTANT USED | GLYPHOSATE IN EXISTENCE | ADJUTANT IN EXISTENCE |
|---|---|---|---|---|---|
| | | | | | |

INNOVATIONS

PERSONNEL

AIRCRAFT

(SIGNED) Head Spraying Base (SIGNED) Radio Operator

**ANTI-NARCOTICS POLICE DIRECTORATE**

**AREA OF COMMAND_______ JUDICIAL RESEARCH UNIT**

MODEL OF MINUTES No.___/__ ON SPRAYING WITH GLYPHOSATE OVER ILLICIT COCA CROPS IN THE JURISDICTION OF _______ MUNICIPALITY OF ______ PROVICE ______

On _____, at ____ ( )day of the month of ___ Two Thousand (2000), in the neighborhood of the rural districts of_____, jurisdiction of the municipality of ____ Province of _____. From ____ hours to ___ hours of today, in the following coordinates:

| | | | | |
|---|---|---|---|---|
| N | N | N | N | N |
| W. | W. | W. | W. | W. |
| | N | N | N | N |
| | W. | W. | W. | W. |

Mr. CT______ Pilot PNC_______, Mr. CT____ Pilot of the PNC____, Mr. TE________ Copilot PNC_____, Mr. TE______ Copilot PNC_____, CAPT______ Pilot of PNC_______, CAPT______, TE______ Commander Anti-Narcotics Group______, CAPT _______ Pilot of TURBO TRUSH PNC_____, CAPT______ Pilot of the TURBO TRUSH PNC_______, Dr.___________ Criminal Officer from the Attorney General's Office, Mr. PT ______ Anti-Narcotics Judicial Officer from Zone _________, appeared with the purpose of carrying out the matter of destruction of plantation of coca trees, previously detected and identified on ____Hectares of illicit crops located at the above mentioned coordinates; the owner of the property where the crops were located was not established.

Thus, the provision of Article 77 of Law 30 could not be complied with, because it is a high-risk zone and there is no place within the area where aircrafts could land. Once the above matters were done, destruction of the plantations was carried out by Aerial Spraying in the neighborhood of the rural districts of _____, jurisdiction of the municipality of _____, Province of _______.

NOTE: ________________

_______gallons of commercial formulation of the active ingredient Glyphosate were used

_____hectares of coca trees were sprayed, being identified previously according to the above mentioned coordinates.

Through communication No. _____ dated _______ Mr(S) Regional Delegate from the Attorney General's Office in _______was requested to be present at the operation of eradication of illicit crops.

Through communication No. ______ dated _______ The Agrarian Officer from the Attorney General's Office was requested to be present at the operation of eradication of illicit crops.

There being no further business, this matter has ended, and the record was read and approved in all and each of its parts, it is signed by all who intervened, as follows:

CT______________________ TE __________________

Pilot PNC___________ Pilot PNC ___________

CT______________________ TE __________________

Pilot PNC___________ Pilot PNC ___________

CT______________________ TE __________________

Pilot PNC___________ Pilot PNC ___________

## 2.4. GLYPHOSATE CHARACTERIZATION

Glyphosate is a simple, broad spectrum, non-selective herbicide with systemic action and suitable for the control of many weed species in the post-emergence treatment to foliage. It has no effect on seeds that are below ground and it is also not absorbed by the roots. Things being equal it can also be said that it has no long term residual action and that it is neither a soil sterilant herbicide nor does it act as one.

It is the most widely used herbicide in the world due to its effectiveness, safety and its multiple applications. Glyphosate formulations are registered in more than one hundred (100) countries including the United States, where it has been approved by the US Environmental Protection Agency to be used in over sixty agricultural crops, in forest management undergoing intervention for preservation, and different cropping systems, including maintenance of canals, roads and public and domestic gardens.[5] (130 total applications)

### 2.4.1 Physical-chemical composition and characteristics

Glyphosate is a molecule made up a fraction of glycine and a radical amino phosphate joined as substituent of one of the hydrogens of the α-amino group.

Composition: Isopropylamine salt of N-(phosphonomethyl) glycine.

ROUNDUP: a light amber viscous solution, pH 4.4 to 4.9, specific gravity 1.17, faint amine odor, molecular weight 169.08 and melting point 200° C.

Chemical Group: N-phosphono amino acid

[5] According to Fred Slyfe, University of Illinois. 1992.

Pure compound (active ingredient)

O O

II II

OH – C – $CH_2$ – NH – P – OH
$CH_2$ –

I

OH

Glyphosate salt - isopropylammonium

O O

$CH_3$

II II I

OH – C – $CH_2$ – NH – P – O
$CH_2$ – $H_3N^+$ –
CH

I I

OH

$CH_3$

Almost all commercial formulations of glyphosate are easy to handle; they are very soluble in water and are chemically very stable in any proportion. In addition, the vapor pressure is low, which renders the formulations for use in the field not volatile.

Chart 2.2 shows the major physical and chemical properties of the herbicide.

**CHART No. 2.2**

**PHYSICAL-CHEMICAL PROPERTIES**

| PROPERTY | PURE COMPOUND (ACTIVE INGREDIENT) | GLYPHOSATE SALT ISOPROPYLAMMONIUM |
|---|---|---|
| **Molecular formula** | $C_3H_8NO_5P$ | $C_6H_{17}N_2O_5P$ |
| **Molecular weight** | 169.1 g/mol | 228.2 g/mol |
| **Physical state** | Solid white | Amber to yellow viscous liquid |
| **Smell** | Odorless | Virtually odorless, slight amine odor |
| **Density** | 0.5 g/mL | 1.160 to 1.180 g/mL |
| **Melting point** | 184.5° C | Not applicable (liquid) |
| **Vapor Pressure** | $1.84 \times 10^{-7}$ mm Hg at 45° C | $3 \times 10^{-7}$ mm Hg at 25° C |
| **Boiling point** | It decomposes | It decomposes |
| **pH at 1% solution** | 2.5 | 4.7 |
| **Solubility in water** | 12,000 ppm at 25° C | 900,000 ppm at 25° C |
| **Other solvents** | None | Only water-soluble |
| **Stability** | 32 days at 25° C and pH = 5.7 or 9 | 32 days at 25° C and pH = 7 or 9 |
| **Octanol - water partition coefficient** | Pow = -2.8 | N.A. |
| **Henry's Law Constant** | $< 7 \times 10^{-11}$ | N.A. |
| **Corrosivity** | Non-corrosive | Non-corrosive |

| | | |
|---|---|---|
| **Flashpoint** | | |
| **Combustion Products** | | |
| **Reactivity towards container material** | | |
| **Reactivity towards container material** | This chemical can react with galvanized steel but not with stainless steel containers to produce hydrogen which could form a highly explosive mixture. It may react with caustics (bases) to release heat. It is corrosive to iron. This chemical is stable for two weeks at a temperature of 60° C, if protected from light. Solutions of this chemical in water, ethanol 95% or acetone are stable for 24 hours under normal conditions. | |

Source: Environmental Management Plan for the Eradication of Illicit Crops, 1999, 2000, 2001. DNE.

### 2.4.2. Commercial formulation types

Before referring to commercial formulations, it is appropriate to provide the following definitions, in accordance with Decree 1843 of 1991 and other sources (CIAT, 1977; Revelo, 1976):

Herbicide: A pesticide used to destroy plant material

Active ingredient: The biologically active part of the pesticide

Surfactant: A reducer of surface tension of the pesticide molecule, to allow greater contact area with the leaf of the plant

Adjuvant: An inert additive substance without biological activity. It is used to reduce evaporation, resistance to ultraviolet rays and others. Cosmoflux is in fact a drift reducer.

Inert substance: A substance that imparts a desirable feature to the herbicide.

**Glyphosate** is a herbicide which is sold in the form of soluble concentrates of isopropanolamine salt of N-(phosphonomethyl) glycine, in which the Glyphosate and the required inert ingredients are combined for each type of commercial formulation. Although the most common marketing form is the water-soluble concentrate, the following preparations are also available for specific uses.

- Chemically pure grade ingredient (for laboratory use)
- Technical grade ingredient
- Emulsifiable concentrates and concentrates in inverse emulsions
- Water-soluble concentrates, in different concentrations
- Wettable powders, soluble in water and for dusting and fumigant formulations
- Granular formulations, pellet formulations and encapsulated formulations

In the Colombian market commercial presentations are made by companies established in the country, with current sales records to April 1997, as indicated in Chart No 2.3.

### 2.4.3 Surfactants and inert ingredients of basic formulation

In the process of preparing the formulations of glyphosate for commercial use, solvents and mixtures or anionic and nonionic surfactants are used. According to the manufacturer, the typical formulation of glyphosate in commercial use, in its soluble liquid presentation, corresponds to:

***Active ingredient: Glyphosate. N-(phosphonomethyl) glycine, in isopropylamine salt 41.0%***

***Inert (Ethoxylated tallowamine)* 59.0%***

Some commercial formulations of glyphosate, including the one used in PECIG, incorporate a surfactant known as POEA in a ratio nearing 15%.

Also part of the formulation for use is a fraction of a surfactant and alleged drift and evaporation reducer, commercially called Cosmoflux 411 F, on which the production and/or distributor company, Cosmoagro, has supplied the following technical specifications. It is fitting to provide such comment because, according to several publications, various environmentalists identify it toxicologically as one of the hazardous constituents.

**CHART NO. 2.3**

**COMMERCIAL PRESENTATIONS OF GLYPHOSATE**

| COMMERCIAL NAME | PRODUCTION COMPANIES | CONCENTRATION* | ICA REGISTRY |
|---|---|---|---|
| Faena 320 | Proficol SA | 320 g/L | 1800 |
| Faena 320 SL | Monsanto Colombiana | 320 g/L | 1775 |
| Fuete SL | Monsanto Colombiana | 480 g/L | 2475 |
| Ranger SL | Monsanto Colombiana | 240 g/L | 2312 |
| Rocket SG | Monsanto Colombiana | 74-75% | 1993 |
| Rocky SL | Monsanto Colombiana | 120 g/L | 1757 |
| Roundup madurante SL | Monsanto Colombiana | 480 g/L | 2670 |
| Roundup SG | Monsanto Colombiana | 74-75% | 2488 |
| Roundup SL (Salt) | Monsanto Colombiana | 480 g/L | 756 |
| Glifosato 48 SL | Coagro Ltda. | 48% | 2699 |
| Clinofox | Cedar Crystal Chemical | 480 g/L | 2490 |
| Glifosol SL | Colijap Ind. | 480 g/L | 2337 |

| | | | |
|---|---|---|---|
| | Agroquimica | | |
| Glyfosan SL | Químicos e Insumos Agrícolas | 480 g/L | 2234 |
| Glyphogan 480 SL | Magan de Colombia | 480 g/L | 2530 |
| Candela 120 SL | Agroser SA | 120 g/L | 2233 |
| Candela XL | Agroser SA | 120 g/L | 2800 |
| Coloso SL | Basf Química Colombiana | 480 g/L | 2609 |
| Panzer 320 SL | Invequímica SA | 320 g/L | 2569 |
| Panzer 480 SL | Invequímica SA | 480 g/L | 2399 |
| Regio SL | Quimor SA | 480 g/L | 2211 |

* All commercial formulations refer to active ingredient contents such as salt.

Classification: Spraying Additive

Physical State: Liquid at 25° C

Viscosity at 25° C: 60 mPas, approximately

Specific Gravity: 0.89

Flash Point: above 149° C

pH (1% aqueous solution): 6.3

Oil concentration: 80 - 85% p/p

Solubility: < Soluble in mineral and vegetable oils

< Dispersible in water

< Insoluble in ethanol

Classification as poison: Not classified

Eye irritation: Non irritating

| | |
|---|---|
| Rabbit skin irritation: | Undiluted produced mild irritation after 24 hours |
| Human skin irritation: | Not irritating or sensitizing |
| Biodegradability: | Greater than 98% |

In opinion of October 4, 2001, the Ministry of Health established the classification of the mixture GLYPHOSATE + POEA + COSMOFLUX (1%) as follows:

| | |
|---|---|
| a) Glyphosate active ingredient: | Toxicological category IV (Slightly Toxic) non carcinogenic, mutagenic or teratogenic |
| b) Glyphosate + POEA (polyoxy-ethyleneamine): | Toxicological category III (Mildly Toxic) |
| c) Other formulations in the market: | Toxicological category IV (Slightly Toxic) |
| d) Cosmoflux 411 F: | Toxicological category IV (Slightly Toxic) |
| e) Mix of glyphosate + POEA + Cosmoflux 1%: | Toxicological category III (Mildly Toxic) |

The Ministry adds in its opinion that "pesticides in that category are admitted according to their action for use in domestic environments as in the case of household pesticides such as Baygon spray, Raid mosquitoes and flies, Rayol spray, Rodasol, Cupex kills flying bugs, and even for public health use such as Malation, Fenitrothion and Solfac used for the control of dengue and malaria."

Annex No 2 presents the aforementioned opinion and the descriptive annexes of the Cosmoflux 411 F adjuvant.

The title bearer of the sales registry of glyphosate in Colombia is the company Industria Colombiana Agropecuaria.

#### 2.4.4. Classes, materials and capacity of the containers

Plastic containers (polyethylene) are used for glyphosate, with a capacity of 55 gal (approximately 200 liters). In the case of surfactant Cosmoflux, 5-gallon plastic containers (approximately 20 liters) are used.

## 2.5 HERBICIDE APPLICATION METHODS

### 2.5.1 Herbicide application technique

***General***

For it be effective, the spraying method to be used should ensure a uniform distribution of the herbicide in the required active ingredient dose on the illicit crop to be eradicated, with the use of the mix of the formulated commercial product with the water as a transport means, to produce evenly dispersed droplets over the crop to be applied. The coverage or density of coverage is measured by the number of droplets/cm2 captured by the crop foliage, which will determine the biological success or the effect of the application.

Studies conducted to date by the DNE however, together with the Anti-Narcotics Police (DNE, 1998, 2000, 2001), show that no aerial spraying equipment produces a steady droplet size, therefore, the standard should be the Volume Median Diameter (VMD), defined as the droplet size that satisfies the distribution of a spraying volume producing 50% of a fine droplet size and the other 50% of a large size.

The droplet size depends, nonetheless, on a number of factors such as physical characteristics of the product, viscosity, vapor pressure, density, pump pressure, spraying unit position with respect to the airflow, speed and operation altitude of aircraft, environmental conditions related to temperature, relative humidity, speed and wind direction and characteristics of the spraying equipment. To achieve optimum results, the DIRAN has established operating parameters that allow the control of the negative effects of these conditions. These parameters are illustrated in Chart No 2.4.

***Spraying Method***

Two modes of spraying can be applied: parallel and “race track.” These methods were described above (Section 2.1.2.2)

***Factors that alter the effectiveness of spraying***

Before spraying, the pilot and the commander of the operation should take into account a number of factors, with the aim of making the final decision on whether or not to spray and, if so, the parameters to adopt. Factors to consider may include the following:

- *Meteorological factors (very variable in the tropics, especially in the mountains)*
  * Rain: affected by washing and leaching of the product (runoff)

  * Wind or air currents: drift losses

  * Temperature: evaporation losses

- *Application factors*
  * Height: friction loss (underdosing)

  * Speed: losses for breakup of the droplet and weakening of the application

Consequently, the expertise and professionalism of the pilot plays the biggest role in the success of the spraying.

The effectiveness of the eradication methods depends on the criteria used in the mission to define the one that best meets the established goal. For this, the type of crop (density, size, location), the distance from the center of operations and operating time should also be taken into account, so that the mission is swift, safe and effective.

***Application dose and total discharge volume***

The application dose, the characteristics of the mix with water and with the adjuvant and the total discharge volume is shown in Chart No. 2.5.

The volume of applied or discharged mixture, with reference to crop density, i.e. the effective discharge of mixture, is 23.65 L/ha for coca and 51.09 L/ha for poppy, calculated for a “boom” of 28 nozzles, 2 mm in diameter 1.6 mm and 1.2 mm. The doses applied are 10.4 L/ha of commercial glyphosate formulation and 2.5 L/ha for poppy. It should be noted that this is not solely an active ingredient but rather the commercial formulation, with a concentration of 480 grams of active ingredient per liter of IPA salt.

***Number of applications and frequency***

One pass for each type of crop (coca, poppy or marijuana)

**CHART NO. 2.4**

**OPERATING PARAMETERS OF THE PROGRAM FOR THE ERADICATION OF ILLICIT CROPS BY AERIAL SPRAYING**

| PARAMETER | UNIT/MEASURE | VALUE OR RANGE | VALUE OR RANGE |
|---|---|---|---|
| | | COCA | POPPY |
| FLIGHT ALTITUDE | Meters | Less than 25 | Less than 12 |
| Aircraft speed | T65 mph | 120 - 150 T 65 | 120 - 150 T 65 |
| Aircraft speed | OV-10 kt | 180 | OV-10 (not used) |
| Cargo of Aircraft | Gallons | 350 - 500 - 800 | 200-350 |
| Discharge expected | Liters/hectare | 23.65 | 51.09 |
| Discharge of Glyphosate i. a. | cubic m.m./cm2 | 0.0384-0.0480 * | 0.0096 to 0.012 * |
| Commercial glyphosate | Liters/hectare | 10.0 | 2.5 |
| Droplet size | Microns | 300-800 | 300-800 |
| Hours of application | Day/night hours | 5:30 to 10:00 a.m.<br>4:00 to 6:00 p.m.<br>2:00 to 10:00 a.m. | 5:30 to 10:00 a.m.<br>4:00 to 6:00 p.m. |
| Magnitude of recovery | In % of the spraying | 75% to 80% | 75% to 80% |
| Pump pressure | Pounds per cm2 (psi) | 20 to 25 | 20 -25 |
| Swath width | Meters | 25-30 | 25-30 |
| Expected drift | Meters | < 5 to 7 | < 5 to 7 |

| | | | |
|---|---|---|---|
| T.V.B. Nozzles | hole mm | 2 | 2 |
| Ambient temperature | Degrees Celsius | Up to 30 degrees C. | up to 20 degrees C. |
| Relative humidity | Percentage | 75 to 90% | 75 to 85% |
| Wind speed | In meters per second | 0 to no more than 2.0 | 0 to no more than 2.0 |

* Due to the extent of recovery, the effective dose is estimated at 20% less than that discharged

The ICA recommends changing the dose of the commercial glyphosate as follows:

For coca crops under one year old: use 8.0 L glyphosate, diluted in 15.413 L water

For coca crops over one year old: use 10.0 L glyphosate, diluted 13.423 L water

For both formulations, 236 cc of Cosmoflux should be added.

Source: this study

*Operational parameters of fumigation operations*

The parameters considered in the operation are due to existing environmental, aviation and air safety regulations and which apply to programs. They are summarized in Chart No. 2.4.

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**CHART NO. 2.5**

**APPLICATION DOSE AND COMPOSITION OF THE MIXTURE USED BY TYPE OF CROP**

| SUPPLY | COCA (L/ha) | POPPY (L/ha) |
|---|---|---|
| Commercial formulation with glyphosate active ingredient (480 grams per liter of IPA | 10 | 2.5 |

| | | |
|---|---|---|
| salt) | | |
| Cosmoflux 411 F Adjuvant | 0.23 | 0.51 |
| Water | 13.42 | 48.08 |
| **MIX RATIO (%)** | | |
| Commercial formulation with glyphosate active ingredient (480 grams per liter of IPA salt) | 42 | 5 |
| Cosmoflux 411 F Adjuvant | 1 | 1 |
| Water | 57 | 94 |
| **MIX DISCHARGE PER HECTARE (L/ha)** | | |
| Discharge of mix per hectare | 23.65* | 51.09 |

Source: Anti-Narcotics Police, 2001. * Calculated in accordance with the ICA recommendation of 10 L/ha of commercial formulation diluted in 13.423 L/ha of water for crops over a year.

### 2.5.2 Exclusion areas of the operation and buffer strips

In order to protect the environmental aspects of the spraying program areas, a number of elements not to be sprayed have been identified; these are the exclusion zones which include the national nature parks, human settlements, water bodies and socioeconomic interest areas (substitution projects).

Additionally, buffer strips have been established around the illicit crops themselves, in order to provide a protection area for each of the environmental elements potentially affected by the spraying operation. Chart 2.6 shows the exclusion zones and buffer strips currently being used in the program. The proposal is to adopt, in addition, a 1,000-meter alert distance, that is, the area where the SATLOC system will notify the pilot not to spray on exclusion areas or buffer strips surrounding them.

### 2.5.3. Herbicide tanking systems

Glyphosate is pumped from the 55-gallon plastic drums into a 500-gallon deposit, where it will be kept to feed, also by pumping, the tanks of the aircraft (fiberglass for T-65 and stainless steel for OV-10). In fixed doses for the mixture, the encapsulating agent (Cosmo Flux 411 F) is added simultaneously with the tanking of the herbicide and finally water. Each tanking equipment is equipped with flow meters that register the exact values to be mixed.

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**CHART NO. 2.6**

**BUFFER STRIPS ON ENVIRONMENTAL ELEMENTS APPLIED IN THE OPERATION OF THE PROGRAM**

| ENVIRONMENTAL ELEMENT | EXCLUSION ZONES AND BUFFER STRIPS | ALERT DISTANCE (SATLOC SYSTEM)* |
|---|---|---|
| Bodies of Water<br>Static: lakes, lagoons, ponds, fish farms and wetlands.<br>Flowing: brooks, rivers | No spraying over bodies of water<br>Buffer strip at least 100 meters | 1,000 meters |
| Areas of zones belonging to the National Nature Parks System | No spraying within them<br>Spray the outside leaving a safety belt of at least 100 meters | 1,000 meters |
| Areas of human settlements<br>Rural settlements, reservations, urban areas. | No spraying within them.<br>Spray the outside with a safety belt of at least 100 meters. | 1,000 meters |
| Areas with plant cover | No spraying | |

| | | |
|---|---|---|
| other than illicit crops. | The pilot must open and close the valve within the plot. | |
| Areas of socioeconomic interest: productive projects, areas of covenants. | No spraying.<br>Establish a safety belt of at least 100 meters. | 1,000 meters |

Source: DIRAN, 2001. * The alert distance is the area where the SATLOC system installed inside the aircraft must notify the pilot to respect the buffer strip, which should not be sprayed. The distance of 100 meters as the sole buffer strip is adopted in accordance with Article 87 of Decree 1843 of 1991.

#### 2.5.4. Methods and frequency of calibration of the spraying equipment

The most frequently used methods for calibration of spraying equipment are:

- ***Definition of flow***. 300 gallons of water measured on the ground, for one minute of flight at 208 MPH with the spraying equipment open and pressure of 55 psi (bypass completely open) after several tests, it is determined that the equipment sprays 200 gallons. Back on land the tank is filled again and if there is a difference between the amount sprayed and the replacement, the calibration number should be adjusted. The operation should be repeated on several successive flights to ensure that the calibration is correct.

- In order to observe the distribution of the spraying and to measure coverage in relation to the number of droplets/cm2 and width of effective pass, 46 cards are placed transversely to the direction of flight, each 1 meter apart starting from number 4 to 43 and the last 3 at each end, every 5 meters, in order to see the effects of drift. The criterion to measure the lateral drift is the displacement of the droplets smaller than 200 microns and densities under 10 droplets/cm2

- To measure the accuracy of the opening and closing of nozzles in the application area, cards are placed in the direction of the flight, 7 in the (south) entrance and another 7 at the (north) exit, aligned with the flags and 10 meters apart from each other. The criterion is a minimum of 10 droplets/cm2.

Calibration for determining the flow must be conducted before each operation. Other calibrations can be performed every month, in a representative area of the conditions of the operation nucleus.

### 2.5.5. Limitations caused by environmental conditions

As noted above, for optimum results in the application of the herbicide, the conditions of wind speed, relative humidity, temperature, time of day and topography of the land should be taken into account, together with the flight altitude and speed of the aircraft. Chart No 2.4 summarizes the ranges where operations should be conducted. Meteorological data can be taken from the stations of the nearest airports. Where possible, at each anti-narcotics base there should be an automatic weather station available to measure the parameters mentioned.

***Limitations by evaporation and drift***

Evaporation and drift are two major issues in the application of pesticides by aircraft. Evaporation causes more or less significant herbicide “loss,” depending on flight altitude, the size of the particles sprayed and the environmental conditions. At high altitude flight, low relative humidity and high ambient temperature, the rate of evaporation can reach 80% or more. This condition occurs in a 2-meter-high fall, if the initial size of the droplet is less than 100 microns in diameter, the relative humidity is approximately 50% and the temperature is above 30° C. The spraying from 10 m high is unlikely to reach the surface of the crops if the initial particle size is less than 200 microns in diameter.

“Drift” or lateral displacement by wind of a part of the pesticide spraying is one of the main drawbacks of the spraying program, due to the effects that may result on crops, people, water sources and all other ecological constituents of which sprayed crops are part. In the case of treatment with glyphosate, the main concern is the condition that it may cause to crops and other plants around them.

The phenomenon of drift depends essentially on the velocity of the crosswind, the altitude of the sprayer aircraft, the initial size of the droplets sprayed, the density of the chemical compound, ambient temperature and the spraying experience of the pilot of the aircraft, and other less common factors. In general it can be noted that, at higher altitudes, lower initial particle size, wind speed greater than 8 km/hour and eventual presence of phenomena of “thermal inversion” (light wind, cold air at ground level and warmer in the upper layers, commencing at 2 to 3 meters high), the product drag increases because it extends the period of particle “suspension” in air.

The particles with initial sizes of 200 microns produced by 1.0-density fluids take slightly over 4 seconds to fall 3 m and 11 seconds when the size is 100 microns. With winds of 8 to 10 km/h, particles of 100 microns in diameter can be dragged up to 400 m, when the spraying is made from 6 m high. That drag, however, does not get deposited on the surface near the ground because most of the material is lost by dissipation in the atmosphere (volatilization or evaporation) before reaching the ground.

This is demonstrated by tests conducted in previous phases of the environmental studies, on the effect of drift, droplet size and coverage pattern (droplets/cm2), and the results were delivered to the Ministry of Environment in September 2000.

***Limitations of coca control with Glyphosate***

Glyphosate herbicide effectiveness depends in part on the stage of development and physiological activity of the botanical species to be controlled. In the case of coca species of the *Erythroxylum* genus, it is estimated that the development stage most susceptible to the effect of glyphosate is between 3 and 12 months of age in the field.

Given that commercial coca crops covered by the Program to Eradicate in some cases exceed 12 months in age in different parts of the country, including the geographic region of San Jose del Guaviare, the technical strategy to be adopted must include, as a mandatory measure, special procedures able to override the negative effect of having to make applications on crops whose ages are not, for the most part, the most susceptible to the herbicide effect, without using too high (and expensive) doses of the product, per surface unit (hectare).

On the other hand, cutting the plant at the neck of the root, which growers perform post-spray, prevents the herbicide from being absorbed by the plant. Also, growers have developed plant washing systems with products such as brown sugar water to minimize the effect of the herbicide.

## 2.6. TECHNOLOGICAL TOOLS, EQUIPMENT AND MATERIAL OF THE PROGRAM

### 2.6.1. Equipment

***General equipment***

- Twin Otter aircraft for transport of commission personnel
- C-26 aircraft with technological support equipment
- SAR, UH - 1N, Bell 212, UN II helicopters
- Huey II helicopters
- Black Hawk helicopters, to transport VIP/Protection
- PNC Huey II helicopters
- PNC Bell 212 Helicopters
- Turbo Thrush aircraft with differential GPS and SATLOC system
- OV-10D with FLIR with SATLOC system
- Air Tractor aircraft with differential GPS and SATLOC system
- Night Navigation instruments (Night Vision)

***Types of aircraft used in the spraying***

Turbo Thrush Aircraft, OV-10 and Air Tractor AT-802

***Technical Specifications***

- *Turbo Thrush*

  Aeronautical:

  * Pratt and Whitney Engine PT 6A-65 AG

  * 1230 HP Power

* The instrument panel is designed to facilitate the installation of additional equipment such as GPS (Global Position System) and flow meters.
* The wings are 90 inches each and 16 meters long (built in chromed steel).
* Maximum takeoff and landing weight allowed 5,670 kg (1,250 lbs)
* 228-gallon fuel capacity
* Tank Capacity 660 gallons
* Cruise speed 175 MPH
* Maximum permissible speed 200 mph (322 kph)
* Minimum takeoff distance 1,500 ft (457 meters)
* Distance needed for landing 600 ft (183 meters)
* Fuel tanks are located inside the wings and are part of the airframe, the 2 main tanks have a capacity of 115 gallons and are interconnected.

* The dashboard is equipped with:
    * Artificial electric horizon
    * Fuel Gauge
    * Oil temperature
    * Vertical speed indicator
    * Altimeter
    * Air Speed
    * Anemometer
    * Compass
    * Voltmeter

* Maximum herbicide load: 450 gallons
* Capacity up to 550 gallons

- OV-10

  * Maximum herbicide load: 350 gallons
  * Twin Engine
  * The dashboard is equipped with:
  * Electric artificial horizon
  * Fuel Gauge
  * Oil temperature
  * Vertical speed indicator
  * Altimeter
  * Air Velocity
  * Anemometer
  * Compass
  * Voltmeter

- ***Air Tractor AT-802***

  * Fuel tank capacity: 254 gallons
  * Tank Capacity: 800 gallons
  * Maximum takeoff and landing weight: 16,000 lb
  * Empty weight with spraying equipment installed: 6,320 lb
  * Total weight loaded: 9,680 lbs

- *Spraying Equipment*

### 2.6.2. Materials and elements used

- Bullet-proof vests
- Binoculars
- GPS
- Video cameras
- Cameras
- MP8 Videos
- Photographic film
- Cartography
- Forms

### 2.6.3. Technological tools

The technological tools used in developing the spraying program are:

- SPOT and LANDSAT satellite images updated with of 20 and 30-meter resolutions respectively. These are regularly acquired from distributors in Colombia and managed by the SIMCI Project (DNE-DIRAN-UNDCP).

- Software for recording, analysis and interpretation of satellite images (ILWIS, ERDAS, PCI, ILLISYS). The Program has these types of satellite image processors, which can be used according to the characteristics of the images and the needs.

- Field registration software (SATLOC). This software serves for satellite tracking of aircraft in each of the spraying operations. After each flight, the computer provides a list and coordinates that allow the plotting of the flight paths of the aircraft.

- Panchromatic aerial photographs with a resolution to 1 meter.

- IGAC and DMA base mapping

- High precision geopositioning

To ensure accuracy of the operation, the Police rely on the SIMCI project (Illicit Crops Integrated Monitoring System), which interprets the images aimed at establishing the various types of coverage in different provinces, with emphasis on the characterization and quantification of illicit crops. Each image is processed and integrated at the province level not only for updated information regarding the size and location of illicit crops, but also for other physical type of information that may be obtained from the satellite image, which allows monitoring and tracking the areas of operation. Annex No 1 has a more detailed description of this project and the methodology used.

## 2.7. PROGRAM FOR THE ERADICATION OF ILLICIT CROPS

### 2.7.1. General Aspects

By authority of the National Narcotics Council, the Anti-Narcotics Police runs the operations of the Program for Illicit Crop Eradication in the context of national policy to combat drugs called the "**National Plan to Combat Drugs, Colombia 1998 - 2002,"** which is the basic framework in which state agencies should implement their action to tackle the drug problem in the country.

*The purpose* of the program is the eradication of illicit crops, taking into consideration aspects of social, political, economic, legal, environmental and health nature in order for it to be executed in a controlled manner from an operational and environmental standpoint.

The program is developed in regions where the presence of illicit crops is identified, taking into account their *differential character*, according to their nature and purpose, that is, their type or category, extensive or industrial crops and potential risks.

The Illicit Crop Eradication Program does not operate in environmentally sensitive areas: populated areas, parks and natural reserves, watercourses and water bodies

### 2.7.2. PECIG Structure and organization

Chart 2.7 shows the structure and organization adopted for the development of the program.

Within this framework, it is the responsibility of the National Narcotics Directorate to coordinate the development of the eradication plans, as well as the environmental management plan and all the programs contained herein. At the province level it works through the Regional Technical Drug Units, which are specialized structures in drug issues at the province level created by initiative of the National Directorate of Narcotics and backed by the political will of governor offices, using as a criterion the magnitude of the drug problem, including its various manifestations, and the awareness and sensitizing of it.

The Regional Technical Units are multi-agency teams of technical support to the Sectional Council of Narcotics, comprising members of all entities that have some responsibility for the execution of the Province Drug Plan, consistent with the manifestations of the problem in each locality: production, trafficking and/or consumption and consistent with the policies and goals of the National Plan to Combat Drugs.

Its purpose is to manage the plans, programs and projects for comprehensive assistance to the drug problem, reach inter-sectoral agreements to define priorities for intervention, to manage resources in the Province Development Plan and assess compliance with the defined Province Plan.[6]

### 2.7.3. Inter-institutional coordination activities

[6] LAW 30 OF 1986 "ADOPTING THE NATIONAL DRUG STATUTE AND OTHER PROVISIONS," deputy DNE office

The different entities involved in the Program To Eradicate Illicit Crops With Glyphosate-PECIG should guide their activities in accordance with common goals, adjusting their actions and involving communities in the management. To reach agreements is the fundamental element in the unification and optimization of actions. The program has three major processes: crop detection, spraying and verification.

#### 2.7.3.1. Detection group coordinating activity

The objective is to identify and establish areas of illicit crops, taking into account area, exact location of the plot by coordinates, topography and surrounding vegetation, among others. Similarly, high-risk areas are located, productive projects and voluntary agreements being developed by responsible institutions, and buffer strips are established for the Eradication Program not to operate in these areas.

Chart 2.8 shows the organization and responsibilities of those involved in detection.

**CHART 2.7**

**STRUCTURE AND ORGANIZATION FOR THE DEVELOPMENT OF THE PROGRAM**

| ACTION | RESPONSIBLE | ACTIVITY |
|---|---|---|
| Policy Leadership | National Narcotics Council (CNE) | Authorize the DIRAN to develop PECIG |
| National Program | National Narcotics Directorate (DNE) | Coordinate with all entities involved in PECIG its implementation and |

| | | |
|---|---|---|
| Coordination | | enforcement of technical and legal actions established for the Program. |
| Operational execution | Anti-Narcotics Police (DIRAN) | Based on the guidelines given by the National Narcotics Council, develop the Program which will operate under the technical parameters of reference and/or operational procedures to ensure its development with low procedural and environmental risk. |
| Monitoring and control | National Narcotics Directorate (DNE), directly and through environmental audit services * | Supervise the proper implementation of the program.<br><br>Control, tracking and monitoring to allow assessment of the environmental, agronomic and health impact generated by this Program. This monitoring should be conducted in accordance with programs of Inspection, Evaluation and Control, and of Environmental Monitoring of the Environmental Monitoring Plan. |

* When reporting about environmental auditing in this document, it refers to the ongoing mandatory activity of environmental audit and/or environmental inspection to the program, whether it is international or by services provided by national firms.

#### 2.7.3.2. Coordinating action of the spraying group

The aim is to develop glyphosate spraying operations under technical application parameters in accordance with operational and environmental standards set in the established legislation, Environmental Audit and Environmental Management Plan. Chart 2.9 shows the organization and responsibilities of participants in the spraying.

### 2.7.4. Program Goals

The annual aerial spraying goals at the national level and at each nucleus level will depend on national and international resources available for this purpose. By 2000 the sprayed area in coca cultivation was 58,073 hectares and 9,254 in poppy. A conservative estimate of the goals for 2001 includes the spraying of 50,000 hectares of coca and 10,000 hectares of poppy.

As was explained in the description of the program (Section 2.1), the eradication activities of illicit crops by aerial spraying are an ongoing activity of the Anti-Narcotics Police.

**CHART 2.8**
**COORDINATION OF DETECTION ACTIVITIES**

<table>
<tr><th>GROUP</th><th>ACTION</th><th>UNITS, INSTITUTIONS AND AGENCIES INVOLVED</th></tr>
<tr><td rowspan="2">D<br>E<br>T<br>E<br>C<br>T<br>I<br>O<br>N</td><td>There is a report of illicit crop detection and the tentative annual spraying schedule for submission to the National Narcotics Council for approval.</td><td>National Drug Council, Anti-Narcotics Police, SIMCI Project and DNE.</td></tr>
<tr><td>Identification, characterization and spatialization of the areas affected by illicit crops and identifying exclusion zones of the Program.<br><br>• With satellite images<br>• With mapping<br>• Overflights<br>• Aerial photography and filming<br>• Recognition of industrial clusters and subsistence farmers<br><br>Characterization of areas to be</td><td>Anti-Narcotics Police<br><br>DNE<br><br>COMPREHENSIVE SYSTEM OF MONITORING OF ILLICIT CROPS Project<br><br>In accordance with the provisions of Resolution 0005 of 2000, a request for base information and cartography is made to the following institutions:<br><br>• Ministry of Interior<br>• Ministry of Agriculture<br>• National Alternative Development Plan<br>• Social Solidarity Network.<br>• Ministry of Health<br>• Colombia’s National Parks</td></tr>
</table>

| | | |
|---|---|---|
| | sprayed<br><br>Evaluation of the information collected.<br><br>Submission of the characterizations to the inter institutional technical committee for its recommendations | • Governors<br>• Mayors<br>• Autonomous Regional Corporations<br>• ICA Branches<br>• Municipal Departments<br>• Province and city Health Departments<br>• Universities<br>• Institute of Hydrology, Meteorology and Environmental Studies - IDEAM<br>• IGAC<br>• National Bureau of Statistics |
| | Scheduling of activities and aerial reconnaissance | Anti-Narcotics Police, DNE, Attorney General's Office, Environmental Audit, National Plan for Alternative Development and SIMCI Project officials.<br><br>Eventually involved are the Ministry of Environment and the Solidarity Network. |
| | Identify and spatialize buffer strips | National Drug Council, Anti-Narcotics Police, SIMCI Project and DNE |
| | Approval or not by the CNE of the development of the Program. | National Drug Council |

Source: DNE

**CHART 2.9**

**COORDINATION OF THE SPRAYING ACTIVITIES**

| GROUP | ACTION | UNITS, INSTITUTIONS AND AGENCIES INVOLVED |
|---|---|---|
| ASPERSION | Preparation of operational planning | Anti-Narcotics Police |
| | Planning and control<br>• Meetings for planning of the operation<br>• Coordination of intelligence operations,<br>• Coordination with organizations at the national and local level | Anti-Narcotics Police<br>Police and Military Forces<br>Local authorities, Environmental Audit, Delegate Attorney's Office for Environmental Affairs and National authorities identified by the CNE. |
| | Evaluation and control of operating parameters established in the Environmental Management Plan | Anti-Narcotics Police, DNE, Environmental Audit and the Attorney General of the Republic |
| | Adjust the Satellite Tracking System SATLOC or any other monitoring tool, to perform the operation in a precise manner according to the geographical location of the sites | Anti-Narcotics Police<br>Environmental Audit |
| | Illicit crop spraying operations under the operating parameters established in the Environmental Management Plan. | Anti-Narcotics Police, DNE, Environmental Audit, Attorney General's Office.<br>Eventually, the Ministry for the Environment, Ombudsman, Ministry of Health and Health Departments, local authorities, Colombian |

| | | |
|---|---|---|
| | | Agricultural and Livestock Institute and other determined by the CNE |
| | Systematization, statistical analysis, preparation of records and archives. | Anti-Narcotics Police and Environmental Auditing. |

Source: DNE

### 2.7.5. PECIG's Schedule

The following is a tentative schedule, based on hectares sprayed in 2000. The actual distribution will depend on weather and safety conditions of each operation site.

**CHART 2.10**

**GENERAL SPRAYING SCHEDULE BY GOALS (HA)**

| MONTH | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AREA* | 6733 | 6733 | 6733 | 4039 | 4039 | 4040 | 4040 | 4040 | 6732 | 6732 | 6733 | 6733 |
| % | 10 | 10 | 10 | 6 | 6 | 6 | 6 | 6 | 10 | 10 | 10 | 10 |

* These percentages were assumed because the months of April to August are the rainiest in the eastern area

### 2.7.6. PECIG's costs

The costs of spraying illicit coca crops with glyphosate are estimated at US $471.51 per hectare for OV-10 aircraft and US $463.30 per hectare with T-65 aircraft, for an average of US $467.405/ha. For poppy, costs are US $429.89/ha with T-65 aircraft.

If the 2000 spraying goals continue for the coming years, that is, 58,073 hectares of coca and 9,254 has of poppy per year, the total project cost would be US $27,143,610 dollars for cocaine and US$3,978,202 for poppy per year. In pesos, that would mean figures of $63,787.5 million pesos for coca and $9,348.8 million pesos for poppy, for $73,136.3 million pesos in total.

Chart 2.11 shows the discrimination of the cost of spraying

The above calculations were estimated using fixed-wing aircraft and rotary wing, staff and supplies.

According to estimates by the National Police, this investment is preventing drug dealers from earning at least:

- US $144,000 ha/year of coca
- US $140,000 ha/year in poppy

The cost of spraying includes:

- The cost of the human resources includes employed civilians, civilian and police pilots and logistical staff
- The aircraft operating cost includes cost of flight/ha in OV-10 and T-65.
- The cost of glyphosate refers to the value of the herbicide
- The cost of adjuvants
- The cost of water used in the program

- The cost of fuel used by aircraft

**CHART 2.11**
**COST OF AERIAL SPRAYING WITH GLYPHOSATE PROGRAM**
**(Dollars per hectare)**

| DESCRIPTION | COCA | | | POPPY |
|---|---|---|---|---|
| | OV-10 | T-65 | Average | |
| 1. Human resource | 94.42 | 60.47 | 77.44 | 60.47 |
| 2. Aircraft operation | 255.92 | 283.64 | 269.78 | 308.84 |
| 3. Glyphosate | 84.85 | 84.85 | 84.85 | 20.71 |
| 4. Water | 0.02 | 0.02 | 0.02 | 0.05 |
| 5. Adjuvants | 2.23 | 2.23 | 2.23 | 5.46 |
| 6. Fuel | 34.06 | 32.08 | 33.07 | 34.36 |
| TOTAL/HA | 471.51 | 463.30 | 467.41 | 429.89 |
| | | | | |
| Alkaloid Sale/ha | 36,000 | 36,000 | 36,000 | 70,000 |
| Total sales/year | 144,000 | 144,000 | 144,000 | 140,000 |

Source: DIRAN, 2001

**[CHAPTER 3]**

## 3. ENVIRONMENTAL BASELINE

This chapter consists of two main sections:

- The first is dedicated to presenting and discussing the influence area of the program to eradicate illicit crops through aerial spraying of glyphosate (PECIG).

- The second is dedicated to presenting the main elements of the baseline in the areas of program implementation, taking into account that the potential area is across the country, except the paramos, the semi-deserts and wetlands. Part of this baseline is a brief description of the environmental impacts of the drug industry in Colombia, since they are one of the key elements in order to assess more clearly the impact of PECIG, which is the subject of Chapter 4.

The baseline is not presented in detail throughout the country, 1:25,000 scale mapping, as would be required for infrastructure projects, for the following reasons:

- Although the surface of the plots with illicit crops is 163,289 hectares, they are divided into 24 provinces and 183 municipalities, in such a way that the area of indirect influence to cover would be, in practice, extremely great and its social and environmental characterization at a detailed scale could easily take several years.

- On the other hand, for the same marginal conditions for agriculture in areas where most of illicit crops are cultivated (areas of tropical humid and very humid forest) and due to the criminal activity underlying drug trafficking, the regional dynamics of illicit crops is very fast in such a way that the areas that are now coca zones will no longer be such tomorrow and vice versa. This implies that any social and environmental characterization of the current areas of crops would be quickly outdated.

- Each of the glyphosate spraying operations requires careful planning in the days before execution, as is demonstrated in Chapter 2, “Program Description”, not only in the technical aspects of air navigation and the spraying method to use, but regarding public safety issues, prevention of attacks by armed groups, previous definition of exclusion zones and buffer strips, among others.

- Consequently, the DNE considers that at this stage–the conducting of the spraying–is when the detailed characterization of the area to spray should be available, in order to organize the activities of prevention, correction, mitigation and compensation for possible environmental and social impacts.

*This approach means that this management plan is considered a master plan which should be embraced by all activities of PECIG both in the counter-narcotics bases and in the spraying operations themselves, anywhere in the country, either in current areas of illicit crops or where they would develop in the future.*

*This approach also means that at this stage of environmental planning it is not necessary to have detailed environmental characterization of all areas to spray, as this should be a requirement for the planning of each spraying operation, when and where needed, that is, in real time.*

Nevertheless, for the purposes of the framework of the environmental management plan it was considered necessary to develop a national characterization of each of the nuclei included in PECIG, to appreciate the basic environmental constraints of each of them and especially, the definition of the fragile, delicate, critical, strategic and/or socially relevant ecosystems, according to the provisions of Decree Law 2811 of 1974 and Law 99 of 1993 and its implementing regulations.

## 3.1. IDENTIFICATION OF THE AREA OF INFLUENCE

### 3.1.1. Criteria for selection of areas for aerial spraying

The criteria for selecting areas to be sprayed are established by resolutions 001/94 and 005 of 2000 of the National Narcotics Council.

### 3.1.2. Areas of influence for the PECIG

Currently, illicit crops are distributed in 24 provinces and l83 municipalities. According to the August 2000 census, a total of 163,289 hectares have been cultivated with coca and 6,200 in poppy. Chart No 3.1 displays the distribution of these crops by province.

It is noted that the province of Putumayo alone represents 40.4% of coca crops. Next in importance with 16.3% is Caquetá, Guaviare with 10.8% and Meta with 6.8%. In total, the jungles of the Colombian Amazon area (including the Guaviare) concentrate 68.9% of coca crops in the country (including those in Guanía and Vaupés). The savannas of the Orinoco area (Arauca, Meta and Vichada) gather 10.4% of the crop. In total, the Orinoco-Amazon region accounts for 79.3%, i.e. four-fifths of the national area planted in coca. Among the Andean provinces, the largest coca areas are Nariño with 5.7% and North Santander with 3.8%, while the crops are mainly in the humid lowlands of these provinces, in the foothills of the Eastern (in the Amazon and Orinoco basin) and Western Mountain range (Pacific plain) and in the Catatumbo (North Santander).

In poppy, the most important province is Cauca with 32.2%, Nariño and Huila trail with 24.2 and 16.1% respectively, of the cultivated area.

Considering the distribution of coca by nuclei (Chart No 3.2), the most important is the Putumayo-Caquetá 59.2%, followed by Meta-Guaviare-Vaupés with 21.4%, South of Bolivar-Antioquia-Cordoba 7.3% and Cauca-Nariño with 6.7%.

Accordingly, it is possible to distinguish two types of areas in which the program may manifest its effects: the area of direct influence and the indirect area of influence.

- The **area of direct influence** is one in which the impacts directly caused by the spraying of glyphosate could be manifested, such as the destruction of the coca plants, the affectation of other types of natural vegetation and crops, soil and water pollution and the effect on wildlife. In this case, this area is strictly limited to industrial crops susceptible to spray, plus a buffer strip bordering them, to a distance of 5 meters, which is the permissible drift according to the spraying parameters.

# CHART 3.1

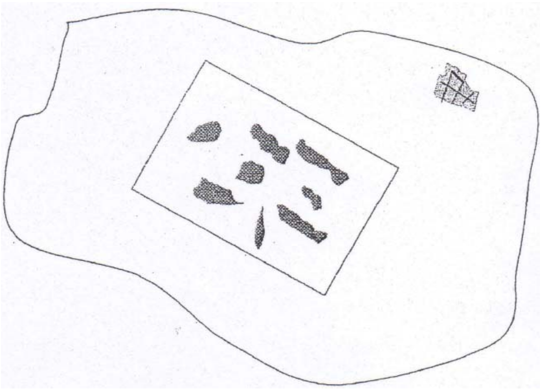
## AREAS OF ILLICIT CROPS IN COLOMBIA

| PROVINCE | AREA OF COCA CULTIVATION YEAR 2000 (Ha) | % | AREA OF POPPY CULTIVATION YEAR 2000 (Ha) | % |
|---|---|---|---|---|
| Antioquia | 2,547 | 1.6 | | |
| Arauca | 978 | 0.6 | | |
| Bolívar | 5,960 | 3.6 | | |
| Boyacá | 322 | 0.2 | | |
| Caquetá | 26,603 | 16.3 | | |
| Cauca | 4,576 | 2.8 | 2,000 | 32.2 |
| Cesar | 779 | 0.5 | 700 | 11.3 |
| Cundinamarca | 66 | 0.04 | | |
| Córdoba | 117 | 0.07 | | |
| Guainía | 853 | 0.5 | | |
| Guajira | 321 | 0.2 | 200 | 3.2 |
| Guaviare | 17,619 | 10.8 | | |
| Huila | | | 1,000 | 16.1 |
| Magdalena | 200 | 0.1 | | |
| Meta | 11,123 | 6.8 | | |
| Nariño | 9,343 | 5.7 | 1,500 | 24.2 |
| Norte de Santander | 6,280 | 3.8 | | |

| | | | | |
|---|---|---|---|---|
| Putumayo | 66,022 | 40.4 | | |
| Santander | 2,826 | 1.7 | | |
| Tolima | | | 800 | 12.9 |
| Valle del Cauca | 76 | 0.05 | | |
| Vaupés | 1,493 | 0.9 | | |
| Vichada | 4,935 | 3.0 | | |
| Chocó | 250 | 0.2 | | |
| Total | 163,289 | 100 | 6,200 | 100 |

Source: Anti-Narcotics Police, DNE, SIMCI Project. Institutional Censuses of illicit crops

- The **area of indirect influence** is one which could exhibit the indirect impacts of the program. For the purposes of this program, this area corresponds to areas of the municipalities where illicit crops are found, and therefore, where there will be the need to interact with communities through the social management plan. The following diagram illustrates the concepts of direct and indirect area of influence.



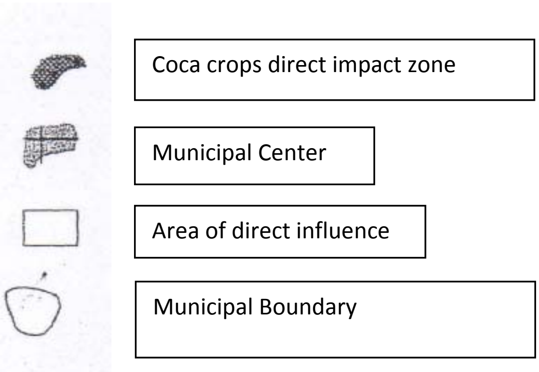


**CHART 3.2**
**AREAS COVERED BY COCA CROPS IN THE 2000 CENSUS RESULTS BY NUCLEUS**

| NUCLEUS | Total Area (ha) | National % | Program Object Area | Nucleus % | Municipalities affected |
|---|---|---|---|---|---|
| Putumayo-Caquetá | 96,694 | 59.2 | 57,174 | 64.4 | 27 |
| Meta-Guaviare-Vaupés | 34,878 | 21.4 | 16,859 | 48.2 | 24 |
| South Bolívar-Antioquia-Córdoba | 11,959 | 7.3 | 4,989 | 42.0 | 49 |
| Cauca-Nariño | 10,906 | 6.7 | 3,899 | 66.5 | 21 |
| La Gabarra | 6,103 | 3.7 | 1,472 | 24.1 | 15 |
| Arauca | 1,234 | 0.8 | 636 | 51.6 | 5 |
| Boyacá-Santander | 743 | 0.4 | 257 | 34.6 | 31 |
| Sierra Nevada Sta. Marta | 522 | 0.3 | 133 | 25.5 | 5 |
| Chocó | 250 | 0.2 | --- | --- | 2 |
| TOTAL | 163,289 | 100.0 | 85,419 | 56.3 | 183 |

Source: SIMCI, August 2000 Census

While the area of direct influence can be readily identified, as it is the area of illicit crops and the licit area sprayed, the boundaries of the area of indirect influence is more diffuse, so it is usually demarcated by a line drawn at a certain distance of the project or work under study, forming a rectangle or a circle. In the case of PECIG, this distance would not be greater than 1 km from the edge of the sprayed plots (in the case of roads up to 2 - 2.5 km from the axis are considered, but in this case alterations to the drainage must be considered). Some projects may have areas of broad socioeconomic influence that may cut across local or even national boundaries, as is the case of coca whose product, cocaine, is sold in the cities of many countries around the world.

Taking into account Chart No 3.2, the area of direct influence of the coca crops would be about 85,419 ha for industrial crops, plus the 5-meter perimeter buffer strip to allow for the drift. The area of indirect influence would be related to the coca fields of the 183 municipalities involved. It must be noted that in these regions, the size of the municipalities is often very large, sometimes greater than in some provinces in the interior of the country.

Annex No 2 shows in detail the illicit crop area by municipality, province and nucleus, according to the census of August 2000. Map 1.1 in Chapter 1 shows the general location of coca crops in the country and the maps in figures 3.4 to 3.11 show the distribution of the coca crops per nucleus.

## 3.2. GENERAL CONDITIONS OF THE ILLICIT CROP AREAS IN COLOMBIA

Illicit crops are distributed in much of the country, but because of its illicit nature and ecology, they have chosen certain types of areas characterized, on the one hand, by their marginal ecological conditions, with high rainfall and temperatures in the case of coca, and high rainfall and cold weather in the case of poppy. On the other hand, they correspond to areas with an established process of colonization, but with a very low coverage of roads and utilities. They are not, then, as can sometimes occur, areas of primeval forest; illicit crops come in after the clearing and the use of the land. This can be very well illustrated in the coca-growing areas of southern Bolívar and Caquetá-Putumayo (see photos 2 and 3, etc.).

### 3.2.1. Physical component

As announced and substantiated at the beginning of this chapter, this is a general characterization of the areas of illicit crops (Program Nuclei). The detailed environmental characterization, in those aspects that should interest the PECIG (vegetation cover, land use, human settlements present, nearby national parks) should be the object of the stages of detection, characterization of illicit crops and assessment of information collected that take place at the very process of selecting areas for spraying (see Chapter 2, Sections 2.1.1, 2.1.2 and 2.13 and tab No 2 on the protocol of the spraying process).

Chart No 3.3 shows the general physical condition of each of the nucleus purpose of the Program. Upon observation of the Chart the following conditions can be highlighted:

- In general, the areas chosen for the cultivation of coca (and marijuana) are warm, humid to very humid, with rainfall generally above 2,000 mm per year and, in some nuclei, exceeding 5,000 mm, as are Cauca-Nariño and Chocó.

- Flat to rolling topography (hills), because they correspond mostly to the plains of the Amazon, the Orinoco, the Pacific and the low Catatumbo. However, in the land cleared for cultivation of poppy, the topography can range from ravine to steep lands, with serious risks for the generation of erosive phenomena (see photos 1, 4 and 5)

- Soils with low to very low potential for traditional farming activities as a result of high humidity, which makes soil nutrients to leach rapidly, which requires the use of chemical fertilizers at higher rates than in other climates. In addition, high rainfall, coupled with high temperatures favor the growth of insects of all kinds, which requires also the intensive use of pesticides at doses and frequencies much higher than in sub-humid and semi-dry climates. In the rugged areas of the Andean forest, the slope of the land is an additional constraint for agricultural use.

- High drainage density, with numerous rivers and streams flowing permanently as a consequence of the high precipitation. These rivers are very important from a water biodiversity point of view, and they can therefore be seriously affected by intensive and uncontrolled pesticide use. In areas of Andean and high Andean forest used for poppy cultivation, deforestation can drastically affect the water systems of its watercourses, largely used to supply the water systems of the towns located downstream.

Photos 1.3 and 4 show the physical condition of some areas of illicit crops.

### 3.2.2. Biotic conditions

Chart 3.4 shows the general biotic conditions in each of the nuclei under the program. Upon observation of the box the following conditions can be highlighted:

- In general, the areas chosen for the cultivation of coca correspond to potential areas of humid to very humid tropical forest (equatorial evergreen forest or ombrophilous forest), intervened to very intervened and in some cases, cut for the most part, as is the case, among others, in southern Bolivar (see photo No. 3).

- In its original state, these forests have a great flora and fauna diversity with many endemic and endangered species. In some sectors, coca cultivation is performed in areas with anthropic savannas and gallery forests of the Orinoco.

- Poppy crops, however, take place in areas of potential Andean and high-Andean forest, also very intervened, and in many cases, completely replaced by pastures and crops. In its natural state, these forests are also of great importance for their biodiversity and the interest for the conservation of water, whose sources are used, as noted, for rural and urban water supply downstream.

- There are protected areas, affectable or affected by illicit crops in most of the nuclei, except the South of Bolivar, Antioquia, Córdoba and Boyaca-Santander, which, however, are excluded from the PECIG spraying operations.

Figures No 3.12, 3.13, 3.14 and 3.15 show satellite images (in color composition), where the existing vegetation can be seen in some areas of the nuclei of Guaviare, Putumayo and southern Bolivar. It is noted that although the dominant vegetation is secondary forest or primary forest, coca crops are in or near areas already cleared and occupied by grasslands. Of particular interest is the alluvial complex observed in La Hormiga sector in Putumayo (Figure No 3.14), where it can be observed that many of the coca crops are on the banks of the Guamuez River.

### 3.2.3. Social, economic and cultural components

Chart No 3.5 reveals the outstanding socioeconomic and cultural conditions of each of the areas of illicit crops object of PECIG (crop nuclei). Observation of the Chart allows highlighting the following conditions:

- Coca cultivation is done in general, in areas of low population density, although the trend is growing because of migration generated by illicit crops, characterized by extreme poverty levels and lack of public services, economy based on extractive activities and with no economic infrastructure for the development of traditional economic activities or with low coverage (roads, energy, etc.).

- Poppy crops are cultivated usually in areas of relatively higher population density, but in all cases low compared to average levels in the country, characterized by extreme poverty levels and lack of utilities, traditional smallholder economy, with a low coverage of economic infrastructure for the development of traditional economic activities (roads, energy, etc.).

- In some areas, illicit crops are in areas close to population centers, as seen for example in the satellite image of the figure 14, in Putumayo.

- In almost all areas of illicit crops, indigenous communities are present, particularly in the areas of the nuclei Meta-Guaviare-Vaupés, Choco, Putumayo-Caquetá, and Córdoba, although the majority of the indigenous population is located in the area of influence of the poppy nucleus (Chaparral-Iquira-Páez-Teruel).

- A very important feature from an environmental point of view is that coca cultivation, for the most part, is not located within the forest but in open areas previously occupied by pastures and traditional crops, indicating that the coca crops are more typical of areas of established settlement or in the process of consolidation.

**CHART 3.3**

**OUTSTANDING PHYSICAL CHARACTERISTICS OF THE AREAS OF ILLICIT CULTIVATION**

| NUCLEUS | WEATHER | GEOMORPHOLOGY | SOIL | HYDROLOGY |
|---|---|---|---|---|
| Putumayo - Caquetá | Warm (T>24° C) and humid to very humid (P>25000 mm per year).<br><br>Prevailing winds from the SE, of low power (<2 m/s) and heavy incidence of the calm. | Putumayo: plain with low hills in Lower Tertiary marine sediments.<br><br>Caquetá: high plain with relief in Higher Tertiary sediments.<br><br>Alluvial fans in foothills and recent alluvial beds along rivers. | Haplorthox and Dystropepts of the humid and very humid high plains of the Amazon area.<br><br>Tropaquents, Fluvaquents, Tropaquepts and Plinthaquepts in recent alluvial plains. Suitable forests and extensive cattle growing | Basins of the Putumayo and Caqueta rivers, tributary of the Amazon. Abundant rivers with numerous tributaries permanent flowing and partly navigable. |
| Meta-Guaviare-Vaupés | Warm (T>24° C). Very humid for Guaviare and Vaupés (p>3000 mm) and humid to very humid in Meta (p>2500 mm). Prevailing winds from the SE, of low power (<2 m/s) and heavy influence of the calm. | Meta: high flat and dissected Quaternary terraces. Plains and low hills with ferralitic shields.<br><br>Guaviare: high plain with relief on upper Tertiary sediments and flattening surfaces currently dissected. Vaupés: idem Guaviare + | Meta: Petroferric and tropeptic Haplustox. Haplorthox, Dystropepts and Haplustox on terraces and piedmont cones. Guaviare: Haplorthox and Dystropepts of the high humid and very humid plains with Ultisols in the | Basins of the Meta River and its tributaries, Guaviare and its tributaries, Vaupés and its tributaries, Apaporis and its tributaries, all flowing |

| | | | | |
|---|---|---|---|---|
| | | peneplain in crystalline Precambrian rocks of the Guiana Shield.<br><br>Alluvial fans in foothills and recent alluvial beds | savannas of Yari.<br><br>Vaupés: idem Guaviare + Troporthents, Haplorthox and Quartzipsamments in relief of the shield. Suitable forests and extensive cattle growing. | and partly navigable. |
| South of Bolívar - Antioquia-Córdoba | Warm (T>24° C) to mild (18-24° C). Subhumid in the north (P>1500 mm) to very humid (p>2500 mm) to the south. Predominant NE winds, low power (<2 m/s) and heavy influence of the calm. | Antioquia and Cordoba: hills of Tertiary sedimentary cover, folded and dissected.<br><br>Bolivar and part of Antioquia: metamorphic igneous massif of San Lucas, sedimentary cover of the base in the eastern foothills of San Lucas and fluvial lake plain of Magdalena-Cauca-San Jorge. Landslides in humid clay areas. | Troporthents in the Serrania de San Lucas. Fluvaquents, Tropaquepts, Dystropepts and Haplorthox in the fans of the foothills of the mountains and floodplain. Haplorthox and Dystropepts in the sedimentary mountains dissected and folded. Suitable forests and extensive cattle growing, partly for mechanized agriculture. | Córdoba: Basins of the Sinu and San Jorge rivers. Antioquia: basins of the Cauca and San Jorge rivers. Bolivar: basins of the rivers Cauca and Magdalena. Alluvial lake plain of the Lower Magdalena-Cauca-San Jorge. |
| Cauca-Nariño | Warm (T>24° C) and very humid to perhumid (P between 3000 and over 6000 mm). Prevailing | Piedmont hills of Cenozoic and Pleistocene age in volcano-sedimentary detrital materials. | Dystropepts, Troporthents and Tropodults in the hills. Tropofluvents, Eutropepts and Dystropepts in | Basins of the Micay, Pati, Iscuandé, Tapaje, Patia and |

| | | | | |
|---|---|---|---|---|
| | winds from W and NW, low power (<2 m/s) and heavy incidence of the calm. | Quaternary detrital deposit plain on tertiary materials. | dams and terraces of the floodplain. Trpoquents, Fluvaquents and Trpaqueps in poorly drained areas. Suitable for forestry because of the high humidity climate. | Mira rivers, characterize d by being bountiful. |
| La Gabarr a | Warm (T>24° C) and humid (P>2000 mm). Prevailing winds from the NE and N of low power (<2 m/s) and heavy influence of the calm. | Low and medium hills on clay and sandy sediments of the Higher to Lower Tertiary. Lower slopes of the Serrania de Los Motilones in sediments of the Cretaceous. Alluvial valleys with recent detritus material | Haplorthox and Dystropepts in the humid hills.<br>Tropaquents, fluvaquents and Tropaquepts in recent floodplains.<br>Suitable for forest and extensive cattle growing | Cataumbo and Tarra Rivers, Suroeste and their tributaries, all constantly flowing. |

| NUCLEUS | WEATHER | GEOMORPHOLOGY | SOIL | HYDROLOGY |
|---|---|---|---|---|
| Arauca | Warm (T>24° C), subhumid (P>2000 mm) in the plains to very humid (p>3000 mm) in the foothills and lower slopes. Prevailing winds from the NE and SE, of low power (<2 m/s) | Overflow floodplain, dejection cones and torrential piedmont fans. Lower hills and mountains of the Cordillera Oriental are folded and dissected in varied Tertiary and | Tropaquents, Tropaquepts and Dystropepts in plains and alluvial fans. Tropofluvents, Eutropepts and Dystropepts in well-drained alluvial plain. Fluvaquents, | San Miguel, Ele, Cravo Norte and Casanare rivers and their tributaries in the foothills, all flow permanently. They are part |

| | | | | |
|---|---|---|---|---|
| | and heavy influence of the calm. | Mesozoic sediments. Landslides in humid clay areas. | Tropaquepts, Dystropepts and Haplorthox in very humid areas of the foothills. | of the Orinoco basin. |
| Boyacá-Santander | Warm (T>24° C) and humid to very humid (P between 2000 and 4000 mm). Prevailing winds from the E and SE, of low power (<2 m/s) and heavy influence of the calm. | Moderately steep lower slopes of the Cordillera Oriental in Cretaceous sediments. High and low hills in clay and sandy Tertiary sediments. Landslides in clay slopes. | Haplorthox, Trpaquepts and Dystropepts in the damp hills. Tropaquents, Fluvaquents, and Tropaquepts in recent alluvial plains. Suitable forest and extensive cattle growing. | Quebradas, Dosquebradas, La Fiebre, La Ceiba, Las Pavas and La Muerta, tributaries of the Magdalena River, all flow permanently. |
| Sierra Nevada Sta. Marta | Warm (T>24° C) to cool (18-24° C). Semi-dry (p>1200 mm) to wet (p>2000 mm) on the north side. Eastern and western slopes are relatively dryer.<br><br>Prevailing winds from the NE and N of low power (<2 m/s), with occasional moderate winds and heavy influence of the calm. | Massif in broken relief, in metamorphic igneous rocks of different ages. Erosion by intense diffuse runoff with gullies located in lower areas of the eastern and northwestern slopes. Landslides in humid clay zones of metamorphic rocks. | Troporthents, Quartzipsamments, Psammaquents, Tropaquods and Haplorthox in the massif, generally of low to no farming suitability. Fluvaquents, Tropaquepts, Dystropepts and Haplorthox in humid alluvial valleys of the piedmont, with agricultural potential. | North Slope: basins of the Agua Clara, Don Diego, Palomino, San Miguel and Tapias rivers. Eastern slope, basins of the Rancheria and Cesar rivers. Western Slope: Córdoba, Manzanares, Frio, Tucurinca, Sevilla, |

| | | | | |
|---|---|---|---|---|
| | | | | Aracataca and Piedras rivers. |
| Chocó | Warm (T>24° C), very humid (p>3000 mm) to perhumid (p>5000 mm). Prevailing winds from W and NW, low power (<2 m/s) and heavy influence of the calm. | Low hills in sinking pit and semi-pit in Tertiary sediments. Atrato river floodplain with detrital deposits originating in the recent torrential alluvium Quaternary and Holocene. Mountain chains in sedimentary and volcanic rocks (Serrania de Baudo) and metamorphic (Cordillera Occidental). Landslides in mountain clay areas. | Tropofluvents, Eutropepts and Dystropepts in well-drained alluvial soils, suitable for agriculture and cattle growing. Tropoquents, Fluvaquents and Tropoquepts in poorly drained alluvial soils, suitable for extensive cattle growing. Dystropepts, Troporthents, Tropodults and Tropoaquents locally, in areas of hills and foothills, suitable for forest. Troporthents and Dystropepts in the hills and mountains suitable for forestry and conservation. | Basins of the Atrato and San Juan rivers, both ranked among the most abundant rivers in Colombia and the world (flow per unit area). |
| (Huila and south western Tolima) (Chaparra | Cool (T <18° C) to cold (T 10-18° C) humid to very humid (P 2000 to 4000 mm). | Moderate to very steep slopes of the igneous-metamorphic Massif of the | Troporlhents, Quartzipsammements, Psammaquents, Tropaquods and | Upper basins of the rivers Blanco, Iquira, Pacamí, Baché, Ata |

| | | | | |
|---|---|---|---|---|
| I-Iquira-Páez-Teruel)* | Prevailing winds from the SE, of low power (<2 m/s) and high influence of calm. | Cordillera Central (Nevado del Huila and Paramo de Las Hermosas). Mass wasting processes on clay slopes. Intense diffuse runoff erosion under clean cultivation. | Haplorthox on the massif. Soils, in general, low to no agricultural suitability. Fluvaquents, Tropaquepts, Dystropepts and Haplorthox in humid alluvial valleys, with better agricultural potential. | and Saldaña. All with permanent flow. |

Source: This study, based on data from Igac Regional Atlas, soil surveys, geological plates and other sources.

* Included for its importance to the cultivation of poppy

## CHART 3.4

## OUTSTANDING BIOTIC CHARACTERISTICS OF ILLICIT CROP AREAS

| NUCLEUS | VEGETATION | FAUNA | IMPORTANT ECOSYSTEMS AND NATIONAL NATURE PARKS |
|---|---|---|---|
| Putumayo - Caqueta | Evergreen equatorial forest (or tropical humid forest according to Holridge) multilayered, high, with dense lower layer, high biodiversity of species. This forest has been replaced mostly by grasslands in the foothills between the Caquetá | Fauna is very biodiverse. 210 mammal species, 147 species of reptiles, 95 amphibians and 868 species of birds have been | The entire equatorial evergreen forest (humid forest). The national parks are: * Chiribiquete National Nature |

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|---|---|---|---|
| | and Guaviare rivers. Sparse floodable forests, with palm trees in the flood plains of the rivers. 5400 species of higher plants have been reported for the Amazon area. | calculated. Endangered species: 23 mammals, 9 birds, 1 reptile. | Park (Caquetá)<br>* La Paya National Nature Park (Putumayo) |
| Meta-<br>Guaviare-Vaupés | Guaviare: Evergreen equatorial forest, multilayer, low, with sparse lower level, with palms in poorly drained areas, with high biodiversity of species, intervened. Vaupés: evergreen equatorial forest (or tropical humid forest according to Holdridge), multilayered, high, with dense lower level, high biodiversity of species, intervened.<br>Meta: grassland savanna, partially evergreen equatorial forest to the southeast. Sparse floodplain forests, with palm trees in the flood plains of rivers, intervened. For the Orinoco, 2047 species of higher plants have been reported. | Idem Amazon area (Caquetá-Putumayo), plus fauna of the Orinoco area, where 28 species of amphibians, 644 birds, 119 reptiles, 65 arachnids and 359 hymenoptera have been reported. Endangered species: 25 species of mammals, 1 reptile and 5 birds. | The entire equatorial evergreen forest (humid forest). The national parks are:<br>* Nukak National Nature Park (Guaviare)<br>* Macarena National Nature Park (Meta) |
| South of Bolívar-Antioquia-Córdoba | Evergreen equatorial forest, multilayer, high, with dense understory, high biodiversity of species. Sparse forest floodplain, with Palm trees in the river flood plains. Forests have been interfered and replaced by pastures. For the Caribbean plains 3429 species of higher plants have been reported. Forests moderate to | Fauna is very biodiverse. 32 species of amphibians, 951 birds, 101 reptiles, 133 arachnids and 434 hymenoptera have been reported. No information on | The entire equatorial evergreen forest (humid forest). The system of marshes in southern Bolivar and the lagoon area of Bajo Magdalena-Cauca-San |

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|---|---|---|---|
| | high intervention. | endangered species. | Jorge. |
| Cauca-Nariño | Ombrophilous tropical forest or Hylaea of the Pacific, with 3 layers, 35 m high and closed canopy. Predominates in the foothills of the Cordillera Occidental. In the central area of the Pacific plain the Hylaea is in mosaic with flooded native and/or guandal forests. The guandal is swamp forest rich in palms. The native is a forest in transition between mangrove and Hylaea, so it has the influence of brackish water. In some areas these forests have been taken over by logging, gold exploitation and cattle growing. For the Pacific 5474 species of higher plants have been reported. | Fauna is very biodiverse. Although there has been no inventory of the fauna of the region, 127 species of amphibians, 577 birds, 104 reptiles, 101 arachnids and 649 hymenoptera have been reported. Because of its high moisture, the existence of many endemic and endangered species is assumed. | The entire ombrophilous tropical forest, including native and guandal forests. The national parks are:<br>* Munchique National Nature Park<br>* Sanquianga National Nature Park |
| La Gabarra | Evergreen equatorial forest, multilayer, high, with dense lower layer, high biodiversity of species. Sub-Andean forest on the eastern foothills of the Serrania de Perija. Sparse floodable forests, with palm trees, in the flood plains of rivers. Forests have been moderately to highly intervened. | Fauna is very biodiverse. for the area 70 species of fish, 73 amphibians and reptiles, 99 mammals and 120 birds have been reported. Endangered species: 26 species of fish, 6 species of | Evergreen equatorial forest. National parks are:<br>* Catatumbo-Bari National Nature Park |

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|---|---|---|---|
| | | reptiles, 6 species of mammals. | |

| NUCLEUS | VEGETATION | FAUNA | IMPORTANT ECOSYSTEMS AND NATIONAL NATURE PARKS |
|---|---|---|---|
| Arauca | In the foothills, relicts of the equatorial evergreen forest, multilayer, very intervened, with pastures and agricultural areas. On the plains, grassy savannah on poorly drained surfaces. Floodable forests and Moriche palms along rivers and streams. For the Orinoco area 2,047 species of higher plants have been reported. | It is part of the Orinoco area (Orinoquia), where 28 species of amphibians, 644 birds, 119 reptiles, 65 arachnids and of 359 hymenoptera have been reported. Endangered species: 25 species of mammals, 1 reptile and 5 birds. | Relicts of the equatorial evergreen forest. The areas of the National Nature Parks are:<br>*Flora and Fauna Sanctuary of Arauca |
| Boyacá-Santander | The potential vegetation consists of evergreen equatorial forest, multilayer, high with dense understory, high biodiversity of species. Sub-Andean forest remnants in the foothills of the Cordillera Oriental. Sparse floodable | Since it is in the transition between the medium and lower Magdalena river basin, it shares its composition of flora and fauna with the Caribbean region, where 32 species of amphibians, 951 birds, 101 reptiles, 133 | Relicts of the equatorial evergreen forest (or humid and very humid tropical rainforest) |

| | | | |
|---|---|---|---|
| | forests, with palm trees in the flood plains of rivers. Forests have been moderately to highly intervened and replaced by grasslands and crops. | arachnids and 434 hymenoptera have been reported. No information on endangered species has been provided. | |
| Sierra Nevada Sta. Marta | Since the crops are mainly on the humid north side, the potential vegetation consists of evergreen equatorial forest (or tropical humid forest) and sub-Andean forests in the mountain ridges. To the east and west, on the floor between 1,000 and 2,000 m, deciduous forest or tropical dry forest predominates. All forests have been intervened and replaced by grasslands and crops. For the Sierra Nevada de Santa Marta 1800 species of higher plants have been reported. | Being a mountain range to the sea, its fauna is very diverse. For this area 195 species of birds, 46 reptiles, 18 amphibians and l00 mammals have been reported. Endangered species: 4 species of reptiles and 14 endemic amphibians, 9 endemic mammals and 7 endangered species, 34 endemic bird species (or from a very low range) and 17 endangered species. | Relicts of equatorial evergreen forest, deciduous forest and sub-Andean forest of great interest for biodiversity and water production. The National Nature park areas are:<br>* Sierra Nevada de Santa Marta<br>* Tayrona |
| Chocó | Ombrophilous tropical forest or Pacific Hylaea, with 3 layers, 35 m high and closed canopy. The Hylaea is in mosaic with flooded native and/or guandal forests. The guandal is | Biodiverse fauna. Although there has been no inventory of the fauna of the Pacific region, have been reported 127 species of amphibians, 577 birds, 104 reptiles, 101 | The entire Pacific Hylaca with native and guandal forests. The wetlands of Atrato-San Juan. The National Nature |

| | | | |
|---|---|---|---|
| | swamp forest rich in palms. The native is a transition forest between mangrove and Hylaea, so it has some brackish water. Along the Atrato river there are areas of bog vegetation. In some sectors these forests have been taken over by forestry, gold exploitation and cattle growing. For the Pacific 5474 species of higher plants have been reported. | arachnids and 649 hymenoptera. Because of its high moisture, the existence of many endemic and endangered species is assumed. | Parks are:<br><br>* Las Orquideas (partially) |
| (Huila and southwestern Tolima) (Chaparral-Iquira-Paez-Teruel) | High Andean humid to very humid forests (fog forest). Humid to very humid Andean Forest. Humid subparamos and paramos of the Nevado del Huila and Paramo de Las Hermosas. For this area 1200 species of higher plants have been reported. | Biodiverse fauna. For this sector of the Cordillera Central 62 species of reptiles, 52 amphibians, 103 birds and 191 mammals have been reported. Endangered species: 22 species of amphibians, 2 snakes, 13 mammals and 21 birds. | Andean fog forest and humid paramos. The national parks are:<br><br>* Paramo de las Hermosas<br><br>* Nevado del Huila |

Source: 1) This study, based on data from Igac Regional Atlas, soil surveys, geological plates and other sources

2) Rangel, J.O, 1995, Colombia, Diversidad Biotica I y II. *Included because of its importance to poppy cultivation

**CHART 3.5**
**MAJOR SOCIOECONOMIC CHARACTERISTICS**

| NUCLEUS | **SOCIAL ASPECTS** | **ECONOMIC ASPECTS** | **CULTURAL ASPECTS** |
|---|---|---|---|
| Putumayo-Caquetá | Areas bordering zones of recent colonization, jungle or semi jungle, density of population under 5 hab/km2 and less than 1 hab/km2 High poverty levels and lack of public services. | The traditional economy is fundamentally extractive, except in perimeter areas of recent settlement, where it is mainly for cattle. Coca is the main speculative crop. Lack of economic infrastructure for production. | Indigenous population: Putumayo: 9 ethnic groups, 2146 families and 15,311 people, 13 reservations (Inga, Kamsá, Witoto, Cofán, Siona)<br>Caquetá 10 ethnic groups, 482 families, 2698 people, 14 reservations (Witoto, Inga, Coreguje). |
| Meta-Guaviare-Vaupés | Guaviare: areas bordering zones of recent colonization, jungle or semi jungle with population density of less than 5 hab/km2 and less than 1 hab/km2. Vaupés: jungle areas with population density lower than 1 hab/km2 except around Mitu (<5 hab/km2). Meta: natural and anthropogenic savannas with | Guaviare and Vaupés: the traditional economy is fundamentally extractive, except in perimeter zones of recent settlement, which is primarily for cattle. Meta: the economy revolves around cattle and crops such as rice and palm. Coca is the main speculative crop. Lack of economic infrastructure for | Indigenous population: Guaviare: 4 ethnic groups, 588 families, 4340 persons, 6 reservations (Sikuani, Carripaco, Guayabero). Vaupés: 19 ethnic groups, 2669 families, 16,569 persons, 1 reservation (Cubeo). Meta: 4 |

| | | | |
|---|---|---|---|
| | population densities between 1 and 5 hab/km2 in peripheral areas and 5-20 hab/km2 to the foothills (municipality of Vista Hermosa, Puerto Lleras, San Juan de Arama, and others). High poverty levels and lack of public services in general, although slightly better in the municipalities of the foothills. | production. | ethnic groups, 963 families, 5793 people, 13 reservations (Sikuai, Piapoko, Guayabero, Achagua). |
| Sur de Bolivar-Antioquia - Córdoba | Rural population density less than 10 hab/km2. High poverty levels and lack of public services, but slightly better in the municipality centers. | Extensive cattle growing (<1 head/ha), especially in the terraces and flats of Cauca, San Jorge and Magdalena rivers. Localized agriculture. Extractive forestry and fisheries economy. Mining in some enclaves (gold and ferronickel). Coca is the speculative crop. Lack of economic infrastructure for production. | Indigenous population in area of influence: Antioquia: 7 reservations in area of influence (Embera, Embera-catío and Cuna); population is unknown<br>Córdoba: 2 ethnic groups (embera), 3147 families, 17,385 persons, 3 reservations. |
| Cauca-Nariño | Rural population density is generally less than 5 inhabitants per km2, although in some sectors it may be between 5 and 10 hab/km2. High poverty levels and lack of | Traditional economy is fundamentally extractive (wood), except in perimeter zones of recent settlement, where it is mainly cattle. In some sectors alluvial gold | Indigenous population in the Pacific:<br>Cauca: 3 reservations (Embera); population is not |

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|---|---|---|---|
| | public services, but slightly better in the municipality centers. | mining is developing. Coca is the main speculative crop. Lack of economic infrastructure for production. | known.<br><br>Nariño: 54 families, 278 inhabitants, 2 reservations of Cuaiker ethnicity.<br><br>The Andean region is excluded. |
| La Gabarra | Rural population density is generally less than 5 hab/km2 although some sectors may be between 5 and 10 hab/km2. High poverty levels and lack of public services, but slightly better in the municipality centers. | Traditional economy is fundamentally extractive (wood), except in perimeter zones of recent settlement, where it is mainly cattle. In some sectors coal and oil is developing. Coca is the main speculative crop. Lack of economic infrastructure for production. | Indigenous population in the area of influence:<br><br>Norte de Santander: 1 reservation of the Barí ethnicity; population is unknown. |

| **NUCLEUS** | **SOCIAL ASPECTS** | **ECONOMIC ASPECTS** | **CULTURAL ASPECTS** |
|---|---|---|---|
| Arauca | Population density between 1 and 5 hab/km2 on the plain and 5-20 hab/km2 toward the foothills. High poverty levels and deficit of public services, although slightly better in the | The traditional economy is based on extensive cattle growing and wood extraction activities (the latter in the foothills). In the last decades oil exploration has been the most | Indigenous population in area of influence:<br><br>Arauca: 6 ethnic groups; 350 families 1880 persons, 12 reservations (Sikuani, Tunebo, |

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|---|---|---|---|
| | municipality centers. | significant. Coca is the main speculative crop. | Betoye, Macaguaje, Cuiba). |
| Boyacá-Santander | Rural population density is generally less than 10 hab/km2, although in some sectors it may be between 10 and 20 hab/km2. High poverty levels and lack of public services, but slightly better in the municipality centers. | Extensive cattle growing (<1 head/ha), especially towards the lowlands of the Magdalena Valley. Localized agriculture. Extractive forestry and fishing economy. Mining in some enclaves (emeralds). Coca is the main speculative crop. Economic infrastructure for production has low coverage. | No reservations have been declared in the area. |
| Sierra Nevada Sta. Marta | In the Guajira sector the population density is less than 10 hab/km2, and in the Magdalena sector it is between 10 and 20 hab/km2. High poverty levels and lack of public services, but slightly better in the municipality centers. | Extensive cattle growing in the Guajira sector, on the northern slopes of the mountains, where the most part of the coca cultivation occurs. Extensive cattle growing interspersed with forest patches and a few crops on the lower slopes of the mountains, in the Magdalena. Alluvial gold mining in some areas. Tourist spots in some areas on the coast. Low coverage of economic infrastructure for | Indigenous population of the Sierra:<br><br>Magdalena - Cesar - Guajira: 3 ethnic groups, 3214 families, 17,032 persons, 2 major reservations (Arhuaco, Kogui, Arzaro). |

| | | | |
|---|---|---|---|
| | | production. | |
| Chocó· | The density of the rural population is generally less than 5 hab/km2. High poverty levels and lack of public services, but slightly better in the municipality centers. | Traditional economy is based on extractive activities (wood), except for parts of the valleys of the Atrato and San Juan rivers which are primarily for cattle growing. In some sectors alluvial gold mining is developed. Coca is the main speculative crop. Low coverage of economic infrastructure for production. | Indigenous population:<br>Chocó: 5 ethnic groups, 4946 families 25510 people, 39 reservations (Embera, Embera - Catío, Cuna) |
| (Huila and southwest of Tolima) (Chaparral-Iquira-Páez-Teruel)* | Areas with substantial indigenous people and subsistence farmers. The rural population density is generally more than 20 hab/km2 in occupied areas. High poverty levels and lack of public services, but slightly better in the municipality centers. | Cold and cool weather traditional agriculture, extensive cattle growing. Low coverage of economic infrastructure for production. | Indigenous Population of area of influence:<br>Cauca-Huila: 15634 families, 94,608 persons, 41 reservations (Paez Yanacona, Coconuco Guambiano, Totoro)<br>Tolima: 326 families, I758 people 1 reservation (Coyaima, Natagaima). |

Source: 1) This study, based on data from Igac Regional Atlas, soil surveys, geological plates and other sources.

2) DNP, 1989. Los pueblos indigenas de Colombia.

* Included for its importance to the cultivation of poppy

### 3.2.4. Social degradation induced by illicit crops: social frame of the PECIG

#### 3.2.4.1. Trends in coca and poppy crops

*Coca*

Until 1970 Colombia had a limited coca production tradition. The industry as such started in the mid-seventies, given that the high profits surpassed those of marijuana. The original coca plantations were developed in colonized areas of the eastern plains and the Amazon basin, including regions of Guaviare and Caguán.

The boom that started in the mid to late seventies which lasted until 1981 brought with it a wave of immigration that upset the development of various regions. The illicit crop boom had distorting effects on the social, economic, and environmental makeup of the area and in the traditional living patterns: it generated the phenomenon called the *"Dutch disease,"*[7] that is, the illicit industry profits were not invested in productive projects or infrastructure works in the same areas, but were accessible for the emergence of conflict and violence.

In the mid-eighties, after a period of depressed market, the production of coca leaf reactivated. The rise in production to the increasing demand consolidated the organizational structure centered on dominant cartels, which set the production areas, prices, and the markets were settled in partnerships.

Several conditions favored the development of illicit crops[8]: the poverty generated in the field because of the low yields of the land, lack of infrastructure, technological lag and the shortage of facilities for credit, trade and marketing of products, the marginalization of indigenous groups; the crisis of the agricultural sector, which in recent years has worsened the poverty levels, migration and violence; and the competition brought about by the economic opening that was not coupled with competitive strategies for agricultural production. Rural poverty has worsened in the nineties: between 1991 and 1995, the percentage of poor people

[7] Thoumi, F. Economía Política y Narcotráfico. TM Editores, Bogotá
[8] Plan Nacional de Lucha contra las Drogas: 1998-2002

in rural areas increased from 65 % to 72%, that is, it increased by 7% (Lopez, 1998).

There is no doubt that the origin of this conflict is decades old. Santiago Perry mentioned that the level of land use in a country and the way it used reflect the level of development of this country and in particular of its agriculture sector[9]. The productivity crisis in the countryside has been related to the inefficient use of land, as it has not been used intensively or technically; the use for extensive cattle growing; the degree of concentration of land ownership; and, in addition to the above factors, the effect of the armed conflict in the country. This was further exacerbated by the lack of roads, rail, credit and social investment, among others.

The presence of illicit crops in the regions gave rise to a phenomenon that would be of great concern to regional national and international governments: the migration dynamics. In Colombia, migration flows have changed the demographic map of the territories with increased presence of illicit crops. Thus, the population of the Colombian Amazon soared from 50,700 in 1983 to 502,876 in 1993[10]. In the last three years, the phenomenon of forced displacement of persons has increased dramatically in the Orinoco and Amazon area in Colombia and, in particular, in Meta, Caquetá, Putumayo and Guaviare.

The provinces of Caquetá, Guaviare and Putumayo are growing at rates above the national average. It is worth mentioning that these regions have been the stage of the greatest social, environmental, economic and territorial conflicts derived from inequality levels created by the migration process, the problem of drug trafficking, armed conflict, weak presence of the state and the absence of economic alternatives, among others. Of the 45,000 cultivated hectares in 1994, 53.3% were concentrated in Guaviare, 20.7% in Caqueta, and only 9.2% in Putumayo. The three provinces accounted for 83.2% of the national total.

The beginning of the decade of the nineties was characterized by the expansion of illicit crops in the country (see Chart No 3.6), which have centered in recent years in the south, mainly in the provinces of Putumayo, Caquetá, Guaviare, Nariño,

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[9] La Crisis Agraria en Colombia: 1959-1980, Santiago Perry
[10] DANE

Cauca, Huila and Tolima, which are part of the geographical regions of the Colombian Massif, in the southeast, which includes part of the Amazon area. This problem is linked to the factors described before and a systematic drop in coca production in Peru and Bolivia, which facilitated the development of the illicit activities.

**CHART 3.6**

**RATIO BETWEEN CULTIVATED AREA AND**

**COCA LEAF PRODUCTION**

| Years | Cultivated Hectares | Coca Leaf Production (metric tons) |
|---|---|---|
| 1991 | 37,500 | 30,000 |
| 1992 | 37,100 | 29,600 |
| 1993 | 39,700 | 31,700 |
| 1994 | 45,000 | 35,800 |
| 1995 | 50,900 | 229,300 |
| 1996 | 67,200 | 302,900 |
| 1997 | 79,500 | 347,000 |
| 1998* | 101,800 | 414,000 |

Source: United States Department of State. Bureau for International Narcotics and Law Enforcement Affairs. Colombian Anti-Narcotics Police. Note the large increase in productivity between 1991 and 1998.

The province of Guaviare was the largest producer of coca leaf. The crops development in this region marked an upward trend from 1992 to 1996, starting from 22,900 hectares to 38,600 hectares, to begin to decline starting from 1997, which was the year the spraying process intensified. This had the immediate effect of a rapid expansion in the provinces of Caquetá and Putumayo, which became the two major domestic producers in 1998.

The province of Putumayo presents a significant increase in areas planted with coca mainly in the last two years. From 5,000 hectares in 1995 it increased to 19,000 in 1997, 30,100 in 1998, 58,297 in 1999 and 66,022 in 2000. The percentage change between 1999 and 2000 was 13.25% and in the last year it represented 40.4% of the total planted area in the country (Figure No 3.2).

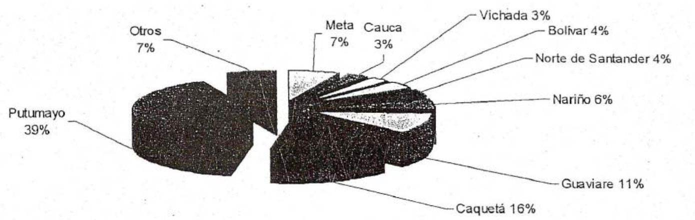



*Figure No 3.1*

*Major provinces of coca cultivation (year 2000)*

***Production potential:***

The Anti-Narcotics Police, based on fieldwork, calculated that the national yield of coca leaf is estimated at 2,876 lbs. per hectare per harvest. The potential cocaine production is estimated at 5.8 kilograms per hectare with 4 crops a year.

***Program to eradicate coca crops***

Since 1984, aerial spraying has been used intermittently to destroy illicit crops. The Colombian government, therefore, through the National Narcotics Council (CNE)[11], issued Resolution 0001 of 1994 for the implementation of the Program for the Eradication of Illicit Crops.

The CNE, as of January 1992, authorized the Antinarcotics Police to conduct the eradication by aerial spraying with glyphosate, given its role in controlling and suppressing the production, trade and unlawful use of drugs. Additionally, it ordered the hiring of an Environmental Audit in order to ensure the spraying in compliance with environmental and safety standards to protect human health.

[11] The National Drug Council was established by Decree 1188 of 1974 as an advisory body to the Government in formulating policies that must be carried to combat the production, trade and use of drugs or substances that cause physical or psychological dependence. Among its functions are ordering the destruction of illicit crops by means considered most appropriate, after approval of the agencies responsible for ensuring the health of the population and the preservation of the country's ecosystems.

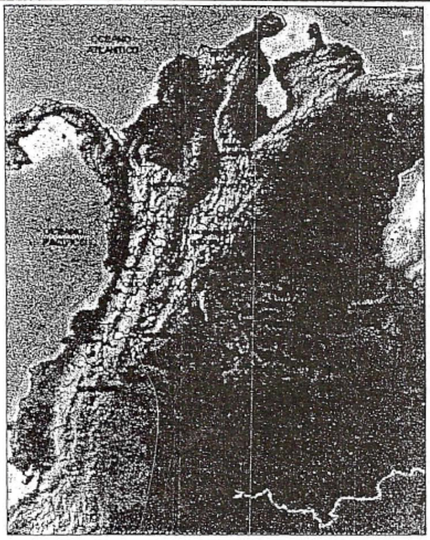
According to Article 35 of Decree 2159 of 1992, the National Narcotics Council is made up of: The Minister of Justice and Law, who chairs, the Minister of National Defense, the Minister of National Education, the Minister of Health, the Minister of Foreign Affairs, the Environment Minister, the Attorney General's Office, the Attorney General's Office, the Director of the Administrative Security Department, the Director General of Police, the Director of the Presidential Program to address Drugs consumption and the National Director of Narcotics (with voice but no vote).

**ESTIMATES OF THE COCA CROPS BY MAIN CROP AREAS**

**ESTIMATIVOS DE CULTIVOS DE COCA POR PRINCIPALES ÁREAS DE CULTIVO**

| DEPARTAMENTO | 1999 Has. | 2000 Has. |
|---|---|---|
| GUAVIARE | 28.435 | 17.619 |
| CAQUETA | 23.718 | 26.603 |
| PUTUMAYO | 58.297 | 66.022 |
| BOLIVAR | 5.897 | 5.960 |
| N. SANTANDER | 15.039 | 6.280 |
| META | 11.384 | 11.123 |
| NARIÑO | 3.959 | 9.343 |
| OTROS | 13.390 | 20.339 |
| **TOTAL** | **160.119** | **163.289** |

Fuente: Policía Nacional - Dirección Antinarcóticos y Dirección Nacional de Estupefacientes.



Source: Anti Narcotics Police

*Figure No 3.2*

*Main areas of coca cultivation*

Spraying processes have generated protests and mobilizations by settlers, growers, indigenous groups and floating population, demanding the cessation of spraying, or come to agreements on conditions for crop substitution, in addition to claims to the national government for investments in health, housing, electrification, schools, among others, given the socioeconomic reality of these regions.

Thus, Colombian state policy adopted a differential nature toward illicit crops, according to their nature and purpose, that is, type or category. For industrial crops, it arranged for forced eradication through aerial spraying of glyphosate, and for crops in marginal rural and indigenous economy, manual eradication and the alternative development strategy (PNDA) was decided. (see Chart No 3.7).

Given that the Program for the Eradication of Illicit Crops has been seriously questioned by some sectors of the national and international community, Resolution 005 of 2000 was issued, amending Resolution 001 of 1994, defining more precisely the areas of exclusion and hiring a Technical Audit to evaluate not only the technical and operational aspects of the Program but also the environmental impacts on human health and agricultural activities.

**CHART 3.7**

**ESTIMATE OF ERADICATION OF ILLICIT CROPS BY METHOD**

**NATIONAL TOTAL (1999-2000)**

| YEAR | COCA (HA) | | POPPY (HA) | |
|---|---|---|---|---|
| | AERIAL | MANUAL | AERIAL | MANUAL |
| 1999 | 43,111.95 | 1,045 | 8,247.61 | 174 |
| 2000 | 58,073.10 | 3,500.28 | 9,254.4 | 74.61 |

According to the Verification Protocol, the actual death rate calculated based on the aerial spraying conducted by the CNP antinarcotics is 95% for poppy crops and 90% for coca.

Source: Anti-Narcotics Police, Armed Forces, Administrative Security Department and CTI of the Attorney General’s Office. The Armed Forces completed eradication efforts using manual methods.

### 3.2.4.2. Poppy

The subsistence farmers took to illicit crops because they considered them a form of profitable productivity for the marginal agricultural regions, such as the regions of Tolima, southwest and eastern Cauca.

The vast majority of poppy crops are located between 2,200 and 2,800 meters above sea level in rugged areas within the fog forest belt near the paramos, occupied largely by subsistence crops and pastures, where institutional presence is not active. The areas where these crops have been recorded are characterized by a lack of access roads and low coverage of state services (colonization fronts). They have generally been isolated regions, often sparsely populated, located on subsistence farmer or indigenous settlements belts.

In 1989 the first seizures of poppy derivatives with 130,000 grams of heroin were recorded, a figure that established a change in the trend of illicit crops in the country. What was initially perceived as a replacement of coca by poppy was subsequently confirmed as a diversification of illicit crops.

In 1991, 2,900 hectares of poppy were identified, with the highest concentrations in the provinces of Cauca, Huila, Tolima and Santander, which meant 83% of the total; by 1992 the increase of the cultivated area was noteworthy and estimating 20,000 hectares were estimated; of these, 12,864 hectares were eradicated, representing about 64%.[12]

In recent years poppy crop hectares have decreased. Between 1998 and 1999, poppy cultivation remained on average close to the 6,900 hectares planted, with a potential production of opium paste of 66 tons and 6.6 tons of heroin. The concentration areas of the crops were in the provinces of Huila, Cauca, Tolima and the Serrania del Perija (Cesar, La Guajira) (see Figure No 3.3)

In 1999 a total of 8,249 hectares were sprayed, 67.3% took place in the province of Tolima, 17% in Huila, and 10% in Cauca. In 2000, 9,254 acres of poppy were sprayed, especially in the provinces of Tolima and Huila.

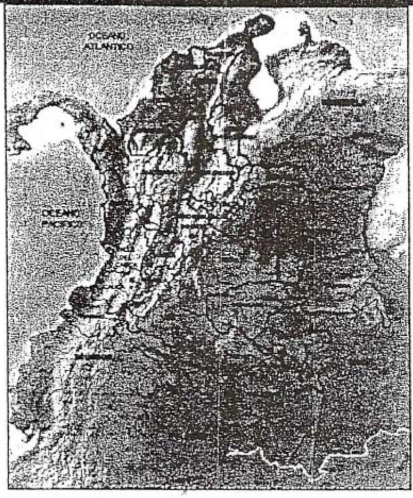
[12] The figures for illicit crop spraying correspond to those recorded by the Anti-Narcotics Police.

**POPPY CROP ESTIMATES**

**ESTIMATIVOS DE CULTIVOS DE AMAPOLA**
**Hectáreas**

| DEPARTAMENTO | 1998 | 1999 |
|---|---|---|
| TOLIMA | 2.400 | 1.500 |
| NARIÑO | 1.500 | 1.000 |
| HUILA | 1.300 | 1.000 |
| CAUCA | 1.000 | 1.300 |
| CESAR | 700 | 700 |
| CAQUETÁ | 300 | 300 |
| GUAJIRA | 100 | 400 |
| META | 50 | 300 |
| **TOTAL** | **7.350** | **6.500** |

Fuente: Policía Nacional - Dirección Antinarcóticos



Source: Anti-Narcotics Police

*Figure No 3.3*

*Major areas of poppy cultivation*

### 3.2.5. Environmental deterioration due to illicit crops: environmental framework of the PECIG

#### 3.2.5.1. The conditions of Colombia

According to a recent study[13], Colombia is considered one of the least known American countries in matters of flora. It has been estimated that it possesses between 45,000 and 55,000 species of plants, representing about 16% of the plants found on the planet. This wealth is evidenced, for example, if compared to the 55,000 species that Brazil has in an area 6.5 times greater. Only in the Reserva Planada (Nariño) Orejuela (1987) described 227 different orchid species in an area spanning merely five square miles. The country has about 3,500 species of orchids representing about 15% of world total. Other groups in Colombia that are representative worldwide for their diversity are the palms, anthuriums, ferns and bromeliads. In the animal kingdom, the country's diversity is world-renowned. The 27 species of primates described represent a third of the primates in tropical America. Another group well represented is that of the tapirs, because only Colombia and Ecuador possess the three American species. In birds, 1721 species have been reported which means about 20% of the world total. In reptiles 205 species of lizards have been reported and it is believed that there are still species to be described. As for amphibians, the inventory is far from finished; in 1985 it was estimated that frogs and toads in the country amounted to 430 species. The total number of reptiles, birds, amphibians and mammals yields a total diversity of 3,389 species, of which about 1,570 are endemic (42%)[14], In relation to fish still very little is known about the national inventory. It would be endless to describe the biological wealth of the country, in particular when taking into account the arthropods and lower species, which today more than ever have become important from a biotechnology standpoint.

On the other hand, in Colombia two hotspots (Priority Land Eco-regions) are the world's center stage, namely, the Tropical Andes and Chocó. Therefore it is not exaggerated to say that on average one in ten species of plants and animals exist within the boundaries of the Republic of Colombia, in an area not exceeding 0.77% of the world's land (McNeely et al., 1990).

In assessing the wealth described above, we can say that Colombian society still does not perceive the ecological damage caused by the cultivation of illicit crops and related activities. These activities directly affect the ecosystems considered "humanity's genetic offer." The purpose of this process is to induce change from passive to active attitudes, to allow expansion of the knowledge on the subject and

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[13] Cultivos ilícitos e impacto ambiental, DNE, 2000. En Inventario Florístico de los Países Tropicales. DG. Campbell and H. D. HAMMOND. 1985.

[14] Cortes, L.M., Biodiversity at Risk. Weather-Sunday Readings. October 1, 2000.

engage institutions and the general population, since it is an issue that involves and engages all Colombians, in particular, and the international community, in general.

### 3.2.5.2. The impact of illicit crops as a component of the PECIG baselines

A conversation piece has always been the environmental problem caused by the eradication of illicit crops through aerial spraying with the herbicide glyphosate conducted by the Antinarcotics Police. Usually the negative effects caused by the other activities related to illicit drug industry are not mentioned. It is possible that the above is a result of defense mechanisms used by the organized groups engaged in this activity[15].

It has been known for long that any human activity within these ecosystems significantly affects the environment negatively, including, obviously, aerial eradication. However, if an environmental cost-benefit analysis is conducted, the conclusion is that, within the activities related to the total process of production-traffic, the effect of the spraying is minimal.

For nearly three decades activities related to illicit cultivation of marijuana, coca and poppy crops have been developed, and thus has been established the processing and trafficking of narcotic substances from these plants. Therefore, in order to evaluate the environmental impact of the illicit drug production on the environment, it is necessary to identify the sequential stages of the process. First comes the selection of the areas in which the crops are intended to be established; then these areas should be made suitable for planting, later comes the construction of facilities for processing the leaf and the extraction of the drug, the adapting of the “warehouses” to store chemicals and, in some cases, the construction of runways for traffic.

In addition to the stages mentioned related to the production processes, it is important not to forget that the first impact on the environment is caused by the

[15] From a purely biological perspective, it is clear that the damage on forests and was caused from the time they are done logging, burning and disposal of substances into water sources.

strong population migration to these areas that do not satisfy their basic needs, considering that they are forest reserve regions. The first to arrive are the primary settlers (itinerant, in charge of trailblazing). Then come the secondary settlers, who buy land from the primary and start developing the crops, either with their own resources or financed by large investors. In times of harvest, hosts of coca leaf pickers (raspachines) arrive, with the consequent emergence of informal traders, prostitutes, processors and buyers of the base, sellers of chemicals, etc. These immigration processes, rather than becoming factors of development for the regions, have had harmful effects to the deterioration of the ecosystems. This stage is where the PECIG must act.

Illicit crops in Colombia are located in strategically selected areas that meet certain requirements essential for them, namely:

- Geographical areas isolated from urban centers, where state presence is hampered by the lack of access roads and the presence of extensive forest areas, especially in the provinces of Caquetá, Guaviare, Meta, Vichada, Putumayo, Santander and Guainía.

- Presence of abundant water bodies that allow its use in processing, waste disposal and food preparation. On the other hand, the presence of navigable rivers facilitates the introduction of chemicals through open smuggling from neighboring countries and the output of large volumes of finished product.

- In Colombia, some of the areas of coca and cocaine production are located in the upper valleys of Apaporis and Caqueta, which is known as Japurá in Brazil, and also in the valleys of the upper Vaupes and Putumayo, known as Iça in Brazil.

- Although less frequent, ecosystems with abundant plant biomass, which obstruct the location of the crops, jungle crops (chagras), laboratories and warehouses for chemicals

- Ecosystems that are adapted to the climatic requirements of the varieties of plants that they wish to grow. In this sense, Colombia has thermal floors that ensure excellent development of the species used for the extraction of psychotropic substances.

- Areas with the presence of armed groups, which impede the action of the authorities and which, it seems, offer security services to the crops and processing complexes.

In evaluating the selected areas, traffickers have basically selected *environmentally sensitive ecosystems as well as environmental important*, such as the Andean and high Andean forests for poppy and the plains and jungles of the Orinoco area and Amazon area for the cultivation of coca.

According to IDEAM, Andean forests occupy only 8% of the national territory[16]. This low percentage is explained by the strong human pressure to which they have been exposed since the days of the colony, to establish pastures and different types of crops. The most important of which is still, coffee.

On the other hand, the Amazon basin, chosen to introduce the cultivation of coca, has a vital ecological importance for its ability to regulate $CO_2$ and to keep the balance of emissions into the atmosphere. In addition, the Orinoco-Amazon area represents for humanity, and especially for Colombia, an environmental supply bank characterized by high biodiversity.[17]

Overall, illicit cultivation of both coca and poppy have been implanted in ecosystems of incalculable environmental value characterized as being the largest germplasm banks in the world, that is, with the presence of biotic communities (fauna and flora) which in many cases are unique and exclusive to these regions[18].

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[16] The main feature of Andean and high Andean forests is the "water production", the rising air, saturated with water vapor, which comes from lower regions, humid and warm condenses to produce clouds regularly and enveloping fog, and a high rain rate.

[17] Biological diversity or biodiversity refers to the variety within the living world. As multifaceted expression of life, it presents different levels of complexity, from genetic variability of populations, the multiplicity of species, to the diversity of ecosystems and landscapes. These levels are closely related so that the interactions between these are both spatially and functionally dependent. (Research Institute of Biological Resources Alexander van Humboldt). A simpler definition is provided by Solbrig (1991): a property demonstrated by living things to be varied, in each of the hierarchical levels of organization of biological nature, from molecules to ecosystems.
The stifling and humid tropical regions are those with the highest rates of successful mutations and recombinations; a much more dynamic evolutionary process resulting in a higher rate of biodiversity than other regions in the world. (Urruela, undated).
RAFI (International Environmental NGO) estimates that medicinal plants and microorganisms from the South contribute at least 30 billion dollars a year to the pharmaceutical industry of industrialized countries.

[18] Colombia has a continental area of 114,174,800 ha, representing approximately 0.7% of the global land surface. In this area is 10% of the world's biodiversity, making Colombia a "mega-diverse" country.

Growing areas that are not in areas of high environmental value are located in biomes that can be classified as focus[19] areas, where a policy to prevent the destruction of ecosystems and control over exploitation of species in critical state or very vulnerable should be promoted.

Most Amazon area soils are suitable for forestry, which is why usual traditional agricultural practices fail, thus contributing to the deterioration of the dynamics of the region.

Finally, with the population immigration, a second migration of higher wildlife flocks to deeper areas of the forests, with the resulting imbalance in food chains and ecological niches. In the case of the Andean forests, the effect is more serious because of the specificity of the ecosystems and the high concentration of endemic species. In this regard it is important to note that the tropical Andes contains between 30,000 and 40,000 plant species, a figure greater than estimated for the Amazon Basin, which is why this biogeographic area is considered to have the greatest diversity of species in the Neotropics.

**3.2.5.3. Site preparation**

The first and most obvious action for the cultivation of a crop is the clearing of native vegetation, which in most cases consists of primary forests, where human activity had never existed, or secondary forests in different successional stages. The most common method to eradicate forests is by logging and/or burning, actions that exert drastic effects on ecosystems, among which are the following:

- Destruction of ecological niches and food chains
- Destruction of unknown genetic potential
- Soil erosion
- Destruction of native vegetation cover
- Changes in rainfall patterns and local climate
- Significant increase in $CO_2$ emissions
- Disappearance of scenic beauty and landscape
- Extinction of endemic species
- Deterioration of water sources

[19] Zones located in the interior of the Colombian Amazon area between the Caquetá, Putumayo, Vaupés rivers and portions of Guainia and Vichada and part of the Andean and sub-Andean forests of the cordillera Occidental.

According to studies conducted in recent years it has been established that to implement one hectare of coca, growers have to destroy four (4) hectares of forest and for one of poppy two and a half (2.5) of Andean forest[16] (Chart No 3.8 and 3.9), in cases where cultivation starts on forest area. Photo 1 shows a recent deforestation in the Andean forest to implement poppy crops. This is because, in addition to land needed for the illicit cultivation, the farmer or settler fells for the planting of staple crops and for the preparation of pasture for some animals. Here, the farmer makes no investment in fertilizer and pesticides, as he does in the illicit cultivation, so those crops and pastures have very low yields, which is compensated by deforesting a larger area. Moreover, in cases of illicit crops developed in colonization fronts of the Amazon area and Cauca-Nariño where high rainfall makes the soil's natural nutrients and those added to leach rapidly, farmers cut down yet more forest to increasingly take advantage of the nutrients that are released in the soil after burning, which provides a first crop with high yields.

On the other hand, the burning of forests and jungles means the destruction of 380 tons of biomass per hectare, which entails a cumulative total of 152 million tons of biomass which turn to ashes, $CO_2$ and sediments[20].

The destruction of these ecosystems severely alters the ecological homeostasis, which in the case of the Amazon area is defined by the unique floristic diversity on the planet–between 96 and 120 tree species per hectare–, an unknown number of minor species, and the microflora and microfauna with incalculable genetic potential (Parra, 1998)

**CHART 3.8**
**ESTIMATES OF FOREST AREA DESTROYED BY THE ACTION OF ILLICIT POPPY CROP**
**(Period 1990-2000)**

| YEAR | ESTIMATED CROP AREA (ha)[1] | ESTIMATED AREA OF DESTROYED FOREST (ha)[2] |
|---|---|---|
| 1990 | 1,500 | 3,750 |

[20] This number is based on the studies performed by the Environmental Audit, National Narcotics Directorate.

| | | |
|---|---|---|
| 1991 | 2,900 | 7,250 |
| 1992 | 20,000 | 50,000 |
| 1993 | 7,500 | 59,375 |
| 1994 | 6,800[3] | 67,875 |
| 1995 | 2,180[3] | 70,600 |
| 1996 | 2,100[3] | 73,225 |
| 1997 | 2,200[3] | 75,975 |
| 1998 | 2,033[3] | 78,516 |
| 1999 | 6,500[3] | 86,641 |
| 2000 | 6,200[3] | 94,391 |

Source: U.S. State Department, Antinarcotics Police, Environmental Audit, Epam Ltda.- Ltda Edema

[1] An estimated 2.5 ha of forest destroyed to establish 1 ha of poppy crop

[2] The figures for estimated area of forest destroyed are presented in aggregate form.

[3] It is estimated that 50% of the cultivated area are new crops.

**CHART 3.9**

**ESTIMATES FOR DESTROYED FOREST AREA BY**

**THE ACTION OF ILLICIT COCA CROPS**

**(PERIOD 1987-2000)**

| YEAR | ESTIMATED CROP AREA (ha)[1] | ESTIMATED AREA OF DESTROYED FOREST (ha)[2] |
|---|---|---|
| 1987 | 25,600 | 102,400 |

| | | |
|---|---|---|
| 1988 | 34,000 | 136,000 |
| 1989 | 42,400 | 169,600 |
| 1990 | 40,100 | 178,800 |
| 1991 | 37,500 | 178,800 |
| 1992 | 37,100 | 178,800 |
| 1993 | 39,700 | 178,800 |
| 1994 | 45,000 | 198,400 |
| 1995 | 50,900 | |
| 1996 | 67,200 | 287,200 |
| 1997 | 79,500 | 336,400 |
| 1998 | 101,800 | 425,600 |
| 1999 | 160,119 | 658,876 |
| 2000 | 163,289 | 671,556 |

Source: U.S. State Department, CIA/CNC, Policia AntmarcotlcüS, Environmental Audit, Epam Ltda.- Ltda Edema

[1] An estimated 4 ha of forest destroyed to establish 1 ha of poppy crop

[2] The figures for estimated area of forest destroyed are presented in aggregate form. This effect of border and collateral damage occurred in 1994.

It is estimated that burning one hectare of forest destroys 140 m3 of wood, of which 30% is potentially commercial and 80% of these tree species only exist in the Amazon ecosystem.[21]

[21] PARRA, L.E., Impacto Ambiental de los Cultivos Ilícitos en Colombia. COLOQUIO, issue 3, March 1977.

The above means that there is a scenario prior to the cultivation of coca or poppy, formed by colonization of areas of the humid and very humid tropical forest and high Andean forest. This colonization in some cases is already well established and which is usually characterized by socioeconomic conditions of poverty and depression. After this comes another scenario, comprised by the entry of illicit crops, which, supported on the low levels of income of the population, become an option for survival for many colonists, farmers and indigenous peoples. It is in this latter scenario, then, where it is the responsibility of PECIG to act, as noted above, because it is where the illicit crops are.

Effects related to the suitability of land for crops not only determine the irreversible loss of native flora and genetic resources, but they also generate side effects such as fragmentation, displacement of wildlife and the severe disruption of food chains.

Erosion is another serious effect produced by the adapting of the land for planting of coca and poppy, because in both cases the soils of selected ecosystems are characterized by high susceptibility to erosion, either by high rainfall or the steep slope, or both factors at once, etc.[22] As a result of deforestation, especially on the slopes of the Andes, it is common for huge landslides to occur including runoff causing siltation of stream beds (a process known as sedimentation), leading to flooding in times of rain and severe drought in the summertime. Photos 2, 4 and 5 show examples of the erosion caused by deforestation due to the implantation of illicit crops.

Given that Colombia ranks fifth worldwide in water resources, which in the case of the Andean forest are represented by about 720,000 watersheds, it can de noted that the effects of logging and burning are exerting undue pressure on this resource.

### 3.2.5.4. Cultivation of the crops

[22] The wider community has the idea that the soils in the south of the country's forests are highly productive, however they are highly fragile soils with large concentrations of aluminum and easily washed when the native vegetation cover is removed.

After completing the logging and burning of forests, following is the cultivation of the crop, that is, agricultural processes inherent in the planting, tending and harvesting of the crops. It is at this stage that chemicals gain entry to the environment, not only to industrial crops, but also to small plots.[23]

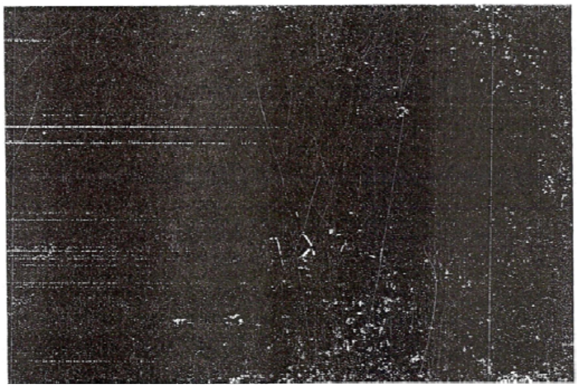

***Photo No. 1***

*Forest clearing for the planting of illicit crops.*

*Note the steep slopes and the onset of localized phenomena of erosion by superficial landslides. These soils, due to the slope, are not suitable for farming,*

The poppy and coca crops are characterized by demand for space and nutrients, which means they are not easily joinable, making it necessary to eliminate the competition. Coca growers, whether they are farmers or middlemen, aim to get the most production possible from the leaf (biomass). For this and due to the low soil fertility, it is common to introduce bio-stimulants, fertilizers and pesticides to control pests and weeds.

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[23] According to the SIMCI Project (DNE-ANTI-NARCOTICS POLICE-UNDP), in Colombia 40% of cultivated coca plots are classified as subsistence farmers and the remaining 60% are classified as industrial.

The containers of pesticides (herbicides, fungicides, etc.) and fertilizers used on crops are disposed of anywhere in the ecosystem. In many cases, producers use substances that are prohibited, as is the case of the insecticide Parathion and organochlorine substances.[24] The containers and waste of a wide range of biocides introduced to the environment and used at the highest possible concentrations and amounts inevitably end up in waterways, adsorbed on soil particles and, at worst, assimilated into food chains. At this point the pressure on the environment is not only confined to the area of cultivation, but it is exported to the entire ecosystem.

The introduction of agro-chemicals on the crops of farmers or of the industrialist extends invariably into the total cultivated plots.

A report prepared for the National Drugs and Narcotics Affairs Section of the Embassy of United States[25] found that 98.7% of growers uses insecticides and fungicides to control pests and diseases, 92.5% uses chemical fertilizers, and 95.5% controls the competition from other plants with herbicides. On the other hand, a SINCHI Institute research[26] shows that farmers, contrary to what they used to do with their own staple crops production, strive to do cultural work on their coca and poppy crops, and they habitually weed, and chemically control insects and pests.

SINCHI notes that the economic logic of these dissimilar behaviors is that while in the staple crops the aim is to maximize the natural fertility of the soil, in the cultivation of coca, due to revenue expectations, the producer is forced to incorporate chemical technology.

Two methods are commonly used to keep the coca crops clean and thus obtain a high biomass production. The first is the use of hoe, which requires an average of ten days' work and the second is the application of Gramoxone every 2 or 3 months. Since coca is a crop that relies intensely on chemical technology, the purchase of these products takes over more than two-fifths of the total costs of inputs.

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[24] Some of the agrochemicals reported to the DNE by authorities are: Gramoxone, Crecifol, Furadan, Tamaron, Tordon, Roundup (this is Glyphosate proper), Faena 323, Desarrollo, Babistem, Agrotin, Malathion, Parathion, Benlate, Manzate, Nutrifolia, etc.

[25] URIBE, S., Proyecto sobre rendimientos de las plantaciones de coca en Colombia. Informe de Progreso # 5. October 25, 1999

[26] ARCILA, N.O., RODRIGUEZ, S. A. Estudio de Caso de la Producción de Coca en el Departamento del Guaviare. INSTITUTO AMAZONICO DE INVESTIGACIONES CIENTÍFICAS SINCHI. Area de Asentamientos Humanos, Santa Fe de Bogotá, September 1997

There are no significant differences among the producers of the coca-growing regions regarding the intensity of the use of agro chemicals, regardless of whether it is the case of small farmers or industrial type crops. In this sense, URIBE (1999) establishes the use of at least 75 different brands of agrochemicals (see the most common in Charts 3.10 and 3.11). The regional difference in the type of substance used is determined by its availability in the market, since many of these come in through open smuggling directly to the farmland.

**CHART 3.10**

**HERBICIDES USED IN COCA PLANTATIONS**

| Trade name | Active Ingredient | % of use | Toxicity Classification |
|---|---|---|---|
| Gramoxone[27] | Paraquat | 61,3 | II DL Oral: 150 mg/kg |
| Faena | Glyphosate | 10,7 | IV DL Oral: 4300 mg/kg |
| Anikilamina | 2,4D | 9,7 | I DL Oral: 699 mg/kg |
| Round up | Glyphosate | 8,4 | IV DL Oral: 4300 mg/kg |
| Atrazina | Atrazine | 4,8 | III DL Oral: 1780 mg/kg |
| Karmex | Diuron | 2,6 | III DL Oral: 5000 mg/kg |
| Otros | n.a | 2,6 | |

URIBE, S., Proyecto sobre rendimientos de las plantaciones de coca en Colombia. Informe de Progreso # 5. October 25, 1999

[27] It is among the pesticides considered worldwide as the "Dirty Dozen" whose use is banned in some industrialized countries, but is widely used in agricultural countries in the developing world. In addition to Paraquat, the use of Lindano is common for control of lice and scabies; pentachlorophenol is used as a fungicide in wood and powerful biocide Parathion's action ranges from pest control in staple crops, to the extermination of insects.

Interestingly, among the substances most commonly used by growers of illicit crops is glyphosate (about 20%). And yet, when this substance is used by the authorities to eradicate the crops, these farmers and producers who use it often feel they are being harmed due to the product's dangerousness.

The number and variety of pesticides (insecticides and fungicides) is greater than the herbicide offer and the use of substances with high toxicity is notorious, which is increased if considered that many farmers still follow the assumption that "the more quantity and concentration of the agrochemical, greater its effectiveness," which is why it is common that the dosages used are not consistent with those recommended by the manufacturers. In addition, the substances most frequently used are classified with a high degree of toxicity, so it is expected that the effect on these special ecosystems and communities is quite negative.

On the other hand, the soils of the Andean forest, characterized by their great capacity to suppress pathogens are losing this feature, since the chemicals used are broad spectrum.

Agrochemical substances that illicit growers introduce daily to ecosystems, cause among others, the following effects on the ecosystems:

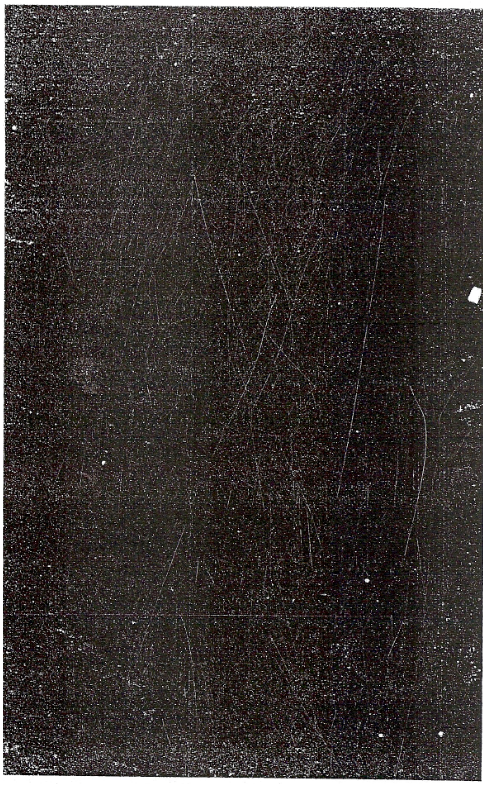


***Photo No. 2***

*Area of clean crops and pastures on the Andean floor.*

*Note the presence of small patches of forest in the valleys and low stubble. Illicit crops are located and rotated in any of the open plots.*

***Photo No. 3***

*Foothills of the Serrania de San Lucas in southern Bolivar. Note that the original forest vegetation has practically disappeared and it is only visible along some streams. Under these conditions, illicit crops grow in areas with a high degree of established colonization.*

- Pollution of resources: pesticides are capable of contaminating drinking water sources for humans and animals, water sources, rivers and seas. The agrochemicals can reach water sources by some of the following means:

  - Percolation or leaching of pesticides applied on the soil surface
  - Discharge of remaining application liquids and waste of empty containers
  - Flood or overflow of rivers that reach the storage sites

**CHART 3.11**

**INSECTICIDES AND FUNGICIDES USED IN ILLICIT CROPS**

| PRODUCT NAME | # OF PRODUCERS USING IT/244 (in %) | ACTIVE INGREDIENT | CONCENTRATION | TOXICITY CATEGORY | ACTION |
|---|---|---|---|---|---|
| Manzate | 87 | Mancozeb | 80% | III | Fungicide |

| | | | | | |
|---|---|---|---|---|---|
| Tamaron | 73 | Methamidophos | 600/lt | I | Insecticide |
| Sevin | 59 | Carbaryl | 80% | II | Insecticide |
| Metavin | 29 | Methomyl | 90% | I | Insecticide |
| Furadan Liquid Granulated | 28 | Carbofuran<br>Carbofuran | 330 g/lt | I | Insecticide |
| Curacron | 20 | Profenofos | 500 g/lt | II | Insecticide |
| Thionil | 20 | Endosulfan | 350 g/lt | I | Insecticide |
| Oxocloruro de cobre | 19 | Copper oxide | 35% | III | Fungicide |
| Parathion | 19 | Methyl Parathion | 48% | I | Insecticide |
| Matador | 10 | Lambda Cyhalothrin | 50 g/lt | III | Insecticide |
| Thiodan | 10 | Endosulfan | 350 g/lt | I | Insecticide |
| Bavistin | 7 | Carbendazim | 50% | III | Fungicide |
| Malathion | 6 | Malathion | 604 g/lt | III | Insecticide |
| Nuvacron | 6 | Monocrotophos | 600 g/lt | I | Insecticide |
| Lorsband Liquido Granulado | 5 | Chlorpyrifos and Cypermethrin<br>Chlorpyrifos | 500 g/lt<br>50 g/lt<br>50/kg | II | Insecticide |

| | | | | | |
|---|---|---|---|---|---|
| Comboy | 5 | Cypermethrin and Diazinon | 25 g/lt<br>200 g/lt | III | Insecticide |
| Politrin | 5 | Cypermethrin | 200 g/lt | II | Insecticide |
| Others | 61 | | | | |

URIBE, S., Proyecto sobre rendimientos de las plantaciones de coca en Colombia. Informe de Progreso # 5. October 25, 1999

The consequences of this pollution are associated with loss of aquatic fauna and flora, loss of water and food sources and human and animal poisoning[28].

- Soil Pollution: Some pesticides are applied directly on the ground (herbicides such as 2,4 D and insecticides such as methomyl). There are others that achieve this indirectly through dripping from the plant, poured from the application equipment, dragged by raindrops (in the case of Chlordane, Parathion), washing of application equipment, waste of containers, etc.

- According to the chemical composition, once in the soil they can be adsorbed on clay particles or organic matter (Methomyl). Others, however, are easily flushed by the water flow. While the first seriously affect the soil, its fauna and flora, the latter contaminate water sources.

- The soil microfauna and microflora, responsible for recycling organic matter, are severely affected by pesticides applied directly to soil, thereby decreasing the supply of soil nutrients, making it dependent on nutrients, so that it becomes even more vulnerable to insects and pathogens[29].

- Persistence in food chains. Insecticides with chemical structure of the chlorinated types (DDT, chlordane, Heptachlor), which are banned in

[28] Many of the complaints that growers associate with the aerial spraying with glyphosate conducted by the DIRAN are due to the use of chemicals such as Paraquat and Parathion, which farmers use on crops without any technical standard and unprotected. Many of these chemicals are fat soluble, allowing them to be absorbed through the tissues and then accumulate in the body, with the consequent intoxication, which in many cases and depending on the toxicological classification of the product may be fatal.
[29] Casadinho, J.S., Plaguicidas y Salud: una relación poco conocida. CETAAR - Faculty of Agronomy - UBA.

Colombia, have the ability to bind to animal fat. This feature is hazardous for the following reasons: a) accumulation in food chains from herbivores to carnivores of second and third order, reaching concentrations that cause physiological damage. When people living in regions where these substances are used in large numbers feed on the fauna of the region, the pesticide molecule concentration levels increase within the body, as they are not metabolized, to reach poisoning levels (a phenomenon known as biological magnification).

- Action on beneficial insects and vegetation. Within the ecosystems a large number of insects, mites and vegetation plays a fundamental role in the balance of biomes and food chains. Among their functions are:

    - Predators parasites of insect-pests: many mites and insects act as micro-parasites of other insects that could become pests of established crops or even of primary forests
    - Incorporators of nitrogen
    - Soil fasteners (reducing the potential for erosion)
    - Soil coverers (wide-leaved plants)
    - Decomposers of organic matter: multi-layer forests are characterized by high activity of decomposition of organic matter when the soils are agriculturally poor.
    - Plants that act as insect traps

It is possible that in regions where illicit crops are currently being developed the beneficial effects of these organisms may be detected only when they have disappeared and their natural enemies are free to act, with greater reproduction rates (causing plague effect) with the consequent need to introduce stronger pesticides[30]

[30] It is logical that once the natural balance of ecosystems is destabilized with the introduction of pesticides, effects of tolerance and resistance are generated which determine, therefore, the introduction of stronger and more harmful substances to the ecosystems. Vicious circle effect.

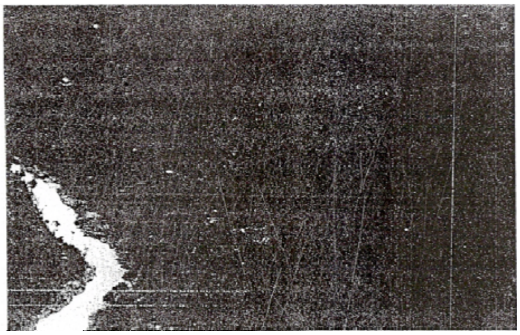


***Photo No. 4 A***

*Burning and felling for planting illicit crops. Note the original forest and the stream receiving the sediment from erosion of the removed slopes.*

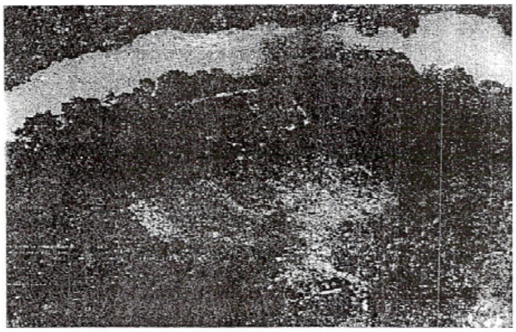


***Photo No. 4 B***

*Coca crops in the river banks. Erosion and the pesticides used on crops affect the water quality of these ecosystems.*

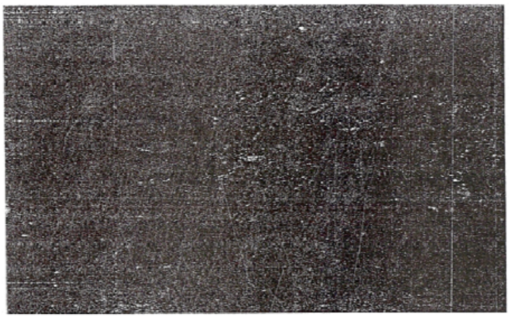


***Photo No. 5 A***

*Plot recently cleared for illicit crops. Note the onset of the erosion phenomena due to terrain gradient.*

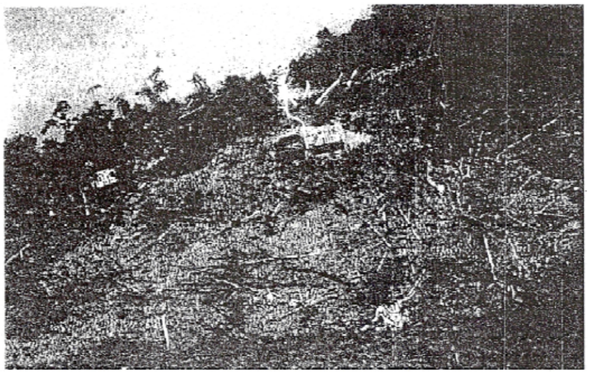


***Photo No. 5 B***

*Coca cultivation in Caquetá. Along the river there is a processing laboratory. The final destination of many chemicals substances will be the river.*

- Waste containers and residual products. In areas of illicit crops, farmers usually discard pesticide containers, surplus product, remnants of spraying processes, and the remnants left in the spraying equipment after washing, into the environment (soil and water sources, incineration, etc.). This process is most used when the plots are near rivers or streams, as illustrated in photo No. 4 A, 4 B and 5 B.

Each of these cases represents a specific problem, but in general they can potentially grow to contaminate directly or indirectly the environment, including in the communities that inhabit it:

- Disposal of packaging: Many containers are recycled for use as tools for daily chores and food preparation.[31]

- Accumulation in wells: the population in rural areas of the country is accustomed to digging wells near homes where they deposit the waste generated. Unfortunately, the wastes are not classified and all types of materials are deposited in wells, whether they are biodegradable, toxic or otherwise.

- Open burning: it can cause greater harm that the mere accumulation. Some products, when exposed to heat, emit dioxins and furans, whose toxic power is vaster than the initial product.

Taking into account that in the cultivation of a coca crop producers generally use 6 gallons of Paraquat (Gramoxone) for the first harvest and one gallon over the next two harvests; 2 liters of dinitroaniline (Waxal) in each harvest; 240 cm3 of carbamates (Furadan) in each of the three crops the first year, 12 kg urea and 12 kg triple 15 (chemical fertilizer), one can infer that in coca cultivation surveyed between 1999 and 2000 the quantities of agrochemicals referred to in Chart 3.12 were used.

Because the area established in 1998 is not taken into account by the difference in methodologies used to determine the areas, the amount of chemicals calculated for both years and especially for 1999 is lower than what was actually used.

[31] If glass containers are generally used for the collection of fluid (in some regions it was found that farmers use the Gramoxone containers to carry their fermented juice), kerosene or water; if they are metal, they are used for heating and storing water and if they are aluminum they are used as pots in the base and refining laboratories.

These calculations were estimated on the basis of focused studies that have been made in the crop areas (SINCHI). However, there are no estimates made with previously established statistical models.

**CHART 3.12**

**ESTIMATES OF THE USE OF AGROCHEMICALS**

**(between 1999 and 2000)**

| AGROCHEMICAL | 1999 | 2000 | Total |
|---|---|---|---|
| Paraquat[32] (gallons) | 640,476 | 653,156 | 1,293,632 |
| Dinitroaniline* lt | 1280,952 | 1,306,312 | 2,587,264 |
| Carbamate*lt | 153,714 | 156,757 | 310,47l |
| Urea kg | 1,280,952 | 1,306,312 | 2,587,264 |
| Triple 15 kg | 2,561,904 | 2,612,624 | 5,174,528 |

DNE III-2000

## 3.3. ENVIRONMENTAL ZONING

### 3.3.1. General conclusion

Based on the above we can conclude the following:

[32] According to Uribe, 1999, SINCHI 1997 and state security agencies, the most used are Paraquat, Wax up and Furadan, in that order.

- *PECIG scenario*. The real scenario of the Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate-PECIG is a highly involved ecosystem by the historical and current action of man. Even in some areas it is a totally transformed ecosystem characterized by grasslands and crops, as in much of southern Bolivar, Caqueta foothills, the Serrania del Perija, or the cold areas of Huila and Tolima cultivated in poppy, where it is grown intercropped with other lawful clean crops. The primary forest in the Amazon area, the Pacific plain or the high Andes belt are therefore not PECIG scenario.

- *Impact of illicit crops*. Illicit crops, upon entering an area, destroy native forests and generate serious environmental impact, expressed in biomass and biodiversity loss, erosion, water pollution, intensive use of pesticides, population migration and the change of cultural patterns of the native population, indigenous or subsistence farmer. The environmental and social impact generated by illicit crops, already existing, is the other side of the PECIG scenario of action, that is, its baseline.

- *Control of existing impact.* In this context, upon pursuing the elimination of illicit crops, the aim of PECIG is the elimination of one of the most important–if not the worst–factors of environmental and social degradation suffered by the country today. It is in this dimension that the program should be seen. It follows the impacts generated by drug trafficking; it does not go ahead, as has been the intent to portray.

### 3.3.2. Criteria of environmental zoning for spraying

Since this is a management plan framework at the national level, designed so it can be applied anywhere in the country where it is necessary to eradicate current or future illicit crops by aerial spraying with glyphosate, it is not possible at this level of the management plan to adopt an environmental zoning plan for the development of PECIG in each of the sectors, properties or plots where they are, as would be the case for a development project or work, because, by political decision of the National Government, eradication by aerial spraying with glyphosate should be done where industrial crops are located.

However, it is important to have criteria to guide the commander of the base and the personnel involved in the planning stages of each spraying operation (detection and operational planning phases described in Chapter 2) to select the areas to try and establish the exclusion zones. These criteria, in principle, should be given in Chart No 3.13. For this purpose, the following definitions are adopted:

- *Ecologically fragile areas.* For the purposes of the Program, these are the areas that contain flora or fauna values of national importance, such as endemic species of native flora and fauna. This applies, in particular, to areas of the National Parks System.

- *Culturally fragile areas.* These are the areas with presence of indigenous peoples or communities with their current language, customs and traditions, which have not experienced the total impact of acculturation by colonization, whereby the intervention could lead to the extinction of the people or community as a nation. They include also indigenous cemeteries and other areas with remnants of extinct cultures, archaeological or historical monuments or otherwise. In the PECIG area of action it is only possible to identify indigenous settlements.

- *Environmentally sensitive areas.* These are the areas that contain particularly valuable vegetation and native fauna, water bodies, special geomorphological values, soils of high agricultural potential or the like, whose intervention could lead to their deterioration, so it is necessary to adopt appropriate control measures. This wealth, however, can be found in other parts of the country or region. The PECIG area works especially with areas of native forest and water bodies.

- *Socially sensitive areas.* These are the areas that contain special richness of social or cultural nature, such as agglomerated settlements (villages, towns, cities), high-density rural settlements or the like, whose intervention could lead to a deterioration of living conditions of its population. This wealth, however, may be found in other parts of the country or region.

- *Economically sensitive areas.* These are the areas that contain special significance of an economic nature, such as roads, airports, river or maritime ports, regulation reservoirs for different uses of water, watering and drainage districts, industrial areas, mines, rural commercial or institutional centers and the like, which intervention could lead to a deterioration of the same. This wealth, however, can be found in other parts of the country or region.

In detail, different categories of sensitivity could be established, depending on the significance of the resource. All fragile areas are sensitive, but not all sensitive areas are fragile.

Consistent with this, in the detection and characterization stages before each spraying operation, it is necessary that the technical team of the base, with the help of satellite images, maps or aerial photographs, identify the presence of the above types of areas or elements, georeference them and integrate them into SATLOC system, so that in the course of the operation, the system alerts the pilot of the proximity of such areas, to avoid spraying and thus respect their buffer strips.

**CHART 3.13**

**CRITERIA FOR DETAILED ENVIRONMENTAL ZONING IN AREAS OF SPRAYING ILLICIT CROPS WITH GLYPHOSATE**

| ZONE TYPE | ZONING FOR PECIG |
|---|---|
| ECOLOGICALLY FRAGILE | Areas of the National Nature Parks System |
| CULTURALLY FRAGILE | Indigenous reservations<br>Archaeological parks<br>Historical monuments |
| ENVIRONMENTALLY SENSITIVE | Water bodies (rivers, streams, wetlands)<br>Native forests |
| SOCIALLY SENSITIVE | Human settlement agglomerates (villages, towns, cities) |
| | Infrastructure works: roads, airports, river and sea ports, dams and power |

| | |
|---|---|
| | plants |
| | Areas of Manual Eradication Pacts |
| | PNDA Productive Project Areas |
| ECONOMICALLY SENSITIVE | Irrigation and/or drainage districts |
| | Industrial zones |
| | Open pit mines in operation |
| | Rural tourism and commercial complexes |
| | Rural institutional complexes |

**3.3.3. General zoning**

Consistent with the above and taking into account the characteristics of the PECIG areas of action, the aim is the zonal planning as indicated in Chart No 3.14, as a framework for planning the spraying operations.

The goal is to standardize the buffer strips to 100 meters from the border of the zone, according to the provisions of Decree 1843 of 1991 and adopt an alert strip of 1,000 meters around the exclusion zone, within which SATLOC aircraft system should notify the pilot of the presence of the same, in order to avoid spraying.

**CHART 3.14**
**ENVIRONMENTAL ZONING FOR ERADICATION BY AERIAL SPRAYING WITH GLYPHOSATE**

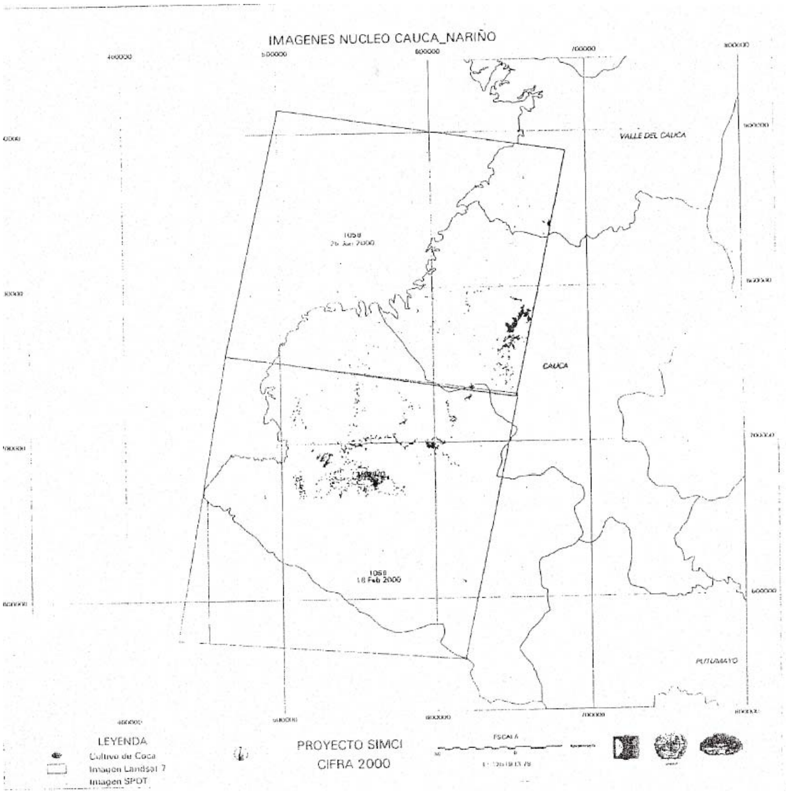
| ZONE TYPE | DEFINITION | MANAGEMENT FEATURES |
|---|---|---|
| | Areas of the National Nature Parks System (PNN) | |
| | Human settlements (towns, villages | |

| | | |
|---|---|---|
| Exclusion zones | and the like) | Must not spray on them or on the security zone of 100 meters. |
| | Bodies of Water | |
| | Areas of socioeconomic interest | |
| | Areas with vegetation cover other than illicit crops | Must not spray on them. Pilot must open and close the latch in illicit crop plot. |
| | Illicit farmer crops | Manual eradication. Must not spray on them. |
| Restriction zones | Strip around PNN | 1,000 meter Alert strip |
| | Strip around Human settlements | 1,000 meter Alert strip |
| | Strip around perimeter of water bodies | 1,000 meter Alert strip |
| | Strip around the areas of socioeconomic interest | 1,000 meter Alert strip |
| Intervention zones | Areas occupied by industrial Illicit crops | Spray with glyphosate |

Source: this study, DNE

Figure No. 3.4

IMAGES OF THE CAUCA-NARIÑO NUCLEUS




LEGEND SIMCI PROJECT

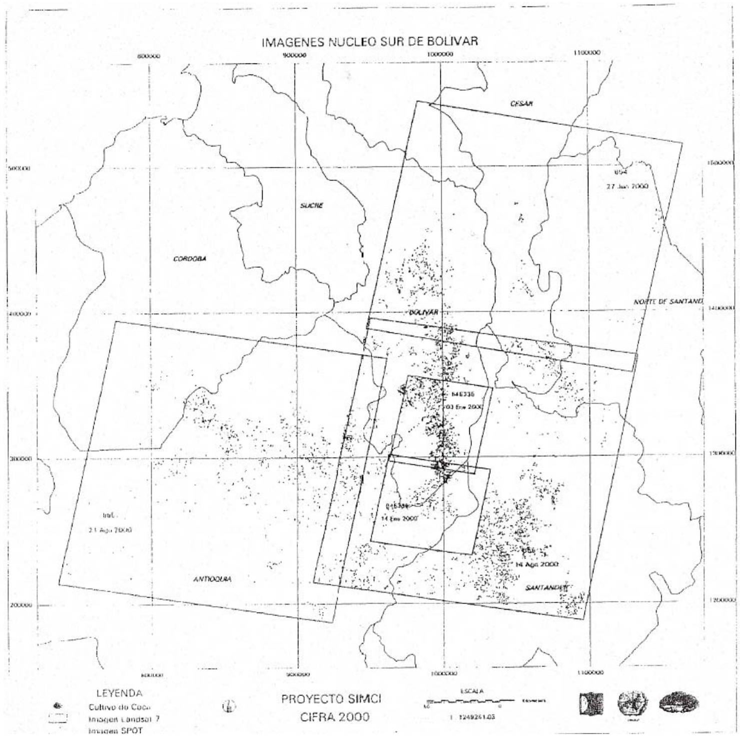
Coca crop

Landsat 7 Image

SPOT Image

Figure No. 3.5

IMAGES OF THE SOUTH OF BOLIVAR NUCLEUS




LEGEND SIMCI PROJECT

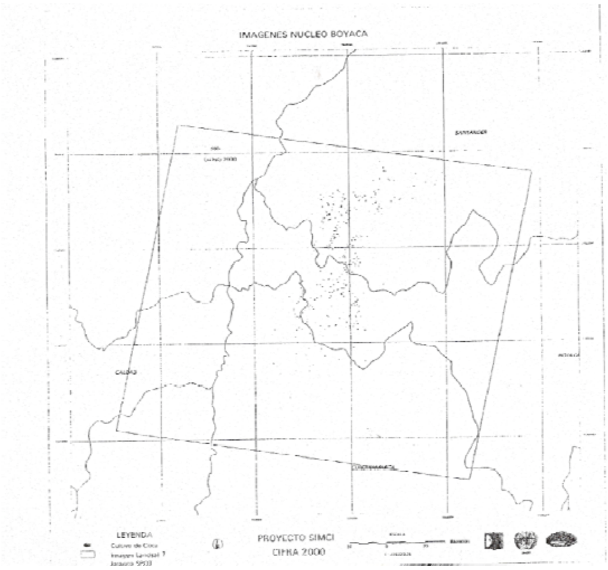
Coca crop

Landsat 7 Image

SPOT Image

Figure No. 3.6

IMAGES OF THE BOYACA NUCLEUS




LEGEND

SIMCI PROJECT

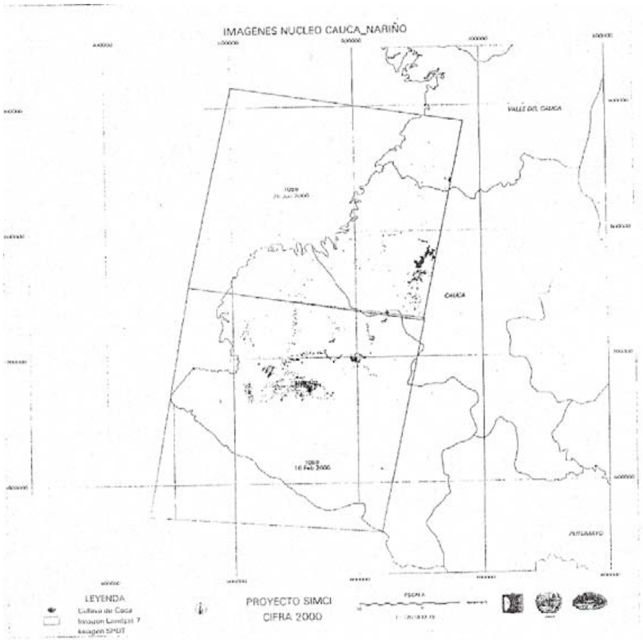
Coca crop

Landsat 7 Image

SPOT Image

Figure No. 3.7

IMAGES OF THE CAUCA-NARIÑO NUCLEUS



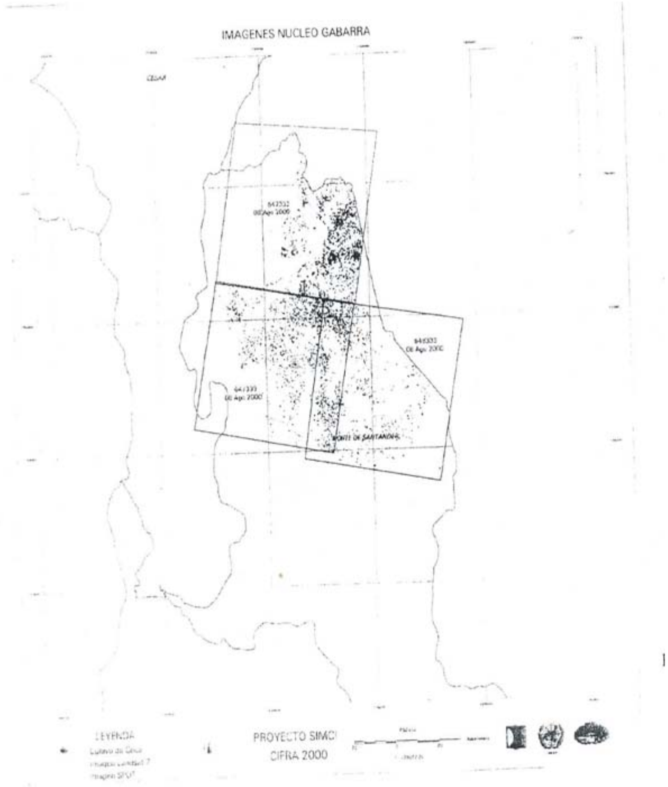

LEGEND SIMCI PROJECT

Coca crop

Landsat 7 Image

SPOT Image

## IMAGES GABARRA NUCLEUS




**SIMCI PROJECT**

**FIGURE NO. 3.8**

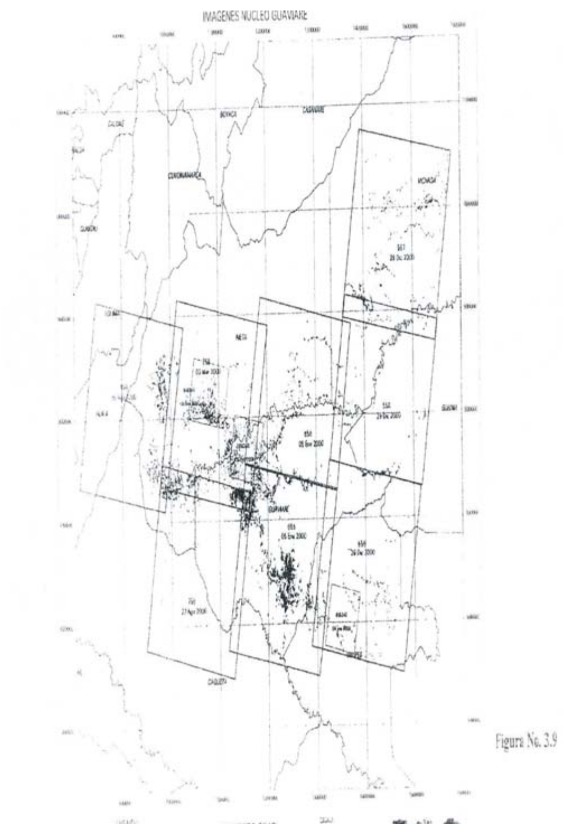
LEGEND

Coca crop

Landsat 7 Image

SPOT Image

## IMAGES GUAVIARE NUCLEUS




**SIMCI PROJECT**

**FIGURE NO. 3.9**

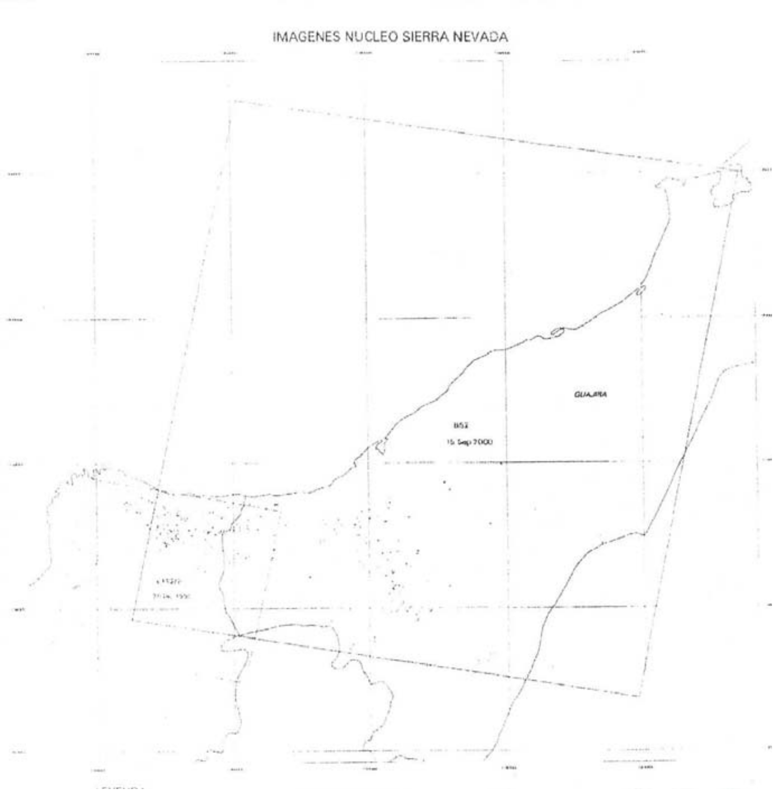
LEGEND

Coca crop

Landsat 7 Image

SPOT Image

## IMAGES SIERRA NEVADA NUCLEUS




**SIMCI PROJECT**

**FIGURE NO. 3.10**

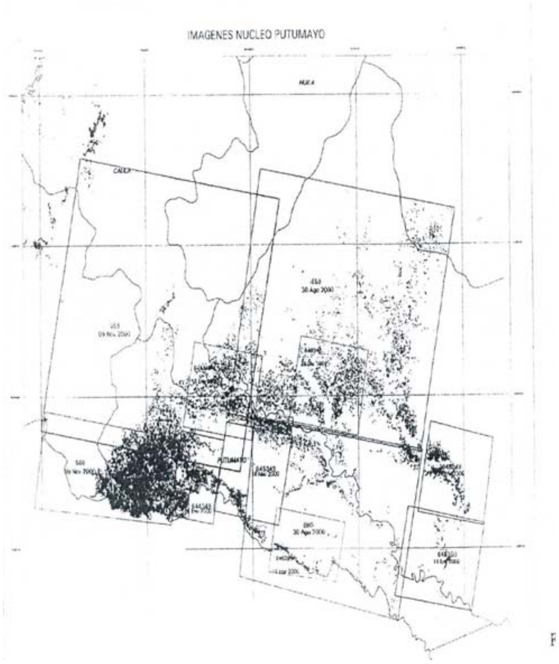
LEGEND

Coca crop

Landsat 7 Image

SPOT Image

**IMAGES PUTUMAYO NUCLEUS**




LEGEND **SIMCI PROJECT** **FIGURE NO. 3.11**

Coca crop

Landsat 7 Image

SPOT Image

[CHAPTER 4]

# 4. ENVIRONMENTAL IMPACT- RISK ASSESSMENT

## 4.1. GENERAL ASPECTS

### 4.1.1. Assessment Criteria

*The concept of impact/risk*

This part of the study is aimed at identifying, predicting and assessing the importance of the program's potential impacts and to select the measures of prevention, correction and compensation that are required in order to make it environmentally viable.

However, given the nature of the program, which consists of the eradication of illicit crops by aerial spraying of a herbicide which might affect, in addition to unlawful crops, other types of natural or cultivated vegetation, and the health of humans and animals who may be accidentally sprayed with the product, the task necessarily and in fact includes an evaluation of risk, understood as being the probability that the impact or adverse effect that might occur.

Therefore, for all purposes of this evaluation, the impact/risk of aerial spraying with the herbicide glyphosate will be considered.

In Chapter 3, there was a synthetic presentation of the environmental impact generated by drug trafficking activities on ecosystems, which begin with the felling of jungle on the Equator, in the Andes and in the high Andes, and ending with the contamination of bodies of water and soils with residues and containers of pesticides and herbicides disposed of without control, and the social and cultural impact found in migration, the decomposition of society, adverse effects on indigenous communities, and an increase in indicators of violence.

Therefore, the control of illicit crops which is one of the most important links in the chain, will allow the impact generated by the drug-trafficking industry as a whole to be controlled and reduced. Evidently, the control of illicit crops by spraying with glyphosate also has an environmental impact, and its evaluation and control are the main objectives of this Management Plan

*Method of evaluation*

Based on the knowledge the knowledge of environmental conditions and characteristics of the program, this phase of evaluation seeks to answer four basic questions:

- What changes occurred will occur as a result of the program? This is the identification of impact/risk, or the determination of possible interactions between the program and the environmental conditions of the area.

**[Page 111]**

- What will be the scope of the changes? This is the prediction of the expected magnitude of impact/risk, or a quantification in physical, biological, economic, social or other terms, depending on their nature.

- Are the changes important? This is the evaluation in essence, or the determination of the real importance of each impact/risk on the current situation, and to the expectations of the local inhabitants, or existing legislation or other reference parameters

- What must be done to manage or control changes? This is the determination of measures of prevention, correction, mitigation or compensation required for those impact/risks which appear to be significant from evaluation

This process is iterative, until measures are found which will make the program viable from an environmental point of view. In the Chapter of Impact Evaluation, the four previous stages, although fully considered in the analysis, are presented in a unified and synthetic manner, seeking to place emphasis on the really significant impact of the program.

For operational purposes, the impact/risk evaluation has been organized depending on the type of medium affected, as follows: impact on physical medium, impact on biotic medium, and impact on socio-economic-cultural medium.

Each impact is classified by the following criteria:

- Character: direct, indirect
- Type of event: negative, positive
- Probability of occurrence: certain, probable, improbable
- Duration: long-term residual, medium-term, short-term
- Reversibility, that is, whether the medium oral resource affected can be recovered
- Real importance: insignificant or not appreciable (0), very low (1), low (2), moderate (3), high (4), very high (5).

The impact summarizing trends is presented in the reduced matrix for environmental impact of the program (Figure 4.3).

*Scenario of evaluation*

Although this is not the most frequent scenario, or even an average one, for the evaluation of impact/risk, the starting point has been a critical scenario, in which the environment around the crop area to be sprayed is in its best possible condition, as follows:

- In the case of coca-leaf, the scenario consists of occurrence of primary woodland around the crop area, specifically felled to make way for the crop.

- In the case of opium-poppy, the scenario is the presence of high-Andes misty woodland, specifically felled to make way for the crop, or around indigenous or smallholder areas, with occasional human presence in the crop areas.

**4.1.2. Effects of Glyphosate.**

**4.1.2.1. Mode of action of glyphosate**

Herbicides are lethal to plants, by interfering with photosynthesis, nucleic acid synthesis, respiration, formation of ATP, membranes and proteins, division and growth of cells, root formation, and germination.

The current level of knowledge allows it to be said with certainty that:

Glyphosate is absorbed by leaves, and removed through the phloem

The action is slow, and may need 5-7 days for the first symptoms to appear

There are various technical items of evidence which shows the inhibitory effect of chlorophyll synthesis, as a consequence of the inhibition of the Delta amino-levolimic acid, which further is an important component in the formation of porphirine (Monsanto, Bol. 0573-2139)

It inhibits the production of chorismic mutase and/or prephenic deshydratase which are interacting active t enzymes in the process of synthesis of shikimic acid, which in turn is the precursor of the synthesis of aromatics Phenylalanine, Tyrosine and Tryptophan, which are also basic to the process of synthesis of the proteins required by the plant.

In addition to the amino acids mentioned above, Leusine, Lysine, Isoleusine, Methionine and Valine are exclusive to plant species and from the point of view of animal nutrition, essential because their only source of supply is vegetation, which, further are the only living organisms able to produce them through biosynthesis. Glyphosate does not act on seeds already lying under the surface of the soil, and is not absorbed by roots (CIAT, 1997; Meister R. T., Farm Chemicals Handbook 1999, and others).

Glyphosate is lethal for plants and bacteria by inhibition of the activity of the enzyme enolpyruvylshikimate-phosphate synthase (EPSPS), which is a constituent element in vegetation and bacteria.

#### 4.1.2.2. Characteristics and magnitude of systemic capacity

Glyphosate is characterised as a systemic-type herbicide, and is non-selective except in the very few special cases of artificially-induced selectivity (certain plant varieties of transgenic origin). The magnitude of systemic capacity is very wide, even though it is almost exclusive through foliage, preferably making use of the tubular system of the phloem, in a large number of the chemical species.

Root absorption, through the xylene, is almost nil, due to rapid deactivation and fixing of the compound as soon as it comes into contact with soil particles.

#### 4.1.2.3. Processes of absorption and translocation

One of the most important characteristics of glyphosate is its systemic action which is almost exclusively through the leaf. The absorption of the active ingredient, however, seems to be a passive kind of process, because it takes place without the intervention of any energy in the plant. The isopropyl amine salt in glyphosate is very quickly assimilated, and usually accumulates in the plant growth points.

#### 4.1.2.4. Most important mechanisms of action (enzyme inhibition)

Technical literature allows the deduction that it is probable that was more than just one process of action, although all the signs are that the most common mode of action is inhibition of chlorophyll synthesis, as a consequence of the inhibition of Delta amino-levolimic acid, which is an important component in the formation of porphyrin. At the same time, it is estimated that aromatic aminoacids can be inhibited (mainly Phenylanalin, Tyrosin and Tryptophan), due to the blocking of the synthesis of shikimic acid.

Inhibition or interference in the process of synthesis of the aminoacids mentioned, in addition to others, is critical to plants, because unlike other living beings, plants cannot substitute them by taking them from sources other than biosynthesis.

**4.1.2.5. Average residuality of glyphosate.**

All chemical products have a process of degradation or of total or partial changes of their molecular constitution, and their physical and chemical properties, as soon as they come into contact with components of the surrounding medium (water, temperature, microorganisms, light, solar radiation, etc).

In order to offer opinion on the average residuality of glyphosate, which can only last 4 days or so in average tropical conditions, the following considerations need to be applied from:

The physical-chemicals comportment of chemical herbicides is very broad and complex, since more than one of the inductive, residents, inductive medic, electronic and field electronic effects act favourably or unfavourably (with respect to the stability of the molecule, for example), environmental conditions in which any pesticide, including glyphosate, is used. It is sufficient to say simply that in addition to polarity and apolarity, molecular threatening, solubility, the rate of hydrolization, surface tension, the capacity for penetration through membranes, affinity and molecular stability, residuality and the rate of metabolization, and others, are effects governed by the flow of electrons, and this flow is in turn governed by the direct or indirect action of factors and living organisms in the surroundings.

The influence of biochemical reactions on pesticide formulations is real. It may be said that the formulations use in pesticides may be acid, or of a week basic reaction, which facilitates the process of hyhdrolization of in aqueous solutions. The degree of ionization or protonation (a process which can take place when adding water to formulations used), however, is governed by the dissociative constant (pKA) and by the pH of the solution. The use of this symbolism may become very complex when involving all the effects of the dissociative constant, but interpretation is easier when, for example, the terms *protonated form* for acid reaction compounds are used, and *deprotonated forms* for basic reaction compounds.

It is a known fact that protonated and deprotonated formulations differ greatly in polarity, and therefore, in their permeability and partitioning properties. Also, it cannot be ignored that electronic interpretations are, today, of great importance when speaking of properties such as polarity, acidity, basidity and proportion and direction of all chemical reactions, to mention only a few effects in the area of biochemical reactions.

#### 4.1.2.6. Toxemic action of chemical pesticides

In principle, all chemical pesticides, with very few exceptions, should be considered more or less toxic for any living being, including humans. What may be surprising, is the fact that many of them, and other chemical compounds usually considered to be non-toxic, may become biocides if the conditions for developing that capacity are present.

From a biological point of view, it is easy to show that the ingestion of certain compounds in similar doses may be fatal for some living forms, and at the same time, inoffensive for others, because toxic capacity is a consequence of the quantity of product, of the response of physiological systems of organisms to be subjected to their effects, and several conditions and circumstances prevalent in each of the ecological systems, which may have the capacity to modify the magnitude of toxicity in each pesticide.

*Parental products and metabolites*

Pesticides form a very heterogeneous group of toxic substances from a chemical point of view. Further, there are certain products which are able to turn themselves into other chemical substances of greater or lesser toxicity, once they enter the organism and react with the biochemical constituents of it. Some of these metabolites, as the substances are usually called, may be the result of oxidative or reductive enzymatic reactions, in some cases, or the product of the fracturing of the parental molecule, through a more or less complicated process of detoxification. Later, we will refer to the most important metabolites of glyphosate.

*Dimensioning of toxicology of pesticides*

The most important concern is the toxicity of chemical pesticides. For a doctor, the most important thing is human health, and for him, any pesticide is or could be a poison, and any benefit that might generate would be of very secondary importance. For another section of the public, including plant health specialists, pesticides are very useful substances, although in all cases, their use is matched by the need to follow certain very strict standards.

Acute and sublethal intoxications in humans and animals, the problems of the resistance to the action of pesticides, and international restrictions imposed on the agricultural chemicals market from against contamination with toxic residues, were the decisive causes for several states to issue restrictive regulations, including the ban on some pesticides.

The dangers of the toxic effects of pesticides referred to the acute risk to health (that is, the risk that simple or multiple exposure, for a more or less short period), which may occur accidentally to any person who manipulates a pesticide, even if he follows the manufacturers instructions or those of agencies responsible for their storage and transport. Nonetheless, in the case of activities proper to our operations bases, the possibilities of intoxication by some of a mixer with glyphosate are in practice non-existent.

In order to place a limit on the scope of the term acute risk, the term "toxic" is used, as a synonym of poison, and toxicology as the science of poisons, with respect to their effects and the problems which are related to poisons, including those of a clinical, industrial or legal nature.

*Non-observable effects limit (NOEL)*

Several studies with laboratory animals determine the existence of a close relationship between dose and response. This relationship allowed a calculation and determination of a dose able to cause observable effects (effects limit), and the dose at a level at which effects are not observed (non-observable effects limit - NOEL)

The toxemic capacity of any pesticide depends on a number of factors, as with which a given quantity (threshold), which may be "the point at which a given stimulus is sufficiently strong to be perceived, to cause a response, to secure access to a given point, or to cause a moment of something". With this starting point, it may be deduced that each pesticide has dosage levels which have no action on a living organism which, further, may be taken into account in calculating the magnitude of certain regulatory norms, including the acceptable daily ingestion for humans.

*The safety and uncertainty factor*

The safety and uncertainty factor is a precautionary procedure to safeguard human and animal health, as practised in the United States and other countries.

When the effects limit has been determined for a given product, US-EPA divides the lowest NOEL value in the study by an uncertainty factor (of 100 or higher), to determine the reference dose (RfD), that is, the level below which the “aggregate daily exposure” to the pesticide, in terms equivalent to one life, will not cause appreciable risks. They spun it an uncertainty factor or safety factor of 100, is the commonest in toxicology, because it is normally assumed that human beings are 10 times more sensitive to pesticides than animals.

Further, US EPA may take account of potential risk factors for infants, and on that basis, decide whether it is relevant to apply the additional uncertainty factor or not. For short-term risks, the EPA calculates a margin of exposure (MOE), dividing the estimated human exposure by the value of the NOEL, making use of appropriate animal studies. In general, the EPA and many organizations in other countries do not accept MOEs of less than 100. This value, which is 100 times greater than the MOE, is based on the same criterion adopted to estimate the value 100 times greater than the “uncertainty factor”.

*The concept and scope of DL 50s*

The degree of hazardousness of each compound is measured in accordance with average lethal doses values (DL 50), which is "the minimum dosage required to kill 50% of a homogeneous group of animals after six hours, under special experimental conditions". DL 50 may also be "the minimum quantity required in a single dosage, to kill half the individuals of a group of at least 10, in specific experimental conditions, and subject to observation over 6 hours-15 days after the administration of the toxin". The dose is expressed in milligrams of the toxic substance per kilogram of live animal weight, specifying the species, sex and age of the animals used. It is applied orally, through the skin, through the eyes, through the mucus and by inhalation.

*Toxicological categories*

Despite the limitations of deals 50 values, in terms of chronic and acute oral absorption, lethal in inhalatory dose and lethal dermal dose, Colombia and other countries have adopted several toxicological categories for the sale and use of agricultural chemical compounds, although some are included in the following current categories in the USA.

**TOXICOLOGICAL CATEGORIES USED IN THE USA AND COLOMBIA**

| Characteristics | classification |
|---|---|
| Less than 10 mg per kilogram of live animal weight | extremely toxic |
| 10 - 50 mg per kilogram of live animal weight | highly toxic |
| 51-500 mg per kilogram of live animal weight | moderately toxic |
| 501-2000 mg per kilogram of live animal weight | slightly toxic |
| over 2000 mg per kilogram of live animal weight | almost non-toxic |

source: EPA, Ministry of health, farm chemicals 2001, USA

The Colombian Health Ministry has established for categories, separating solid from liquid pesticides, and assigned glyphosate into Category IV (slightly toxic), and the mixture of glyphosate + POEA+Cosmoflux 411F into category III (see the opinion of October 4, 2001, Schedule 4). It should nonetheless be explained that POEA forms part of the commercial formulation, that is to say, it is not that it is not added, says it already comes with the glyphosate acquired by PECIG.

*Residues and tolerances*

In order to avoid the damage caused by ingestion and the accumulation of lethal quantities of pesticides, FAO and WHO have recommended a number of measures to reduce the hazards of ingestion of agricultural chemicals.

The maximum quantities of residues permissible in the daily consumption of food are specified and quantified for each animal or plant food source. These quantities are expressed in terms of parts per million (ppm) of the permissible quantities of post-harvest residues, if plants, or post-sacrifice in the case of animals. These values may differ from country to country, depending on the crops, or the processing system, or food habits.

In addition to the tolerances suggested by the standards organisations, account is also taken of the time in acting between the last the most recent application and the harvest (this being a period of degradation of the parental molecule of the compound), and environmental factors and even the influence of biochemical systems on living organisms. In the case of glyphosate, the Ministry of Health classifies it as toxicological category IV (slightly toxic), which means that even in the case of ingestion, there would have to be a considerable dose to cause any damage to the human organism.

In subsequent sections of this Chapter, where referring to the impact on human health and ecosystems, there will be a transcription of tolerances to glyphosate accepted by several international agencies.

*Factors able to influence the toxicity of glyphosate.*

The overall toxicity of glyphosate depends on a number of factors in the ecosystem and in the physiological conditions of each living organism. For the case of the use of this herbicide on the programs for the eradication of illicit crops, the possibilities of contamination with significant doses are minimal, since in practice each crop of the illegal species is treated only once, and the degradation of the parental molecule is very rapid in high-temperature and humidity tropical ecosystems. The following are the most important factors.

- Physical-chemical characteristics of the formulation for use
- Toxic quantity per patient
- Time of exposure time of the receptor organism to the pesticide
- Route(s) of entry to the organism (mouth, nose, eyes, etc)
- Class and type of inert materials in the formulation
- Degree of susceptibility of the receptor organism
- State of health of the organism
- Importance of the physiological system affected
- Efficiency of the organism´s detoxification system
- Chemical stability in the formulation employed

## 4.2. IMPACTS ON THE PHYSICAL ENVIRONMENT

### 4.2.1. Impact on soil

#### 4.2.1.1. Impact on the quality of the soil

*Identification*

The spraying of glyphosate on illicit crops may affect soils in which those crops lie, and legal crops nearby, which may be affected by drift. This is a matter of direct, negative, certain impact, in the short term, and reversible.

*Prediction*

a) Processes old metabolization and degradation of glyphosate in the soil

Glyphosate is not a prolonged residual action herbicide, and its effect is of very short duration in tropical soils. The molecules biodegrade principally by the action of microorganisms in the soil, and since it is a representative of the type of compound known as phosphoric acid, which contains a direct link of carbon to phosphorus (C-P), and although the C-P link is chemically very stable, many bacteria including those in the enteric group such as *Escherichia coli,* have an enzymatic ability to break this link in order to release the organic phosphate.

Glyphosate degrades through photochemical, chemical and biological processes, due to the effect of UV light, but not from chemical hydrolysis, although in practice that of the greatest magnitude is the enzymatic decomposition due to the effect of microorganisms in the soil, which originates the formation of biologically inactive metabolites, such as a minor methyl phosphoric amino acid (AMPA).

In almost all studies on the metabolism of glyphosate, this was the only source of obtaining phosphorus, because the organisms subjected to investigation were not able to use the glyphosate as an additional source of carbon and nitrogen.

If we note that the common route of degradation for AMPA has been found in microorganisms prior to the introduction of defrosted, this fact has allowed for the proposal that the procedure for degradation of this herbicide is something which occurs naturally in the environment, although the prevalence of sarcosine in the intermediate route of degradation, in isolation obtained from glyphosate-enriched sources, also suggests that this route is a process of selection in certain environments, possibly due to the greater favourability for organisms involved in the process.

CO2, water, nitrogen and some phosphates are the general product of degradation of glyphosate. In laboratory conditions, it is possible to estimate and measure the resulting quantities of these compounds as a product of degradation of glyphosate. However, in field conditions, in which processes of adsorption and bacterial degradation play a dominant role, in addition to processes of interception of herbicide from the aerial apparatus of plants and elaboration, it is very difficult to calculate the balances of these masses. Further, they may be valid only at one moment in time, since the action of degradation is continuous.

The process of adsorption is responsible for the greatest loss of herbicide action of the chemical compound in the soil. The particles which fall on the ground may be fixed by absorption, in clays, in organic matter, in metal oxides, and in some humic constituents, through the action of phosphoric acid, which competes for fixing sites with organic phosphates. The pH of the soil has little effect on adsorption, and, since this is a case of a processor of equilibrium, the fixing (adsorption) may be classed as irreversible process.

b) Average life of the parental product in the soil

Glyphosate is not a pesticide with a prolonged residual action, but due to the multiplicity of factors related to the degradation process, the degree of persistence in the soil varies greatly, and it is not easy to provide an appropriate answer to the question "How long is the persistence of glyphosate in the soil?". The average life, that is, the time required for half of the quantity of the product applied to metabolize or disappear, may vary from 3 to 141 days, depending on information from a number of authors, although there are also those who say that the biocide effect is normally of very short duration in tropical soils, because the molecule may degrade rapidly, and is able to be fragmented, and give rise to compounds such as CO2, water, some nitrogenated fractions and certain phosphates - all of this, due to the principal action of microorganisms.

The high values of the systems of the parental molecule which some authors note, only occurs in ecosystems subject to temperatures below freezing point, such as some parts of Canada, where in addition to low temperatures, there is also an almost total reduction of activity of the microorganisms responsible for the metabolization of the parental molecule. This never occurs in Colombian criticisms, and therefore, the average life of the molecule of lesser fate is so short.

Herbicide molecules, as explained earlier, normally fixed in the soil as a result of a process of adsorption in clays, in organic materials, in metallic in metal oxides, and in certain humic constituents, but, because this is a process of equilibrium in electron charges, the fixing (adsorption) may be, and in effect is, a process which can be reversed (desorption). The influence of pH in the soil in the rate of degradation of glyphosate seems to be very small. Nonetheless, although in theory it may be logical, under conditions of tropical soils desorption may be very limited, and at all events, the glyphosate molecules will be quickly metabolised by bacterial action.

The degradation of the glyphosate molecule is certainly a rapid or slow process, depending on several environmental conditions, and various circumstances in which it acts. In most cases, the rate of degradation of the parental molecule determines that the average life will be less than one week in tropical conditions, while in other conditions and environments, degradation and metabolization may take several months, and up to one year, as may be the case of certain applications made in Canadian crops.

c) The range of metabolites, and their relative importance

The metabolization of glyphosate is caused dominantly by microflora, although the resulting metabolites are not used by the microorganisms which originate them. Despite the aerobic and anaerobic degradation of the parental molecule, giving origin to at least six metabolites of which the majority in production and importance are AMPA, and structural formula is $CH_6NO_3P$, and sarcosine (N-methylglycine, hydrochloric sargosine or 2-methylaminoethanoic acid), whose structural formula is $C_3H_7NO_2$. AMPA is detectable in the soil and in plant tissues, and respect with to toxemic capacity, it can be classed as harmless.

For some time, there was concern that the metabolic process of glyphosate could cause the formation of nitrosamines substances known to induce mutagenic, carcinogenic and teratogenic effects, or certain acute intoxications. These concerns have been found to be baseless so far, and no research has shown or found evidence of the formation of these metabolites. Something similar also occurs with reports published since 1990, that among the products of decomposition of the parental molecule of glyphosate, there should also be formaldehyde, a compound which currently appears on the list of potentially carcinogenic substances. Although this possibility exists, the quantities produced as a consequence of the normal use in weed control may perhaps be classed as "trace", and of very low risk to users.

d) Bioconcentration and effects on soil microorganisms

Given the toxicity implants, and the persistence of the compact being considered so small, the use of the compound should be understood, in terms of the comportment of glyphosate, physically and microbiologically in soils.

The first comportment refers to the adsorption of the glyphosate molecule in active sites in the soil, generally composed of available phosphates. There are specific Peons which reduce the capacity of absorption of the molecule, such as $Fe^{+2}$ and $Fe^{+3}$, and $Al^{+3}$. This may occasionally cause a highly constant of absorption of this compound in sandy-clay-chalky and sandy-chalky soils.

Bioconcentration in the soil can be determined is determined by the analysis of the solubility constant (1200/L), and the octanol water constant (Pow) (-2.8). These factors allow the determination of the possibility of bioconcentration of the molecule. Comparing these values with levels considered as critical for these two parameters, it can be said that the risk of bioconcentration of the molecule in soils is not feasible.

| PARAMETER | CRITICAL VALUE | VALUE FOR GLYPHOSATE MOLECULE |
|---|---|---|
| ***Solubility constant*** | **< 30 mg/L** | **1200 mg/ L** |
| ***Octanol – Water constant*** | **> 3** | **-2.8** |

**Source: DNE 2000**

e) Study of Transformation [33]

Several bacterial strains are able to decompose and degrade glyphosate. In most of the laboratory experiments, the rate of degradation of glyphosate in soils seems to be rapid. The speed of transformation can be established by a first-order non-linear model, which describes results observed best (PTRL East Inc, 1991)

[33] Environmental Management Plan for Illicit Crop Eradication, 1999

$$C = C_o (1 + \beta t)^{\alpha}$$

where C is a concentration of glyphosate at time t $C_O$ is the initial concentration, and α and β are constants which reflect spatial variability.

The principal metabolite of glyphosate, produce by the transformation in aerobic conditions, is a metabolite known as AMPA. In laboratory experiments, the maximum quantities found of this metabolite in sandy-chalky and alluvial chalk soils were 27% and 29% respectively, of the radioactivity applied (PTRL East Inc, 1991). Values of TD50 for AMPA can be found from this study, at approximately 50 days, for the types of soil mentioned.

In another laboratory experiment (Monsanto Inc, 1972b), it was found that AMPA may be more persistent than the original molecule, given that after 111 days, between 10% and 17% of the radioactivity initially applied for this metabolite could be recovered.

The mineralization of glyphosate in the soil occurs in aerobic and anaerobic conditions in the laboratory, and although rates are appreciably different, the results are mainly dependent on the soil respiration rate, and on temperature.

In the soil, glyphosate seems to be degradable by microorganisms in two ways (Jacob at al, 1988). One route, via the formation of AMPA, a fragment of CO2 and probably glyoxylate. This scheme of degradation was proposed by several researchers (Monsanto, 1972b, PTRL East Inc, 1991). In this route, the cleavage of the C-N union is the first stage. However, there is another degradation route through sarcosine (N-methyl glycine) and orthophosphate, after which the sarcosine is degraded to glycine, and one unit of a carbon, which eventually forms CO2, probably via formaldehyde (Kishore and Jacob, 1987, Jacob at al, 1988). In this route, the first step is the rupture of the C-P link.

In experiments with $^{14}C$-glyphosate, isolated crops of pseudomonas SB, LBr strain, were able to degrade glyphosate through both routes (Jacob at al, 1988). Approximately 5% of the glyphosate applied was not degraded by AMPA, but was degraded by Sarcosine[34]

*Evaluation*

The low residual energy of glyphosate in the soil, due to bacterial degradation processes and to adsorption and transformation of the molecule into metanbolites allows the conclusion that persistence in tropical conditions would be 3-4 days. If to this we add that it does not act on plant roots, the conclusion may be that the impact on the soil is low to very low.

*Mitigation*

Given that the impact on sprayed areas is normally considered to be low-very low, for the reasons given in preceding paragraphs, no mitigation measures are proposed for the plots of land sprayed. In cases where, due to attacks on the aircraft or an accident in the air, it becomes necessary to dump the entire product somewhere; this work will depend on the location of the place of dumping. If it is possible to arrive at that point quickly, the recommendation would be to apply the inactivation measures recommended in the spraying operations management program (Record 1), at all events applying the terms of the Contingency Plan (Record 13). If this is not possible, then compensation measures provided for in the Social Management and Compensation program would have to be applied (Record 9).

In the case of an accidental spillage of glyphosate on the ground at the operations base, the measures recommended by the Comprehensive Security Program (Record 4) should be applied, seeking to deactivated by covering it with an absorbent material, such as earth, and/or apply line to prevent unpleasant odours.

[34] WHO/IPCS Environmental Health criteria No. 159 Glyphosate. 1994 in Environmental Management Plan for the eradication of illicit crops, 1999

Despite the foregoing, it is considered that a research program should be conducted on demonstration plots representative of the various nuclei of illicit crops, in order to prove these conclusions, based on existing scientific literature (see bibliography). This Plot Research Program is designed on Record 7, and seeks to measure the residual energy of glyphosate in the soil and water in the conditions of the Colombian tropics, and the ecological dynamics of biological communities in the soil subsequent to the application of glyphosate.

#### 4.2.1.2. Impact on morphodynamic processes

*Identification*

The planting of illicit crops in foothills which had previously been stripped generates processes of erosion of different kinds, depending on climate and the nature of the terrain. In many places which had been recently cleared, surface water erosion processes and landslips can be observed.

Once an illicit crop is established, the spraying with glyphosate to destroy the herbaceous cover (only in the case of pastureland, since both coca leaf and opium poppy are clean crops), this may generate new processes of erosion or increase existing ones. This is an indirect, negative, probable, short-term and reversible impact.

Nonetheless, we should stress the terms of the Baseline Chapter, which states that the principal effect on erosion is caused by the initial clearing by the coca leaf or opium poppy grower. Further, both are clean crops, and therefore they generate erosion processes regardless of whether they are sprayed or not. In fact, among the farming practices employed by the coca leaf and opium-poppy growers, there is the intensive use of herbicides, which leaves the soil uncovered and exposed to erosion agents (rainwater and run-off). At all events, the additional impact of spraying of aerial spraying would be for a short time (one vegetative cycle).

*Prediction, evaluation and mitigation*

In general, the climate in which the illicit crops are grown varies from humid to very humid (in general, with more than 2000 mm of annual rainfall), for which reason the process of scarring or regeneration of the vegetation is rapid, and this holds up the advance of processes of erosion, provided that the land involved has not been the object of farming practices again.

For these reasons, which is considered that the impact caused by glyphosate spraying on processes of erosion is low and short-term (see photos 4 and 5, chapter 3).

Therefore, it is not considered necessary to pursue specific measures of mitigation designed to control processes of erosion originated by the application of glyphosate

**4.2.2. Impact on water**

*Identification*

Glyphosate spraying may affect the quality of surface water sources, deteriorating the water habitat. This is a direct, negative, very unlikely, short-term and reversible impact.

Further, the operation of bases generates domestic wastewater, and its discharge may contaminate local water sources. In this case, the impact is direct, negative, probable, mid-term and reversible.

*Prediction and evaluation*

a) Effects of glyphosate on water

A general overview of the large amount of technical information allows an opinion on the regulated use of glyphosate that offers little likelihood of contaminating water currents, as a consequence of run-off or the percolation of residues from the application of the glyphosate in the soil or on foliage.

When the glyphosate comes into contact with bodies of surface water, it immediately becomes soluble and absorbs to the sediments where it biodegrades. The period of persistence of the molecule in the sediments of surface water varies from 4 to 171 days, but its detection occurs several days after the pesticide is exposed to the medium, and the concentration tends to diminish over time.

The solubility of glyphosate in water is in excess of 30 mg/litre (1200 mg/litre), and the octanal-water partition coefficient is less than three (-2.8), and we can therefore conclude that there is no possibility that the pesticide forms bioconcentrations in fish, or transfers itself to organic matter suspended in water or sediments. Therefore, glyphosate can be considered as non-recalcitrant (Log Kow < 5), unlike aldrin, heptachlorin, chlordane and DDT.

The presence of residues is evident in significant quantities if the compound is used as an aquatic herbicide, and further, in static water sources the quantity of residues declines even faster, due to the process of adsorption of particles of matter in suspension, or at the bottom of deposits. In conditions of running water, the process is the same but the particles of the compound can be detected a good distance away downstream from the original site of treatment or contamination.

The adverse effect on groundwater depends on the mobility of the herbicide in the soil, and this is analyzed with the adsorption constants, the standardized adsorption constant and solubility of the molecule, and we describe these criteria below.

Glyphosate is adsorbed and rapidly fixed by the soil. The adsorption of glyphosate is correlated with the number of available phosphate binder sites, and seems to occur due to the binding of the phosphoric acid fraction[35].

In laboratory experiments in which glyphosate is added to aqueous suspensions in the soil, the $K_{S/L}$ absorption coefficient was 18-377 $dm^3$/kilogram in nine soils which varied from sandy-chalky to turbid (Hance, 1976), and from 33 to 76 dm3 /kilogram in three soils from sandy chalky to clay-chalky (Glass, 1987). In both experiments, the process of adsorption may be described by the Freundlich equation. Glass (1997) found adsorption values for montmorillonite clay, illite and kaolinite, of 138, 115 and 8 dm3 /kilogram, respectively[36]. The values of $K_D$ correspond to 324 for sandy-clay-chalky soils, and 600 for sandy-chalky soils.

Given the high affinity of the components of the soil, as already noted, glyphosate is almost immobile, with a minimum probability of transport through lixiviation or being dragged by run-off.

In a fine-layer chromatography of sandy-chalky soils, alluvial-sandy-chalky, it was found that glyphosate has an Rf value (mobility in the fixed phase) of between 0.14 and 0.2 (Sprankle et al, 1975), and in another study with the same types of soil, the values obtained were less than 0.2 (Monsanto Inc 1972c).

In a study of lixiviation in columns 30 cm high, with a strong flow of water of 51 cm in two days, less than 0.1 to 6.6% of the radioactivity applied lixiviated. This experiment was conducted in each types of soil which varied between sandy and chalky, with an organic matter content of 0.7%, to volcanic ash with organic matter content of 9.5%. More than 90% of the radioactivity applied was recovered from the surface layer of 0-14 cm.

The process of translocation of herbicides can take place through a number of routes, including the dragging of particles on air currents, evaporation, and to some extent in running water. However, it is known that the low vapour pressure of glyphosate means that the compound has minimal or no volatility, that percolation

[35] Weed Science Society of America, Herbicide Handbook, 7th Edition 1994. In Environmental Management Plan for the Eradication of Illicit Crops., 1999
[36] WHO/IPCS op cit.

of residues in the soil will be negligible, and that due to the great magnitude of the adsorption process and the remaining evidence available, it should be catalogued as of *very low* radicular absorption and nil mobility in the soil.

The great majority of specialists agree that the rapid process of adsorption of glyphosate particles in the soil is a comportment proper to the group of pesticides which do not have the chemical characteristics that allow them to percolate, and to eventually contaminate surface or groundwater sources, unless there is some process of de-sorption, which is very unlikely in natural circumstances.

Although the rate of degradation of glyphosate residues in water depends on pH, temperature, and the presence of microorganisms, most tropical aquatic environments that may be accidentally contaminated by the herbicide from normal dosage in plant health applications, have the ideal conditions to facilitate the process of rapid degradation and metabolized, without staying there for long enough for residues to accumulate in the tissues of fish.

Further, the effect of adsorption of glyphosate in the soil is so accentuated, and takes place in such a short time, that all tests continue to show that there is no time for lixiviation, and therefore we can state that there is very little possibility of contamination of groundwater, based on the contamination of soil.

In the case of dumping or forcible discharge of the herbicide tank from the aircraft, in a short space of time the processes of adsorption will also act rapidly, such that there will be no place for lixiviation of the product. The only difference with regard to normal spraying would be that the area and thickness of the soil affected would be slightly greater, of the order of a few centimetres, but at all events, there would be very small possibilities of contaminating water below the water table. At all events too, in the case of dumping, the contingency plan is mandatorily activated, to make a quick evaluation of the possible damage produced, and to apply deactivation measures if necessary.

Dumping on surface water is very unlikely to occur, since the pilot should, once the decision has been taken to dump the product, choose a place for dumping with a set of pre-established priorities, namely,: a plot with coca leaf, area with no vegetation, pasture, or scrub. In no circumstances should he dump the product on native forest or bodies of water. If there is an attack by an armed group, and the pilot is seriously wounded or the aircraft might be damaged and four on a body of water and the herbicide might be spilled entirely, it would rapidly be diluted in water, and the impact would depend on the flow or volume of the flow of the body of the water. In this case, the activation of the program would indicate the measures recovery measures to be taken

b) contamination due to domestic wastewater

Sewage generated by the personnel of the operations bases totals some 38 m³/day (90% of consumption). These waters are collected in the sewerage system, and treated and disposed of as follows (see Record 5).

Since the antinarcotics operations bases are in principle mobile (they must move to wherever the illicit crops are), the water from the sewerage system will be treated in a compact and equally mobile plant, with an organic load removal efficiency of 95%, and removal of suspended solids of 95%. This type of mobile plant is formed of tanks of PVC, aluminium and other metal materials, and may be assembled, disassembled and transferred from one place to another as and when needed. The effluent from the plant will be used for irrigation, or it will be discharged into the nearest surface water current with a flow of at least 10 times that of the discharge.

For these reasons, the impact of the operations base on the local water surface water system has been classified as *very low.*

*Mitigation*

The operating parameters for aerial spraying of glyphosate require that bodies of water should not be sprayed at a distance of less than 100 m, in order to avoid any direct impact on water sources. If a body of water or a fish breeding tank is accidentally sprayed, the Social Management and Compensation program provides for indemnity in the form of the compensation which the a environmental authority determines, in accordance with current law, in particular CNE Resolution 17/2001 (see Measures of Compensation, Record 9). Likewise, if the spraying takes place upstream of the intake of a water supply or tanks, the municipal authorities should immediately be advised, so that the service can be suspended until the emergency has been overcome.

In cases of dumping, as noted above, the activation of the contingency plan should in each case determine actions taken to deactivate or recover.

In order to avoid the impact on wastewater from operations bases, measures for the collection of domestic wastewater should be applied (see Record 5), along with measures to collect and handle oils and greases used in machinery maintenance (see Record 3).

**4.2.3. Impact on atmospheric resources**

**4.2.3.1. Impact on air quality.**

*Identification, prediction, evaluation and mitigation*

The volatility of glyphosate is not a significant process, if it is noted that glyphosate is a molecule with very low vapour pressure, and therefore does not vaporise, and this means that there is no possibility of it being inhaled by animals or redistributed by the air, and there is very little danger of toxicological problems in respiratory systems.

In relation to the impact caused by spraying, it should be noted that in general when an aerosol substance is released into the atmosphere, the particles may cause dispersion of visible light, and therefore interfere with the processes of light transmission (particles with sizes particles smaller than 100 μ); this process depends solely on the particle size of the substance, since the larger the size, the more rapidly the force of gravity tends to attract it.

In the case of the illicit crops eradication program, the effect which a glyphosate molecule may cause in the air is negligible, since precisely, one of the objectives of the program is to ensure that drops for effectively on the target (coca leaf crops), for which purpose they use drop sizes of 300-1500 μ, which guarantees effectiveness of application, avoids loss of the product, and so, avoid economic loss. The drop size employed in the eradication program was endorsed by ICA in August 2000.

It is also important to note that the herbicide glyphosate has low vapour pressure, and therefore does not vaporise, which means that there is no possibility that it will be inhaled by animals or redistributed by the air.

Therefore, the impact on air quality, which at all events would be limited to mixing sites, would be *very low* to *negligible,* and therefore measures for mitigation other than those of industrial safety described in Record 11 have not been provided for.

**4.2.3.2. Impact generated by noise**

*Identification, prediction, evaluation and mitigation*

Since the operations bases are close to or inside airport perimeters, they will be subject to relatively high noise levels generated by air operations. Further, the noise generated by the spray aircraft (OV-10 and T-65), is considered to be *low* and within regulatory limits, since these are small modern aircraft, which take off from the main runway and therefore do not create noise levels higher than 70-75 dB(A) on average in the base area, since they take off along the airport runways, which are generally some distance from the airport installations

Helicopters, on the other hand, can generate peak noise levels of 90-100 dB(A) in the base, this requires the use of ear muffs by ground personnel. The average by day or night is with within industrial zone norms (75dB(A)), i.e., classified as airports (Epam Ltda, 2000, based on the experience of measurements of Bogotá International airport over four years, and other airports in Colombia).

Therefore, the related impact has been classed as *low* to *moderate*

## 4.3. BIOTIC IMPACT

### *4.3.1. Impact on vegetation*

*Identification*

During spraying operations, part of the glyphosate may be dragged by the wind (drift effect) over forests or other types of vegetation adjoining the areas of illicit crops sprayed, with a greater or lesser effect upon them, depending on the quantity of herbicide which falls on them.

This section makes an evaluation of the effects on forest areas. Crop areas are discussed in as part of the socio-economic impact.

*Prediction*

Glyphosate is suitable to control many annual and perennial grass species, several broad-leaved weeds, and many shrubs and woody species in crop and non-crop areas. In many countries, application with aircraft is strongly restricted or not allowed, where there are sensitive crops in the area.

In the United States, and in many other countries, glyphosate is permitted has permits for application as a general herbicide for weed control in industrial and recreational areas, along the banks of canals, along rights of way, on golf courses, in dry channels, and with certain restrictions, and prescriptions and technical management, on many farm crops including several leguminous species (soya), to which a transgenic herbicide-resistant gene has been incorporated. In Colombia, and in all countries which produce oil palm, the use of glyphosate has been generalized since the 1980s. There are also registrations authorized for its use in several species of fruit trees, and in sugarcane as an accelerator on maturity.

a) Symptoms of the effects caused by the glyphosate in coca leaf crops

We present a synthesis of the effects caused on the coca-leaf crop, to provide easier understanding of the impact of herbicide on other types of vegetation.

Two weeks after the spraying, it will be possible to see the occurrence of the following symptoms. It should be noted that in the presence of new shoots can only occur in plants which have been treated by cutting within 24 hours, or in plants which due to failures of application or some other reason, were not covered by the glyphosate spray. The symptoms of damage are slower to appear in woody plants more than two years old.

- Foliar chlorosis
- Defoliation
- Necrosis of secondary branches
- Necrosis of main stems
- Necrosis of the roots
- Resprouting of leaves
- Resprouting of buds
- Effect on weeds
- Drift effect on the nearby vegetation.

Two weeks after the applications, there will be strong symptoms of damage to plants not subjected to cutting. After 8-12 weeks, the entire the effect must be total, and plants will show evidence of total necrosis, including their root systems.

It is possible that defoliation, as the first visible symptom of the effects, will be seen before two weeks after treatment. The initial symptoms of necrosis may also be present within 8-10 days of the treatment.

The weeds present in the soil of coca-plants are also affected by glyphosate spraying, but unlike coca-leaved plants, the population of gramineous weeds begin to show significant recovery after one or two months.

The damage attributable to drift, affecting trees close to the coca plants, is identifiable after 2-3 weeks, but has no lethal effect on most tree species. In some observations, it was possible to determine that defoliation was greater and more pronounced in a single species of Guarumo, whose leaves have a silvery colour, from the *Cecropia genus,* but after one or two months the trees recovered their foliage (Environmental Audit, 2001.

b) Natural succession

When there is an event in original piece of woodland, whether caused by man (felling) or nature (landslip, falling trees), there is a process of vegetal recuperation, a phenomenon known as succession. The first species to appear may be fungi, moss and lichen, but to the naked eye, it is the herbaceous species that count. So, Gramineae or Poaceae and the compounds of Asteraceae will be the first to cover the soil, and they have therefore been called the "Pioneer species". In a short time (2-3 months), the effect can already be seen, although some herbaceous species may come out in a few weeks.

If there are seedling trees nearby, such as guarumo (ceiba asculifolia), balsa, guamo or puntelanzas (inga spectabilis), zurrumbos (Tournefortia longiloba), tuno (opuntia rubescens) etc., the wind or some animals (birds, bats) start to scatter the fruit or seeds; the germination of the seed is quick, and the growth of the plants as well, and the average size of leaves is very large, and this produces a secondary succession. With the guarumo, there is the belief that if the seeds are scattered in the jungle, in a latent state, awaiting the arrival of considerable amounts of sunlight for germination; at all events, coverage may be produced from a single species (pure association), or several at the same at once (mixed association); in an overflight, or in aerial photographs, associations can be seen on continuous and flat treetops. In the guarumo, the whitish foliage can be detected, in the balsa (Ochroma), they are there are a large red leaves, in the guamo or puntelanza (inga spectabilis) there are medium sized reddish leaves. Photograph 6 shows a pure guarumo association, characterized by uniform flattened treetops, developed on a small plot of abandoned land, next to a plot which has recently been burned off, with remnants of patches of woodland.

It should be noted that some shrubs, creepers and palms also appear, depending on the climate. The time they take the form is also very short, growing three or ore metres per year, given the warm and humid climate prevailing.

When the smallholding, hearing or felled area is not large (1-3 ha), animals begin to scatter fruit and seeds of the original forest, under the secondary forest, and this is the longest stage of recovery of woodland, because many years must pass for the woodland to return to its primitive state (100-200 years).

Processes of plant succession in cold climates are similar to those mentioned earlier, but with other species, and in citing more difficult ways due to the terrain, which does not allow seeds to be retained for germination. In cold climates, kikuyu, ferns, (Pteridium Dicranopteris) and wild fuchsia start to provide cover, followed by croton spp, paramo bamboo, indian fig and cecropia peltata afterwards they form almost pure associations of oak, weinemannia tomentosa, melastomaceae and myrica pubescens.

In the cordillera, when the ridge or hilltop is bare of vegetation, the hillsides have no possibility of fully returning to their former state.

In practice, the appearance of vegetation depends on the situation in which the surface soil has been left after the crops. Generally, they are burnt off in order to make sowing easier and this causes many problems, such as the removal of nitrogen, the burning off of plantules, fruit and seeds already there, eliminating the composers (fungii, bacteria, and microorganisms) exposing the soil to direct sunlight and rain, the destruction of raw humus, etc. During the Environmental Audit visit, it was noted that after spraying, very small plantules appear of some herbaceous species, whose seeds have resisted burning, and the action of glyphosate (glyphosate does not affect seeds); further, it has been observed that when the crop has been covered in weeds, the effect on the surface of the soil is not acceptable; however, if the soil is burned and not turned over, the buds of the plantules and creepers sprout again, as do graminoids (grass for hay, rushes).

Fertiliser practices help abundance in the appearance of weeds, due to the nutrients that remain.

Many mammals (bats, monkeys, and others) and birds that depend on the food provided by vegetation repay this service by scattering food or seeds; some work with grassland (graminea), others with secondary woodland, and others again with primary woodland, distributed by levels or floors, since there are flowers or fruit in the layers or trunks, mainly berries, drupes or capsules.

The other element which scatters this material is the wind, for which fruit and sees seeds have wings and hairs The very small seeds are ingested and scattered directly, while medium-sized and large seeds are covered with other meaty material ingested by animals, and subsequently regurgitated or deposited without that covering.

In general, observing crops already sprayed with glyphosate and with woodland and vegetation around them, there is no marked effect on them. This means that even in the case of temporarily losing their leaves, there is no total or partial death of woodland, while this fate does occur in the foliage of graminoids (see Photographs 7 and 8).

Therefore, if a smallholder has deforested a hectare of land, it is logical to think that spraying may also affect a very small part of vegetation. 15 days after spraying a coca-leaf crop, a large number of germinated herbaceous seeds have appeared.

*Evaluation*

In view of the above, and following the observations of one of the forestry consultants in environmental audit (G. Mahecha, a forestry engineer), the impact of spraying with glyphosate on woodland vegetation can be considered to be *low-very low*, and if there is no drift, *non-existent*.

In worst case, with which there would be maximum drift, with the aircraft arriving at the frontier between the coca leaf crop and the woodland, the strip of wood land affected by temporary defoliation would be some 5m wide, which with a swathe of 50 m for an OV10 and a length of the plot sprayed of 100 m, (that is, a maximum area affected of 750 m², or 15% of the area treated). If it is considered that illicit crops in general are to be found in areas already cleared and occupied mainly with pasture, with patches of original woodland, in which the woodland does not by now account for even 20% of the total (see photos 2, 3, 4 and 5), the possible impact on woodland vegetation would not be greater than 3% of the total area sprayed. This impact at all events would not mean the destruction of woodland, but a temporary deterioration of foliage, as noted.

*Mitigation and compensation*

In principle, if spraying operations are conducted within the parameters of the Spraying Operations Management Program (see Record 1), in relation to aircraft height, airspeed dosage and drop size, hours of spraying and favourable weather conditions, the impact would be *very low* or *negligible.* Therefore, no special mitigation measures have been provided for.

For cases in which damage is caused to native vegetation, the environmental plan social management program has provided a measure of compensation, consisting of the planting of one hectare with native species for each hectare of woodland affected by the PECIG, in places indicated by the regional environmental authority with jurisdiction over the area, or payment to that authority of expenses incurred in the recovery of woodland.

Photo 6

To the left, land recently cleared to sow coca-leaf in Guaviare. In the middle, note the homogeneous Guarumo woodland, developed after the property was abandoned. On the edge of the two zones, the remains of secondary woodland can be seen.

Photo 7

Coca-leaf crop, in rectangular shapes around the remains of secondary woodland. Note that after spraying, woody vegetation shows no apparent signs of physiological damage.

Photo 8

Deforested area in the region of Guaviare. The coca crops have been indiscriminately sown in many of the smallholdings. Note the helicopter descending to inspect and verify the effects of spraying on illicit crops. The greenish colour of the land evidences the rapid recovery of herbaceous vegetation.

### 4.3.2. Impact on fauna and migrating birds

*Identification*

The deterioration of native land fauna habitat due to glyphosate spraying on their bodies, and the possible defoliation of some trees. This is an indirect, very improbable, negative, short-term and reversible impact.

As in the case of impact on vegetation, the true impact on wildlife has been caused prior to the glyphosate spraying on illicit crops, since in addition to the destruction of their habitats by slash-and-burn practices of the coca-leaf growers, one of their forms of sustenance is the hunting of wildlife. Further, the intensive use of all kinds of pesticide (not only herbicides), affects populations of insects, which occupy a very important place in the trophic chains (see Baseline)

*Prediction*

a) Land fauna

Chart 4.1 shows some environmental indicators for several groups of fauna. It can be seen that all values for average lethal doses by weight of the species is well above critical values, and this indicates that glyphosate cannot come to affect domestic species (mammals, earthworms, birds). However, for bees, it can be seen that the lethal dose in its higher limit is equal to its critical value, and therefore an analysis should be made of the exposure of this type of species to the dosage applied by the program. However, it should be noted that given that the crops which are the object of regulation (coca-leaf) are clean, and permanently fumigated to avoid attacks by pests, and the presence of insects is low.

**Chart 4.1**
**ENVIRONMENTAL INDICATORS FOR LAND ECOSYSTEMS**
**(Concentrations of glyphosate in mg/kg of body weight)**

| SPECIES | PARAMETER | VALUE OF $DL_{50}$ | CRITICAL LEVEL ** |
|---|---|---|---|
| Mammals | $DL_{50,}$oral | 4900- 5000 mg/kg live weight | 100-500 mg/Kg live weight |
| Earthworms | | 158-500 * mg/kg suelo seco | |
| Bees | $DL_{50}$ | 100 $\mu$g of activbe ingredient/bee | 50-100 $\mu$g bee |
| Birds | $CL_{50}$ | 5620 mg/kg of feed | 500-1000 mg/kg of feed |

Source: 1) Wildlife Intl. Ltd, 1978, in Estudio de impacto ambiental erradicación de cultivos ilícitos, 1998. 2) HRC, 1972, same study. *Depends on the soil in which the earthworm lives. **Critical level: value above which there are symptoms

For the analysis of toxicity in birds, values are similar to those observed for mammals, and therefore it is considered that the application of the herbicide does not represent a risk to birds. Further, if it is noted that the full application of the herbicide, through aerial spraying, put the wild birds to flight, thus avoiding any contact with the product.

It should be noted that the values of $DL_{50}$ and $CL_{50}$ for fauna are obtained through laboratory tests of acute and chronic toxicity, which would not be comparable with the probable intake of herbicides into the natural medium to eradicate illicit crops, since the dose would be minimal, and would be affected at most on two occasions for a single spraying site, over an interval of more than six months. At the same time, the compound does not present transfer into ecosystems, due to the molecule´s capacity to absorb itself into soil, water and foliage, nor is there any bioaccumulation.

If we can imagine a spraying activity which impregnates the entire body of a mammal of 12.5 kg and a bird of 50 g weight, the dose received would be of the order of 10 and 22 mg/kilogram of body weight, and the dose absorbed (2%)

between 0.2 and 0.44 mg/kg respectively. These values are lower by 25,000 and 12,488 times the lethal deals 50 doses transcribed. The same analysis can be made for other types of animals, of different heights and weights, to arrive at similar conclusions

b) Aquatic fauna

The toxicity of glyphosate for aquatic organisms corresponds to *moderate-low* intervals, as established by a range of Colombian and international agencies, both for acute and chronic exposure, to this herbicide.

According to the low coefficient of octanol-water partition (very soluble in water), it is very unlikely that glyphosate will bioaccumulate in aquatic animal and vegetal l tissues.

Aquatic ecosystems, like land ecosystems, are not susceptible to bioconcentration in fish and algae, due to the constant values of solubility and the octanol-water coefficient of the glyphosate molecule.

The transfer capacity of water to soil is very low, due to the high solubility of the compound in water. Transfer of water to air may be very large, due to the high vapour pressure of the pesticide, although the solubility of the molecule in water will be dominant, since it is greater, and does not allow for volatilization of the herbicide.

If we consider the total spraying of a body of water under PECIG conditions, the maximum concentration produced will be of the order of 3.74 mg/litre, which are values lower than lethal concentrations $CL_{50}$, and the critical levels indicated in Chart 4.2.

Chart 4.3 shows the comparison of toxicity data for glyphosate, according to several Colombian and international agencies. It can be seen that the toxicity levels for birds (>2.500 mg/kg) are very much higher than the levels potentially caused by maximum exposure to spraying with glyphosate (0.45 mg/kilogram). The same can be said for fish (15-26 versus 3.74 mg/litre, respectively).

**Chart 4.2**

**ENVIRONMENTAL INDICATORS IN AQUATIC ECOSYSTEMS**
**(Concentrations of glyphosate in mg/l in water)**

| SPECIES | ÁRAMETER | VALUES (MG/L) | CRITICAL LEVEL (MG/L) |
|---|---|---|---|
| Fish | $CL_{50}$ (96hours) | 2,4 – 34 | 5-10 |
| Algae | $EC_{50}$ (48 hours) | 2,4 | 5-10 |
| Dapnia pulex | $EC_{50}$ (96 hours) | 19 | |
| Dapnia magna | $EC_{50}$ (96 hours) | 24-37 | |

Source WHO, 1994, Environmental Health Criteria No 159. Geneve.

These data can be extrapolated to fish-breeding pools, since in commercial breeding, which does not exist in the PECIG zone, and in any case, they form part of activities excluded from spraying; and the water will be permanently renewed in flows which depend on each species. The trout, for example, which is common in the opium-poppy growing zones, is a fish which has a high demand for oxygen, and this means that the water in the pools needs to be constantly renewed.

*Evaluation and mitigation*

This means that exposure of land fauna and aquatic fauna to aerial spraying with glyphosate, using the volumes employed in the PECIG, will be much lower than any dosage which could cause any damage or discomfort.

Similar results have been found in a number of items of research on subchronic and chronic toxicity, and in studies of carcinogen factors, with experiments on mice and dogs, given high-glyphosate diets (between 20,000 and 50,000 mg/kg for rodents, and 500 mg/kg of body weight for dogs). No effects were detected in relation to these doses applied for several weeks. The same situation was observed with very high AMPA dosage, AMPA being the principal metabolite of deficit (Williams G. M., Kroes R and Munro I. C., 1999)

The US- EPA, in a rating of A-E, classified the carcinogenic risk of glyphosate in humans and animals as Category E "evidence of non-carcinogenicity in humans".

Therefore, the impact of glyphosate and its metabolites on land and aquatic fauna can be said to be low, especially at the levels of exposure involved with PECIG, which are far lower than the doses employed in laboratory experiments. There has therefore been no consideration of special measures of mitigation for land and aquatic fauna in glyphosate spraying areas.

**Chart 4.3**

**COMPARISON BETWEEN DATA OF GLYPHOSATE TOXICITY ACCEPTED BY SEVERAL INTERNATIONAL AGENCIES FOR RISK EVALUATION**

| . | FAO | IPCS | EPA | WSSA | Health Ministry |
|---|---|---|---|---|---|
| Acute toxicity | | | | | |
| DL50 oral mg/kg | >5000 | >5000 | >5000 | 5600 | >5600 |
| DL50 cutaneous mg/kg | >17600 | >5000 | >5000 | >5000 | >5000 |
| DL50 inhalation mg/kg (1) | >3.18 | >3.5 | >3.5 | >3.2 | >5.48 |
| Skin irritation | Nine | None | None | None | None |
| Eye irritation | Moderate/severe irritation | Slight/moderate irritation | Slightly irritating formulas | Slightly irritating | Irritating |
| Sensitization of skin | No | No | No | No | No |
| Subacute toxicity | 1267mg/kg | 1267mg/kg | 4320mg/ | >1400mg | >1400 |

| | | | | | |
|---|---|---|---|---|---|
| NOEL (2) | | | kg | /kg | mg/kg |
| Chronic toxicity NOEL (3) | 310mg/kg | 410mg/kg | 410mg/kg | 400mg/kg | 362mg/kg |
| Carcinogenicity (4) | No | No | No | No | No |
| Teratogenicity (5) | No | No | No | No | No |
| Genotixicity/Mutagenicity (6) | Not mutagenic | Not mutagenic | Not mutagenic | Not mutagenic | Not mutagenic |
| Toxicity in birds | >2500mg/kg | >2500mg/kg | >2500mg/kg | 960mg/kg | 960mg/kg |
| Toxicity in fish | 12-26mg/L | 14-33mg/L | 15-26mg/L | 86mg/L | |
| Toxicological category | NA | NA | III | NA | IV |

(1) Applicable to glyphosate and commercial formulations as salts, corresponds to that used in PECIG
(2) Without observable adverse effect
(3) Without observable adverse effect
(4) Capacity to produce cancer
(5) Production of congenital malformation
(6) Toxicity in the genome in the form of mutations and malformation of chromosomes

NOTES

1. The spraying mixture used in PECIG contains 10.4/ha Roundup Ultra, 0.24/ha Cosmoflux 411F and 13.2/ha of water. Roundup Ultra is called Fuerte in Colombia (Licence ICA 2475) and contains 360g/of glyphosate as acid equivalent and 180g/ of POEA
2. POEA: ethoxylated seboamines, This analysis takes the greatest concentration existing in Roundup formulations
3. Dose received by a human of 65-70kg weight with a body surface of 1.73sq.m. (Harrison´s Principles of Internal Medicine, 13th ed 1991) as if totally impregnated with spraying mixture.
4. Of one dose of glyphosate administered on the skin, the average maximum absorption is 2% (Talbot et al 1991 in Williams Kros and Munro, December

1999) For a dose of POEA administered on the skin, average absorption is 10% (Martin 1999 and Lundhila et al 1992 in Williams Kros and Munro, December 1999). For Cosmoflux 411F and the spraying mixture, it is assumed that the entire dose is absorbed through the skin.

5. Calculations suppose that water is still or stagnant (tanks, pools etc.)
6. It is assumed that the dose is sprayed onto a Record of water of 1 sq.m. 10cm deep equal to 100/water
7. Internal dose. Amount of the dose ingested which is absorbed. For glyphosate and Roundup formulations, this is 36% of the dose administered (Talbot et al 1991 in Williams Kros and Munro, December 1999)
8. Oral DL50 for Roundup formulas is 184ml (Talbot et al 1991 in Williams Kros and Munro, December 1999) DL50 for glyphosate as acid equivalent and POEA are calculated on the basis of the composition of the commercial formula used
9. Not all the dose applied reaches the bare earth, only 10% reaches the ground in a coca-leaf plantation, the other 90% is retained by the coca foliage.
10. NOEC: No Observable Effect Concentration for earthworms over 14 days exposure (IPCS Environment Health Criteria No. 159 Glyphosate, 1994

ACRONYMS

FAO United Nations Food and Agriculture Organization

LPCS International Program for Chemical Safety (FAO/WHO/UNEP/ILO)

EPA: US Environmental Protection Agency

WSSA: Weed Science Society of America

| **MAXIMUM RISK OF DOSES USED IN PECIG** | | | **Reference levels** |
|---|---|---|---|
| Adult weighing average 65kg | | 9.95 mg/kg | LD50>5000mg/kg live weight |
| Water surfaces (lakes, rivers, streams) | 4.74mg/L | 100mg/L | Fish |
| . | | 8mg/L | Algae |
| . | | 780mg/L | Dapnia |

## 4.4. SOCIO-ECONOMIC IMPACT

### 4.4.1. Impact on public health

*Identification*

During spraying operations, it is possible that part of the herbicide may fall on people who are accidentally working on illicit crops, or who are close to flight swathes, and this may eventually affect health. This is a direct, very improbable, negative, short-term and reversible impact

*Prediction*

The effect which contact with pesticides may have a human being is based on the analysis of the capacity of the compound for:

- Carcinogenic consequences;
- Effects generated by ingestion; and
- Effects generated by exposure through the skin, determined by sensitization to the product

These effects are determined by comparison of lethal dosage or concentration LD50/LC 50, which are classified depending on the effects of a herbicide dispersed in the environment, and tested through exposure on animals.

a) Carcinogenic effect, teratogenesis, oncogenic effect and delayed neurotoxicity

The value of LD50/LD LC 50 is the quantity of the substance which causes death in 50% of our test animals after a given period of exposure. The smaller the LD50/LC 50 number, the more toxic the compound. As stated earlier, US- EPA classifies pesticides acute toxicity in four categories, in descending order (A-most toxic and E-least toxic). Glyphosate is categorized E in the EPA scale for acute oral toxicity based on controlled tests on rats. The results of other types of crops toxicology confirm the result obtained for rats, and support the categorization of the herbicide as non-carcinogenic in humans.

**Chart 4.4**

**CLASSIFICATION OF US EPA**

| CATEGORY | DESCRIPTION |
|---|---|
| A | Human carcinogen |
| B | Probable human carcinogen |
| C | Posible human carcinogen |
| D | Not classifiable as a human carcinogen |
| E | Evidence of non-carcinogenicity for humans |

** Glyphosate is classed “E”

The analysis of the various studies on the adverse effects of acute and chronic intoxication made by a large number of official and private agencies was the technical basis for US-EPA to classify glyphosate in a category which includes pesticides for which no substantial evidence has yet been found of carcinogenic effects on human beings. Further, there are also technical reports in relation to the lack of occurrence of birth defects in rats and rabbits subjected to oral administration during pregnancy, using doses which were sufficient to cause certain adverse effects on pregnant females.

There are reports on studies related to the supply of contaminated food over three generations, in male and female rats, with subacute dosage of deposit. The results of these tests did not show any effect on the reproductive capacity of either sex. Other studies, and standard tests designed to identify eventual genetic changes in animals and animal cells, and in certain bacteria, were also negative.

To cite only a few case studies, it can be said that one of the most recent glyphosate toxicity tests, lasting 13 weeks, in which oral doses were administered to between 5.6 56 mg/kg of glyphosate, carbon-14 marked, to 344/N male rats, to evaluate the process of the elimination of biocide and any symptom of mutagenesis, the results of radioactivity tests on blood, urine, fecal material and tissue samples indicated that before 72 hours after treatment, 20%-30% of marked glyphosate was eliminated in urine, and 70%-80% in feces. Only about 1% of radioactivity remained in the tissues. Subsequent studies after oral demonstration oral, intravenous and intraperitoneal administration shows that radioactivity measured in the urinary tract represented the quantity of glyphosate absorbed, and that average fecal radioactivity measured the fraction not absorbed in the intestinal tract.

In a 13-week study, groups of 10 males and 10 male and female rats 344/N, and B6C3F mice were organized, and administered dosages of zero, 3125, 6250, 12,500, 25,000 and 50,000 ppm of glyphosate in their food. The administration of the toxic substance induced increased acidity in bile serum, and increases in alkaline phosphatase, and in the activity of a alanine aminotransferase in rats, and all this was interpreted as a consequence of slight toxicity in the hepatobiliar system.

No histopathological lesions were observed in rat or mouse livers, and was no evidence of the adverse effects on their reproductive systems, though it is possible to detect certain cytoplasmic alterations in their submandibular salivary glands in rats, and in the parotid salivary glands of mice. The effects of glyphosate on salivary glands could be shown to be related to an adrenergic mechanism, but this could be blocked by the use of propranolol androgenic antagonist.

Other studies related to do the same purpose accumulated evidence that glyphosate did not cause mutagenic effects in Salmonella, and did not induce micro-nucleation effects on rats or mice. Further, the "non-observable adverse effects level" (NOAEL) for salivary glands was 31.127 ppm in mice diets. In this study, however, it was not possible to determine whether NOAEL was the same for rats.

* *

The above studies, and several up-to-date publications on the matter, in confirm the information held, to the effect that despite the existence of certain contradictory results (explainable in some cases), the great majority of experimental evidence shows little possibility that contact, inhalation or ingestion of glyphosate residues in normal conditions of phytosanitary treatment, could be the precursors of teratogenic or carcinogenic effects, or that it would accumulate in adipose tissues.

Although for some time there was concern that the metabolization of glyphosate could cause the formation of nitrosamides, which are known between induce mutagenic, carcinogenic and teratogenic effects, or sudden acute intoxications, these concerns have been groundless so far, if we note that no research has proved the formation of any metabolite of the nitrosamide group.

b) Ingestion

Symptoms and effects which ingestion of the herbicide may generate vary depending on the quantity of pure herbicide ingested.

- No symptom, with ingestion of 5-50 mL
- Slight symptoms with nausea, with ingestion of 50-150 mL
- Moderate symptoms, with erosion of the gastrointestinal tract, 200-500 mL
- Serious symptoms, with difficulties in swallowing and gastrointestinal hemorrhage and may be presented with intoxication is, that is, consumption of more than 500 mL.

Ingestion of large amounts of glyphosate for purposes of suicide may produced serious effects, such as severe hypertension, kidney failure, and in some cases, death (Sawada et al 1988; measures et al 1999; Tominak et al 1991; Temple and Smith, 1992). According to the studies, death supervened in some cases with ingestion of 206 and 263 mL. Nonetheless, the voluntary ingestion of glyphosate for the purposes of suicide would not be an impact attributable to PECIG. Nor is it to be expected that there will be cases of accidental ingestion, because the product is transported and stored in 55 gallon drums. Within that, a person cannot fall or drown, for example. These data indicate that acute toxicity by glyphosate is low in humans, and is in accordance with the results obtained with rats.

In the volume of Attachments, there are the opinions of the Ministry of Health in the toxicological classification of glyphosate.

c) Contact

According to the study made by Shelansky (1973), exposure to glyphosate in the normal spraying solution (0.9% of glyphosate as an IPA salt, IPAG) or higher (4.1% IPAG), did not produce skin irritation. Mailbach (1986) evaluated glyphosate along with other products currently used in the home, and found that the glyphosate herbicide and Johnson & Johnson baby shampoo had a lower potential irritation than dishwashing liquid or detergent. Glyphosate produces a slight irritation in some individuals after the application of concentrated product directly on the skin over 24 hours.

d) Occupational exposure

Jauhiainen et al (1991), when comparing the data of morbidity among farmworkers exposed and not exposed to glyphosate in California, found no effect on hematology, clinical chemistry, ECG, pulmonary functions, blood pressure or heartbeat, one week after application. With the data from California, Pease et al (1993) found that glyphosate products were the third commonest cause of skin and eye irritation among farmworkers, and ranked 15th for systemic and respiratory symptoms, although the use of glyphosate ranked 12th in the list of irritation symptoms reported. Nonetheless, it is clarified and number of cases reported is only a reflection of the greater use of the product compared to other herbicides. Despite the widespread use of herbicides in California among workers and housewives, 25% of conditions reported due to exposure of glyphosate, only 13 are considered to be definite or probable, and of those, 11 showed only slight and reversible and irritation of the eyes; the other two were for headaches, and an exposure to a solvent hydrocarbon.

Acquavella et al (1999) in a study of 1513 cases of herbicide exposure reported by the American Association of Poison Control Centers (AAPCC), found that 21% presented no lesions, and 70% had only transitory ones, and no exposure reported affected the structure or functions of the eye.

e) The situation in Colombia

According to a recent study by Clinica Tpoxicologica Uribe Cualla S.A. in the town of El Tablon (Nariño 2001), is based on 29 cases examined at the Aponte health post between July 2000 and February 2001, of which 21 and had a clinical history. It was found that the great majority of cases showed no causal nexus between public health problems reported and the aerial eradication of glyphosate. He clinical reports were made either before or substantially after each spraying (12 cases). Of the few cases which occurred during or shortly after spraying (7) almost half (3) reflect common endemic and conditions in this area which lives in conditions of poverty, and were not caused by exposure to herbicide (they were bacterial or parasite infections), and only 4 cases did symptoms begin during or after spraying, although none serious, and evolution treatment followed the origins given to infections and other causes. The other clinical histories and religion glyphosate at all levels of exposure at all, and reflect completely different diagnoses.

*Evaluation*

Chart .4.5 shows a summary of the valuation risks due to glyphosate exposure in PECIG. The following should be noted:

The absorption from the skin is 25,000 times less than that required for DL 50, in the case of an individual and 60 to 65 kg, impregnated with glyphosate concentrations employed in PECIG. For POEA the ratio is 2,530 times less, and for Cosmoflux, it is of the order of several million times lower.

- In the case of all ingestion through sprayed water, ingestion is 49,067 times less than CL50 for glyphosate, 17,711 times less for POEA and 10 million times less for Cosmoflux.

- In the soil, the concentrations on the upper layer at 10 cm depth are 112 times less than those established by the NOEC standard.

**Chart 4.5**

**SUMMARY OF THE PANORAMA OF HEALTH RISKS DUE TO AERIAL SPRAYING WITH GLYPHOSATE.**

| TOXON | DOSE APPLIED (mg/ ) | DOSE PER SURFACE UNIT (mg/m$^2$) | DOSE PER BODY WEIGHT (mg/kg). P=65 kg | DOSE ABSORBED (mg/kg live) P=65 kg | $DL_{50}$ (mg/kg) | PECIG vs $DL_{50}$ (P=65 kg) |
|---|---|---|---|---|---|---|
| **EXPOSURE THROUGH SKIN** | | | | | | |
| Glyphosate | 158,26 | 374 | 9,95 | 0,2 | 5.000 | 25.000 times less |
| POEA | 79,13 | 187 | 4,98 | 0,498 | 1.260 | 2.530 times less |

| | | | | | | |
|---|---|---|---|---|---|---|
| Cosmoflux 411 | 0,00845 | 0,02 | 0,000532 | 0,000532 | 2.000 | 3.579.398 times less |
| **EXPOSURE THROUGH ORAL DOSE** | | | | | | |
| **TOXON** | **CONCENTRATION IN SPRAYED WATER (mg/l)** | | **INTERNAL DOSE (mg)** | | **$CL_{50}$ (mg)** | **PECIG VS $CL_{50}$** |
| Glyphosate | 3,74 | | 1,35 | | 66.240 | 49.067 times less |
| POEA | 1,87 | | 1,87 | | 33.120 | 17.711 times less |
| Cosmoflux 411 | 0,0002 | | 0,0002 | | 2.000 | 10.000.000 v. menor |
| **EXPOSURE IN SOIL** | | | | | | |
| **TOXON** | **DOSE APPLIED ($mg/m^2$)** | **QUANTITY ON BARE GROUND ($mg/m^2$)** | **DOSE RECEIVED IN SOIL AT 10 CM (mg/kg).** | **DOSE RECEIVE D IN SOIL AT 5 CM (mg/kg)** | **NOEC (mg/kg )** | **PECIG VS NOEC (10 CM PROF.)** |
| Glyphosate | 374 | 37,4 | 1,41 | 2,82 | 158 | 112 times less |
| POEA | NC | NC | NC | NC | NC | NC |
| Cosmoflux 411 | NC | NC | NC | NC | NC | NC |

Source: DNE, 2001, NAS-PECI. The basis of estimates is the same as for Chart 4.3 above

The values and comparison shown above another conclusion that the impact on human health for persons accidentally sprayed with glyphosate is low.

*Mitigation*

nonetheless, it is thought necessary to pursue a set of preventive measures designed to inform people inhabiting the areas under an illicit crops, about PECIG and about the measures to be taken in the event of aerial spraying (see Educational Communications program, Record 10). At the same time, the intention is to pursue a program of follow-up and epidemiological research of conditions possibly linked to glyphosate in spraying zones, in accordance with the terms indicated in the Social Management and Compensation program (see Record nine), and to take actions to pay compensation where it can be shown that there was a causal relationship between the spraying and health.

Further, it is recommended that immediately prior to spraying operations, a helicopter make a warning pass over the plot to be sprayed, in order to ensure that people are warned to leave the illicit crop area, and therefore reduce the number of persons exposed (see Spraying Operations Management Program), Record 1)

In the public environmental education workshops in the education program communications program, people should be taught to take emergency measures if they are sprayed with glyphosate, such as washing their bodies and heads with plenty of soap, changing their clothes, and so on. Similarly, in relation to tame animals such as horses, cows and dogs. Also, people should be taught ways to deactivate glyphosate in the soil or water, (with absorbent material, urea, etc, as described in impact on soil and water in this chapter, and in the Records on Glyphosate Handling at Bases (see Record 2), and the Handling of Wastewater (see Record 5).

**4.4.2. Impact on agricultural production and livestock**

*Identification*

During spraying operations, part of the glyphosate may be dragged by the wind (drift effect) over cultivated areas adjacent to the illicit crops sprayed areas, having a greater or lesser effect on production, depending on the quantity of herbicide which falls there.

*Prediction*

The impact of spraying with glyphosate on legal crops in plots adjacent to those sprayed varies depending on the type of crop. On an herbaceous and crops and pasture, the effect is similar to that on the illicit crop, that is death of the plant. However, on shrub or tree-type crops, the effect may vary as a function of the dose received.

Spraying operations contemplate a series of parameters, designed to reduce or eliminate the drift effect, particularly, altitude of flight, airspeed, and safety strps around the plant cover other than the illicit crops themselves (see Chapter 2: "Description of the Program").

At all events, although the plant or crop may survive spraying by glyphosate, there is damage due to possible effects on the crop, however slight.

In effect, commercial and subsistence crops in representative areas were illicit crops are to be found have particles of herbicide which are transferred through the phloem and cannot begin eliminated. Further, it is considered that the impact on people who ingest leaves, roots, and grains of these crops will have no effect on health.

In order to discover or evaluate the impact, account should be taken of the following:

- Residual energy of the herbicide components (see impact on soil)
- Degradation (see impact on soil)

Photo 9

Cold climate clean crop area. The opium-poppy is sown in between potato, peas and other crops.

Photo 10

Crops intercalated with opium poppy and other crops proper to cold climates. The integrated crops are a way of preventing the authorities from detecting and eradicating the illicit crop with glyphosate.

- Toxicity
- Tolerance to toxicity (permitted levels)
- Average and lethal doses (see impact on fauna and health))
- Accumulation in plants, soils and man (see impact on soils, water, fauna and health)

In relation to toxicity, the establishment of tolerances of residues in materials used for food may be standardised, following general parameters suggested by WHO and the FAO Codex Alimentarius, but in the last instance, it is the authorities of each country that will adopt certain "variations" on values suggested, for different reasons, including the feeding habits of the country, and agreements or demands of the market for export products.

As an example of the foregoing, we could mention US-EPA, which on its own initiative and in concordance with FFDCA standards has set a number of combined tolerances of residues in the parental product and in the glyphosate metabolites (N-[phosphonomethyl]Glycone) in dried peas, shelled peas, hay, grass in silos, lentils and kidneys (of cows, goats, horses or sheep), in the magnitude of 5, 60, 200, 90, 5 and 4 ppm respectively. These tolerances, however, EPA itself has said, will be reviewed, and will subsequently expire.

The value of the EPA tolerances is the "legal limit permitted for the presence of residue of a chemical pesticide in or on a given food", and only if this Federal agency establishes that this value is "safe", meaning that "there is a reasonable certainty that there will be no resulting damage due to the aggregate exposure to the residues of a chemical pesticide, including in advance, all dietetic exposures and all other exposures on which reliable information is available". This condition includes exposures coming from drinking water in residential estates, but excludes those corresponding to occupational exposure.

In the US regulations related to the allocation of tolerances to the various biocides, it is also stated that the EPA must afford special considerations to the exposure of babies and children to residues of chemical pesticides, and that it "the sure that there is reasonable certainty that babies and children will not suffer damaging damage due to exposure to the residues of a chemical pesticide".

In summary, it can therefore be said that glyphosate has several tolerances for different food substrates for a defined period of time, and subjects depending on the circumstances, the constant review.

Further, the experience in areas visited during the Environmental Audit showed that the re-installation of new crops on plots treated in a few weeks before with a dose of 4.8-5 kg/ha (10-10.6 L) is successful, which is a decisive evidence that the herbicide does not disable the land from being used for new crops. It is calculated that after 9-18 months, depending on manner and timing of the sowing, the harvesting process can begin. If the new crops, have been subjected to pruning immediately after the application of the herbicide, the recovery period may be less than six months.

One way of avoiding the control of illicit crops by glyphosate spraying, common among subsistence farmers, is to sow them intercalated with legal crops (plantain, in the case of coca-leaf; potatoes, peas and others in the case of the opium-poppy). In these cases, there is no control of glyphosate spraying, and therefore no impact (see Photos 9 and 10).

*Evaluation*

As a consequence of the foregoing, and following the observations of Forestry Engineer G Mahecha (this study), the impact of glyphosate spraying on crop vegetation can be considered low, and if there is no drift, non-existent.

In worst case, in which there was maximum drift, with the aircraft reaching right to the line between the coca leaf and the illicit crop, the stripof crops affected would be 5 m wide, and this, with a swathe of 50 m and a spraying length of 100m, would represent an affected area of a maximum of 750 m², that is, 15% of the area treated.

*Mitigation*

In Record 9 (Social Management Program), there is provision for means of measurement of compensation, consisting of an estimate and payment of all damage or loss caused to legal crops affected, and indeed, this measure has already been regulated in CNE Resolution 017/2001.

### 4.4.3. Impact on human settlements and migration

*Identification*

It has been frequently noted that aerial spraying with glyphosate generates displacement of growers to increasingly remote areas, thus adding to the deforested area in tropical and high Andean forests. This is an indirect impact, which is very unlikely, negative, and medium-term.

*Prediction and evaluation*

Chart 4.6 and Figures 4.1 and 4.2 show several aspects which contradict the theory that glyphosate spraying encourages the growth of illicit crops.

- It can clearly be seen that the spraying comes after the crops, that is, that the greater the area of illicit crops that are, the greater the effort in glyphosate spraying

- Nonetheless, as in 1998, although the area sprayed was smaller, the area under cultivation had its greatest increase.

- In consequence, the fact that up to 1998 there was a linear relationship between the area under cultivation in the area sprayed, this does not mean that the area sprayed makes the area under cultivation increase, but the opposite.

- The correlation is shown in Figure 4.2 corroborates this, and allows the appreciation that although the two variables are related, spraying does not necessarily explain the growth in the area under cultivation.

Further, the important migrations which have taken place towards the areas of illicit crop growing, especially in the Amazon basin, are prior to the time at which spraying began, as explained in the Baseline chapter. The illicit crops are in general not to be found in the middle of the jungle, but mostly where there was already some settler activity which was more or less consolidated.

*Mitigation.*

The control over illicit crops may rather be a way to reduce the attractions of the zones of the Amazon and Orinoco basins for poor settlers from the rest of the country

Nonetheless, it would be necessary to act in parallel with the repressive work of the State, to pursue programs from alternative development and infrastructure work and public services that could give different economic options to the local population.

This is the reason for the emphasis placed in the Social Management and Compensation Program, in relation to this Environmental Management Program (EMP), that the action of the eradication should be coordinated with interventions designed to improve the socio-economic conditions of the local population, and to create alternative sources of income.

The social management program in this EMP establishes a series of activities to promote this type of support for alternative development

### 4.4.4. Cultural impact

#### 4.4.4.1. Impact on indigenous communities

PECIG does not generate negative impacts on indigenous communities. On the contrary, by combating illicit crops that have been shown to have a major impact in deforestation and destruction of the cultural values of these communities, what PECIG does is to try and preserve systems from which they depend, and to reduce the processes of territorial occupation.

### 4.4.5. Other impacts

PECIG will generate other additional are other impacts in addition to those analyzed, particularly on employment, infrastructure and transport, and long-term farming production. In all cases, these are positive forms of impact, although due to the dimensions of the bases and their activities, they will be *low* to *very low.* Nonetheless, the operational planning activities for spraying, and above all, the coordination with development agencies pursuing activities of promotion in the PECIG target areas will have positive long-term effects.

**Chart 4.6**

**EVOLUTION OF AREAS CULTIVATED UIT ILLICIT CROPS AND SPRAYED**

| | COCA | | OPIUM-POPPY | | MARIHUANA |
|---|---|---|---|---|---|
| Year | Area cultivated (ha) | Area sprayed (ha) | Area cultivated (ha) | Area sprayed (ha) | Area sprayed (ha) |
| 1990 | 40.100 | 760 | 1.500 | 0 | 36 |
| 1991 | 37.500 | 459 | 2.900 | 1.497 | 7 |
| 1992 | 37.100 | 944 | 20.000 | 12.864 | 100 |

| | | | | | |
|---|---|---|---|---|---|
| 1993 | 39.700 | 846 | 7.500 | 9.821 | 138 |
| 1994 | 45.000 | 4.904 | 6.800 | 5.314 | 14 |
| 1995 | 50.900 | 25.402 | 2.180 | 5.074 | 36 |
| 1996 | 67.200 | 23.025 | 2.100 | 7.411 | 37 |
| 1997 | 79.500 | 44.123 | 2.200 | 7.333 | 261 |
| 1998 | 101.800 | 69.155 | 2.033 | 3.077 | 18 |
| 1999 | 160.119 | 44.195 | 6.500 | 8.434 | 9 |
| 2000 | 163.289 | 61.573 | 6.200 | 9.329 | 122 |

Source: CNE, DNE, DIRAN, 2001

* * *

**4.5. General Summary**

figure 4.3 shows a reduced matrix of environmental impact..5.1 in chapter 5 shows a summary of impacts, as being analysed in this chapter.

Following the above, PECIG in general has a low environmental impact, and to a great extent, a positive one.

This situation is intimately related to the following facts.

PECIG seeks to detain the process of deforestation of humid and very humid forests in Colombia, and high Andean woodland, by discouraging and persecuting the most important factor in this environmental problem, which is illicit crops.

In this process, the spraying of illicit crops may generate some impacts on forests adjacent to those crops, but that impact will be of very small and unimportant, as is shown in this EMP. Further, where these impacts occur, they will be properly compensated by the environmental authorities.

International scientific literature and Colombian experience in the use of glyphosate in legal plantations shows that the herbicide degrades rapidly in soils and water, it is not bio-accumulative, and the concentrations which it may reach in trophic chains as a result of spraying are well below the limits established by Colombian and international authorities as being levels at which some type of significant damage can be caused to land and aquatic fauna and human health. US-EPA has accepted, based on available research, that glyphosate is not carcinogenic or teratogenic, and is not a cause of delayed neurotoxicity in humans or animals.

The environmental management which will be given to the Program, which provides for the exclusion of zones in the Nature Parks system, bodies of water, human settlements and areas of economic interest, as well as buffer areas with respect to the same elements and areas of vegetation other than illicit crops. Likewise, the program provides a set of operating procedures to reduce impact due to spraying procedures to a minimum, along with activities for herbicide the management of the herbicide at operational bases, and other elements or activities which might generate environmental impact.

In this general context, the most important and numerous environmental impacts of the project are caused by two activities: glyphosate spraying on illicit crops, and handling at operations bases (storage, mixing, equipment maintenance, and aircraft)

The main negative impacts of falls on legal crops which might be sprayed by because they are very close to the illicit crops, and on woodland in the same situation. Nonetheless, given the technical and operational specifications and security measures taken at antinarcotics bases, the importance of this impact is considered to be low. It is also important to note the possibility of attacks on bases and aircraft by the armed groups.

Further, the Program will have an undoubtedly positive impact, in particular in discouraging deforestation to make way for illicit crops; and the contamination generated by the drug trafficking industry in those areas is responsible for contamination by pesticides which have not yet been sufficiently evaluated.

If we analyze the problem of illicit crops as a whole, in the light of current Colombian regulations which catalogues them as a crime, in the light of Colombia´s international commitments, in the area of control and production and trafficking in drugs, and of the environmental impact environmental and sociocultural impact of the same – of the size that drug-trafficking has caused and continues to cause, particularly in Colombia's most fragile ecosystems, such as the humid and very humid tropical forests and Andean woodland, we can conclude that, without a doubt, the eradication of the illicit crops by aerial spraying with glyphosate is a measure for mitigation of the environmental impact of drug trafficking.

The matrix presented in Figure 4.3 summarizes the situation described in visual terms. The total of 43 identified impacts, 23 are negative and 20 are positive. Of the 23 negative impacts, 15 have very low importance, 6 have low importance, and only 2 have moderate importance -and these two are both linked to the noise generated by aircraft and helicopters used at the operations bases.

Of the 20 positive impacts, 8 had insignificant importance, 9 have very low importance, and only 3 low importance.

Of all the impacts, 27 are medium and long-term (green), although they basically refer to socio-economic impacts. The others are short-term, that is, they the action is visible only for a few days, or weeks, or in worst case, months.

**SUMMARY MATRIX OF ENVIRONMENTAL IMPACT**

PECIG

| | | | | 1. Detection of illicit crops | 2. Operations planning | 3. Spraying | 4. Evaluation of operations | 5. Operations at DIRAN base | 6. Transport of glyphosate | 7-. Storage and mixing | 8. Equipment and aircraft maintenance |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Environmental resources and media | Physical medium | Earth | Soils | | | -1 | | | | | |
| | | | Morphodynamic processes | | | -2 | | | | | |
| | | Water | Water availability | | | | | | | | |
| | | | Water quality | | | -1 | | | | -1 | -1 |
| | | Air | Air quality | | | | | -1 | | -1 | -1 |
| | | | Noise | | | | | -3 | | | -3 |
| | Biotic medium | | Vegetation | | | -2 | | | | | |
| | | | Land fauna | | | -2 | | | | | |
| | | | Aquatic fauna | | | -2 | | | | | |
| | Socioeconomic medium | Social | Public health | | + 2 | -2 | | | | | |
| | | | Employment | +1 | +1 | +1 | +1 | +1 | +1 | +1 | +1 |
| | | | Human settlements, migrations | -1 | -1 | -1 | -1 | -1 | -1 | -1 | -1 |
| | | Economic | Infrastructure, traffic | | +2 | | | | +1 | | |
| | | | Agricultural productionagropecuaria | | +2 | -2 | | | | | |
| | | Culture | Cultural values | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Medium/long term impact

Short-term impact

Negative impact -

Positive impact +

Importance of impact

0 = Negligible
1 = Very low
2 = Low
3 = Moderate
4 = High
5 = Very high

Note: When the text speaks of very low, low, moderate, high or very high impact, it refers to the importance of the impact, the term "negligible" means "insignificant".

[CHAPTER 5]

# 5. ENVIRONMENTAL MANAGEMENT PLAN

## 5.1. Objectives

The Environmental Management Plan (EMP) is designed to integrate the conservation and defence of the natural and social environment into the various activities involved in planning, operations and follow-up of PECIG.

The objective is to be reached through three types of complementary mechanisms.

- Through the integration of specifications of environmental management into the execution of each and every activity proper to the program (operations management). Integration of these environmental specifications implies no additional costs to the Program, but considerable savings in the cost of possible impacts. In this case, the Program seeks to respect the buffer strips, and adopt operational parameters which will reduce the possibilities of drift affecting third parties, and ensure that that aerial spraying take place at certain times, when convective currents are not at their maximum, etc.

- Through activities complementary or additional to those of the program, designed to mitigate or reduce the intensity of environmental impact which is impossible to avoid, or with which there would be no Program at all (mitigation or correction).

- With compensatory action, designed to compensate residual impact, in order to make the project socially viable. This type of action is directed to areas which suffer from the problem of illicit crops, and which such, receive some form of impact from PECIG.

Chart 5.1 gives a summary of the environmental impact of PECIG, as analyzing the documents, with the measures for the management and follow-up recommended.

## 5.2. STRUCTURE OF THE ENVIRONMENTAL MANAGEMENT PLAN (EMP)

As a consequence of the foregoing, the EMP-PECIG covers three types of activity, all complementary to each other; measures for environmental management inherent in the course of the program operations (preventive) and measures to mitigate inevitable environmental impact, and measures related to making the program socially viable (compensation) (Figure 5.1)

**5.2.1. Operations management: prevention measures**

Aerial spraying of glyphosate on illicit crops and operations to handle herbicide at the operations base involves a series of specific operations, each employing a well-defining technology in the field of aerial navigation, aerial spraying, storage and transport of the herbicide, and the preparation of mixtures, amongst others.

The activities which generate the greatest physical, biotic and socio-economic impacts of those which relate to the spraying of deficit on unlawful on illicit crops, and the handling of deficit and its containers or residues at operations bases.

The following general strategies are recommended to minimize these impacts

*Aerial spraying of glyphosate*

In order to prevent the aerial spraying of glyphosate from affecting areas of special ecological, social or cultural value, exclusion zones have been set up, and no spraying operations can be conducted over them, and they are surrounded by adequate buffer strps so that the herbicide will not reach them by wind action. The zones in particular involve the official Nature Parks, bodies of water, human settlements, production infrastructure, and areas of economic interest.

Further, a series of operating parameters have been set in terms of flight altitude, airspeed, weather conditions for spraying (weak winds), doses and volumes of discharge per hectare, and others, in order to reduce the possibilities of drift or diversion of the herbicide to a minimum.

The environmental and operational specifications are contained in the following Program Records in detail for the management of spraying

Record 1. Spraying operations management program

*Management of glyphosate at operations bases*

The storage of glyphosate at operations bases, the preparation of mixtures, and loading onto aircraft may generate impacts on the base personnel themselves. In order to reduce this, a series of measures have been set up designed to avoid spillage or other events which would imply the loss of herbicide, and, should that loss occur, measures have been designed to deactivate and subsequently control the areas affected. In addition, other measures have been provided for the handling of fuel, machinery, equipment and transport systems for glyphosate.

These measures have been organized into a set of programs or Program Records, in particular:

2. Program for the handling of glyphosate and its co-adjuvants and operations bases

3. Program for the handling of fuel, vehicles, equipment and transport of glyphosate.

4. Management of solid waste.

### 5.2.2 Measures for mitigation and correction

The greater part of the mitigation measures have been already included in strategies for environmental management of spraying operations, particularly for key impacts (effect of adverse effects on native vegetation, effects on adjacent legal crops, bodies of water, National Parks, human settlements, etc). Nonetheless, some activities require the application of special mitigation measures

*Handling of domestic wastewater*

Domestic wastewater is generated at each base, as water coming from workshops and maintenance area, and the water from the washing of aircraft tanks. Proposals are made for each type of wastewater, with a system of collection and treatment and disposal, which appear on Record:

- 5. "Program for wastewater management"

*Environmental monitoring*

In order to measure the real impact of PECIG, and to take additional control measures, there must be environmental monitoring and follow-up throughout the period of spraying of illicit crops. For this purpose, a series of activities have been designed, intended to measure the residuality of glyphosate in soil and water and the effect on the ecological dynamics of vegetal and fauna communities and microorganisms in the soil in spraying areas, with demonstration plots representing the various zones of the program.

Further, there are proposals for instruments and procedures to measure the operational and environmental efficacy and efficiency of spraying. In social terms, it is proposed that there should be a follow-up of community complaints about damage to non-illicit crops, and ongoing epidemiological research, concurrently with regional and local health organizations. The description of these instruments appears in the following programs:

6. Program for inspection, verification and control of spraying operations
7. Research program for demonstration plots
8. Environmental monitoring program

9. Social management program

### 5.2.3. Making the program socially viable: measures of compensation

In order to make the program socially viable, in particular, in order to manage conflict with the neighbouring communities, account must be taken of a set of measures for compensation for damage caused, together with campaigns for training, ecological education and attention to the health of the population exposed to glyphosate spraying, and for base personnel required to work with the herbicide. The description of these measures is to be seen on Records:

9. Social Management Program
10. Educational Communication Program
11. Integral Security Program for Operations Bases
12. Environmental Management and Institutional Coordination
13. Contingency Plan.

*Social management and educational communication*

The success of the Program, and above all, of community relations, depends on an appropriate supply of information to the community on the scope, methods, timetables, results and needs of local resources for each activity involved. This information should be given to the local population directly, and also through the authorities and representatives of the organized community.

In parallel, the local community must be provided throughout the execution of the program with environmental education, particularly related to resources affected by illicit crops and their recovery, and environmental training and industrial safety for program personnel, for the correct application of the management plan. There should also be appropriate signposting to avoid accidents, and to report on the project. The problem of control over the health of the local population exposed to spraying must also receive special attention by the authorities responsible for PECIG.

*Industrial safety and contingency control*

PECIG must have a policy for industrial safety and contingency control as an integral part of its environmental policy. Therefore, there Records 11 and 13 have been prepared to give basic guidelines on industrial safety and contingency planning which may affect spraying activities.

*Environmental management*

The agencies responsible for PECIG must have a system for environmental management which will allow them to plan, execute, follow-up and control each and every EMP program on a permanent basis, such that the application of measures for in socio-environmental management recommended in this Plan will be applied.

**5.3. TIMETABLE**

PECIG has an indefinite duration. Therefore, the EMP must also have an indefinite duration. For detailed execution, the Commanding Officer of each operations base is planning and executing spraying programs as described in Record 1 of the EMP. The dates and times of each operation are set by conditions of weather, safety, and availability report local resources, amongst others, as explained in Records 1 and 2.

**5.4. COST ESTIMATES**

Chart 5.2 shows the general timetable by stages, and gives general estimate of the extra the exclusively owned and environmental costs of each of the construction activities and project activities, referring to the objectives of the studies (environmental matters).

The analysis of these charts allow allows the following conclusions:

The annual total cost of environmental activities is COP603, 942, 000 per base, and COP4.227,594,000 for the seven bases of greatest importance, that is, COP 62,792 per hectare/year (or USD 27/hectare/year), on the basis of the 67,327 ha sprayed in 2000.

The cost of environmental activities (mitigation and compensation) represents 5.8% of the cost of spraying per hectare of coca-leaf, and 6.3% of the cost for opium-poppy areas (considering the PECIG costs reported in Chapter 2: US$467.41/hectare average for coca-leaf, and US$ 429.89/hectare for opium poppy.

Account must nonetheless be taken of the fact that most spraying operations, and activities in the bases, imply a series of environmental specifications whose cost forms part of the cost of each activity. It may happen that the application of these environmental specifications will reduce the total cost of a given activity, particularly if account is taken of the possibility of replacement for damage caused by not applying those specifications.

The measures provided for in the EMP seek to ensure acceptable levels of environmental quality in relation to the exclusion of the various program activities. The estimated cost is related to the techniques recommended in the EMP Records. Nonetheless, DNE and DIRAN are free to apply technologies which will reduce the cost, on condition that they guarantee the same objectives of environmental quality provided for in each of the EMP activities. At all events, changes must be consulted and approved by the Program´s Environmental Management.

## Chart 5.1
## SUMMARY OF PECIG IMPACT

EMP measures

| Component | Impact | Cause | Rating | Prevention | Mitigation | Compensation | Followup | Cost of measures (COP000)(8) |
|---|---|---|---|---|---|---|---|---|
| Soil | Soil quality: deterioration | Glyphosate spraying (residual) | Low/very low | Respect dosage, discharge volumes and safety strips (Record 1) | Deactivation of spills (Records 1, 2) Contingency Plan for accidents (Record 13) | Payment for damage (Record 9) | Concentration of glyphosate in soil mg/kg) Record 7) | 117,286(1) |
| Moprhodynamic processes: increased erosion in sprayed areas | Glyphosate spraying (elimination of herbaceous vegetation/other cover) | | Low | Respect dosage, discharge volumes and safety strips (Record 1) | | | | |
| Water | Quality of surface and groundwater: deterioration, effects on water supplies and fish-breeding tanks | Glyphosate spraying: aircraft washing tanks. Residual water at bases | Very low | Respect dosage, discharge volumes and safety strips (Record 1). Advise water supply authorities if necessary | Stabilization pools for tank-washing water. Treatment for household wastewater | Payment for damage (Record 9) | Concentration of glyphosate in surface/groundwater ) Record 7) | 113,1712) |
| Atmospheric resources | Air quality, deterioration | Glyphosate spraying | Very low/ negligible | Respect dosage, discharge volumes and safety strips (Record 1) Respect handling/ storage/mixing regulations at bases (Record 2) | Deactivation of spills (Records 1,2) | | | |
| . | Noise | Aircraft operations | Low for airport areas (within set limits) | Respect Safety regulations (Record 1) | | | | |
| Native Vegetation | Affected by drift | Glyphosate spraying (herbicidal action) | Low | Respect safety strips (Record 1) | | Pay compensation for damage (Record 9) | Abundance-dominance indicator (Record 7) Areas affected (Record 6) | 128,286 (3) |
| Land and water fauna | Direct effects of glyphosate spraying and indirect effect on habitats | Glyphosate spraying (contact with herbicide) | Low in relation to tolerance levels | Respect safety strips (Record 1) | Wash animals sprayed | Pay compensation for damage (Record 9) | Specific biodiversity indices for different groups (Record 7) | |

| Component | Impact | Cause | Rating | Prevention | Mitigation | Compensation | Followup | Cost of measures (COP000)(8) |
|---|---|---|---|---|---|---|---|---|
| Health of exposed population | Direct effect of glyphosate spraying | Glyphosate spraying (action of contact and inhalation) | Low in relation to tolerance levels | Respect discharge doses and volumes, safety strip, measure to give advance notice | Wash eyes and skin of people sprayed. Contingency plan for accidents (Record 13) | Epidemiological monitoring, pay compensation for damage (Record 9) | Epidemiological monitoring. No. of individuals proved to have been affected (Records 8, 9) | 16,412 (4) |
| Farm production | Affected by drift, loss of production | Glyphosate spraying (herbicidal action) | Low | Respect discharge doses and volumes, safety strip (Record 1) | Spray with urea or other leaf fertilizers. Contingency plan for accidents (Record 13) | Pay compensation for damage (Record 9) | Crop area affected (ha/ year). Permanent checks on damage (Record 6) | 54,286 (5) |
| Human settlements/ migrations | Displacement of people seeking new crop areas | Glyphosate spraying | Very low | Respect discharge doses and volumes, safety strip (Record 1) | National Alternative Development Plan. RSS | Information on PECIG, environmental education and training (Record 10) | Annual variation in different soil uses (ha and %) including illicit crops (SIMCI Projecvt) (Record 8) | 36,714 (6) |
| Indigenous communities | Preservation of habitats and communities, reduction min process of invasion of reservations by growers | Glyphosate spraying | Positive, very low/ negligible | | National Alternative Development Plan/RSS | Information on PECIG, environmental education and training (Record 10) | Reservation areas occupied by illicit crops (SIMCI Project) ( Record 8) | |
| Employment | Increased employment ij control activities | Spraying and related operations at each base, monitoring, audit, administration | Positive, very low | | National Alternative Development Plan/RSS | Information on PECIG. Enhancement of impact (Record 10) | | 138,057 (7) |
| Infrastructure, Transport | Increase in road and services infrastructure | Coordination with development agencies (PNDA, RSS, Ministries) | Positive, very low/ low | | | Information on PECIG. Enhancement of impact (Record 10) | | |
| TOTAL | | | | | | | | 603,942 |

(1) $98,000 in research in plots – monitoring, and $15,000 ijn sold waste management + Contingency 4,286
(2) $28,000 in monitoring plots, $79385 in treatment, $1,500 in monitoring wastewater + Contingency 4,286
(3) $24,000 in monitoring plots, $100,000 payment of compensation + Contingency 4,286
(4) $2,857 in social management, $9,000 in integral security, Contingency 4,286
(5) $50,000 in compensation payments (social management) + Contingency $4,286
(6) $36,714 in educational communications
(7) $52,000 in environmental education, $6,857 in social management, $79,200 in inspection, verification and control
(8) Cost in Year 1
The cost of the of Contingency Plan has been divided between components of soil, water, native vegetation, health and farming production

**Chart 5.2**

**ENVIRONMENTAL SCHEDULE, EXCLUSIVELY ENVIRONMENTAL COSTS(1)**

PROGRAM 1

| | J | F | M | A | M | J | J | A | S | O | N | D | cost per base (COP000) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Management of spraying ops | | | | | | | | | | | | | |
| 2. Handling of glyphosate at operations bases | | | | | | | | | | | | | |
| 3. Handling of fuels, equipment, transport | | | | | | | | | | | | | 1,500 (29) |
| 4. Handling of solid waste | | | | | | | | | | | | | 15,000 |
| 5. Handling of wastewater | | | | | | | | | | | | | 79,385 |
| 6. Inspection, verification and control | | | | | | | | | | | | | 79,200 |
| 7. Research in representative plots | | | | | | | | | | | | | 150,000 |
| 8. Environmental monitoring | | | | | | | | | | | | | - |
| 9.Social management, compensation | | | | | | | | | | | | | 159,714 |
| 10. Educational communications | | | | | | | | | | | | | 36,714(3) |
| 11. Integral security | | | | | | | | | | | | | 9,000 |
| 12. Environmental management | | | | | | | | | | | | | 52,000 |
| 13, Contingency plan | | | | | | | | | | | | | 21,429 |
| Total per base | | | | | | | | | | | | | 603,942 |
| Total 7 bases | | | | | | | | | | | | | 4,227,594 |

(1) Cost in year 1, cost per operations base/nucleus
(2) Includes only laboratory analysis for follow-up and monitoring
(3) $31,000,000 per base and $40,000 distributed between all bases

# ENVIRONMENTAL MANAGEMENT PLAN

# PROGRAM RECORDS

| SPRAYING OPERATION MANAGEMENT PROGRAM | RECORD 11 |
|---|---|

## 1. DESCRIPTION OF THE ACTIVITY

In the course of aerial spraying operations with glyphosate some very specific conditions may arise which may potentially generate environmental and social impact from the time that the aircraft takes off to the time it lands. During this time, it may even be necessary to dump herbicide in full flight, either to guarantee the lives of the crew, due to terrorist attack, or due to bad weather conditions, or aircraft failure.

The Antinarcotics Division is responsible for assisting the safety and tranquillity of all, through effective actions in prevention, interdiction and investigation required to combat the many manifestations of drug-trafficking in Colombia directly, and to ensure that these actions do not generate undesirable environmental and social impacts.

The loss of vegetation cover in the forests of Casanare, Meta, Vaupes, Guaviare and Putumayo, and of the mist forests in the departments of Cauca, Tolima, Huila and IN the Serranía de Perijá, Motilones and San Lucas has caused strong imbalances in hydrographic basins and a reduction of minimum flows. These factors are caused by a set of associated elements, such as deforestation, spontaneous settlement, indiscriminate felling of trees, burning off, and deterioration of water sources due to the spread of the agricultural frontier for entirely illegal purposes, and this causes serious imbalances in water resources.

Associated with these factors, there are social problems in those areas, since these activities generate disturbances to public order, due to the presence of illegal groups engaged in associated illegal crimes, all to the detriment of tranquility and public security.

In this context, the eradication of coca-leaf and other illicit crops is a general concern in all countries where this botanical species may be grown. The elimination of coca-leaf in the longer is justified, as a check on the negative effects related to the production and trafficking in drugs, the damage done by the deforestation process, and the introduction of new subspecies of coca-leaf into the cultivation process. There are several systems available, but due to their ecological characteristics, the location of the crops, and the systems of opposition mounted by coca growers, the most efficient and least dangerous strategy is glyphosate spraying from the air, taking advantage of the fact that the negative impact on the environment is very insignificant, and very localized.

The eradication of illicit crops with herbicides applied from aircraft may be a relatively easy task and efficient, if the conditions are right. This is not the case here, and treatment must be conducted in abnormal conditions. In Colombia, where in addition to technical problems, there is the opposition of the coca growers, from seeking all possible means to counter the effect of the herbicide, intentionally obstruct the flight of aircraft leaving tall trees in the middle of the crop, or pruning as soon as possible after treatment with glyphosate, to prevent the herbicide from affecting the root tissues, and ensuring that plants grow back again, and produce harvestable leaves after 3-6 months.

Glyphosate is a herbicide used solely for agricultural purposes, and is registered with Colombian Agriculture and Livestock Institute - ICA Licence 0756 in Colombia. It is produced by Monsanto Company, and has been in Colombia since 1977. Today, the company Agricola Colombiana S.A. distributes the product under the commercial name Roundup. It has non-selective characteristics, and is used in applications or post-emergent leaf structures, and is not, nor acts as, a soil-sterilizing herbicide.

Physically, glyphosate is an amber-coloured soluble liquid, and chemically it is composed of a concentrated polar formula of N(phosphonmethyl) glycine isopropanoloamine salt. It is a highly biodegradable substance, and therefore does not affect animals or the environment. It has been classified by the Ministry of Health as “mildly toxic”, Category IV.

It has no carcinogenic, teratogenic or mutagenic characteristics, and does not accumulate in adipose tissue. However, it may cause irritation - temporary but reversible - of the eye. Oral ingestion in quantities of more than 100 mL may cause pulmonary oedema and hypertension.

## 2. OBJECTIVE

The purpose of this program is:

- To establish procedures and assign responsibilities for complying with technical and environmental parameters for aerial spraying, which entailed effective spraying on illicit crops sown in Colombia, in order to protect and conserve the ecosystem.

- To establish procedures which seek to avoid accidents, where for emergency reasons, the pilot must fly by instruments.

- To set procedures and assign responsibilities for dumping in-flight, in order not to exceed the maximum landing weight.

- To increase industrial safety for pilots, when for diverse reasons, the product cannot be applied over the area allocated.

## 3. ACTIVITIES TO BE PERFORMED

### 3.1. Preventive measures

The following procedures are necessary in order to prevent accidents attributable to equipment:

- Calibration of aircraft equipment
- Follow the technical and operational parameters for the application of the herbicide, such as navigation procedures and this Management plan.

*Calibration*

Prior to each deposit spraying operation, technical personnel attached to the operations base of the Antinarcotics Police (DIRAN) must check the operating conditions of spraying equipment, and if appropriate, recalibrate it. This process must be followed in accordance with procedures established in Record to "Handling of glyphosate and its co-adjuvants at the operations base".

**3.2. Technical and environmental specifications in the different phases of PECIG**

The spraying process involves three stages (see Figure 1)

- Detection of illicit crops to be sprayed
- Spraying
- Verification

**3.2.1. Measures of detection**

In Chapter 2 of this EMP, there is a detailed description of each of the processes of steps in the detection process, whose purpose is to identify, characterize and give a special context to areas affected by illicit crops, and to determine exclusion zones for the program.

From an environmental point of view, the aspect of most interest in this stage is the identification and the location of exclusion zones and alert zones. The characterization is performed on the basis of satellite images, aerial photographs and available maps, with the support of fieldwork performed by operations base personnel or ARECI personnel. The principal objective is to determine the limitations of each operating area with regard to soil use, the presence of human settlements, and specific environmental conditions. In particular, fragile systems and systems sensitive to the spraying program, following criteria given in Chart 1.

**Chart 1**

**CRITERIA FOR DETAILS ENVIRONMENTAL ZONING OF CROP SPRAYING AREAS FOR ILLICIT CROPS, WITH GLYPHOSATE**

| Zone type | PECIG zoning |
|---|---|
| Ecologically fragile | Nature park areas |
| Culturally fragile | Indigenous reservation |
| . | Archaeological Parks |
| . | Historic monuments |
| Environmentally sensitive | Bodies of water (rivers, streams, wetlands) |
| . | Native forest |
| Economically sensitive | Infrastructure works: highways, airports, reports, seaports, dams and power stations |
| . | Areas of manual eradication pact |
| . | Productive project areas (PNDA) |
| . | Irrigation or drainage systems |
| . | Industrial zones |
| . | Opencast mining operations |
| . | Commercial complexes and rural tourist areas |
| . | Rural institutional complexes |

Based on this identification and geolocation, the basic environmental zoning for each operation must then be defined. This must take account of the categories established in Chart 2. In addition to the exclusion zones established in Resolution 5, and those of this Program), and the securing the buffer strips (established by Decree 1843/1991), R spraying may take place, and alert strip has been provided for around and along each of them, within which the SATLOC system installed in the aircraft must advise the pilot that he is close to them, and should take precautions to avoid spraying them.

### 3.2.2. Measures in spraying

For safety reasons, and for the particularly special conditions of crop smallholdings in Colombia, spraying must be performed by the fixed-wing aircraft, applying discharges by hectare in the form of aqueous solutions, so that the spray particles will have a defined size in accordance with parameters established here, in order to reduce loss due to evaporation, and to attenuate drift.

The herbicide to be used in spraying will be glyphosate.

3.2.2.1. Reference comments on evaporation and drift

Evaporation and drift are of primary importance as problems in the application of pesticides from aircraft. Evaporation causes "losses" of the product which will be greater or smaller depending on the altitude of spraying, the initial size of the particles, and environmental conditions at the time of treatment. The higher the flight, the lower the relative humidity and the higher the ambient temperature, the evaporation rate may reach 80% or more. Spraying from 10 m altitude has little likelihood of reaching the surface of the crop if the initial particle size is less than 200 μ in diameter.

The problem of "drift", or lateral displacement of part of the pesticide spraying, is a serious inconvenience, due to the effects which may have on the ecological context of which the crops sprayed form part.

Drift depends on this be displacement of sidewinds, the height of the flight, the initial size of the particles, the density of the chemical compound, ambient temperature, and the experience of the pilot. It may be said that the higher the aircraft the smaller the final size of particles, with a windspeed of over 8 kph, and eventual presence of the phenomenon known as "inversion", the greater the drift.

**Chart 2**

**BUFFER STRIPS AND ALERT AREAS FOR ENVIRONMENTAL POLLUTANTS APPLIED DURING PROGRAM OPERATIONS**

| ZONE | DEFINITION | HANDLING |
|---|---|---|
| Exclusion zones | National parks | |
| | Human settlements (villages etc) | Do not spray, buffer strip of 100m |
| . | Bodies of water | |
| . | Areas of areas of socio-economic interest | |
| . | Areas with vegetation, other than illicit crops | Do not spray. Open and close tap inside the illicit crop plot |
| . | Smallholder illicit crops | Manual eradication. Do not spray |
| Restriction zones | Nature parks | 1000m alert strip |
| . | Fringe around human settlement | 1000m alert strip |
| . | Perimeters around bodies of water | 1000m alert strip |
| | Zones around areas of socio-economic interest | 1000m alter strip |
| Intervention areas ´ | Areas occupied by industrial illicit crops | Spray with glyphosate. |

Source: DNE

3.2.2.2 Operating parameters

During spraying it is therefore necessary to comply with a series of technical navigation requirements and spraying requirements, in order to reduce the potential impact on vegetation cover or neighbouring crops other the crops to be sprayed. These parameter range from flying height, speed, size of droplets or particles of herbicide, nozzle type, pressure of the spray pump, and through to the time of application, wind speed, relative humidity and other favourable atmospheric conditions.

Chart 3 shows the operating parameters to be met during spraying operations. These predators have been calculated taking account of Colombian Agriculture and Livestock Institute - ICA recommendations, so that coca-leaf crops of less than one year old should use 8 L of glyphosate diluted into 15,413 L of water and full crops more than one year old, the maximum of 10 L of glyphosate (commercial formula) diluted into 13,423 L of water.

Chart 4 is the composition of the mix and lived in the aircraft for different types of slope on the ground.

The following are some comments in relation to glyphosate and its effects, based on direct experience, by Dr Miguel Revelo Ph.D. in phytopathology, who is collaborating in the activities of Environmental Audit for PECIG, and they are to be taken as the basis for suggestions and later to improve the effectiveness of spraying.

**Chart 3**

**PARAMETERS OF OPERATION IN PROGRAM FOR ILLICIT CROPS ERADICATION, BY AERIAL SPRAYING, T65 AND OV10**

| PARAMETER | UNIT/ MEASUREMENT | VALUE/RANGE | VALUE/RANGE |
|---|---|---|---|
| | | (i) COCA | OPIUM POPPY |

| | | | |
|---|---|---|---|
| HEIGHT OF FLIGHT | M | Less than 25 | Less than 12 |
| Airspeed | mph (T65) | 120 - 150 | 120 – 150 |
| Flight speed | knots (OV-10) | 180 - 200 | OV-10 (No aplica) |
| Aircraft load | gals | 350 – 500 - 800 | 200 - 350 |
| Discharge planned | L/ha | 23,65 | 50 |
| Glyphosate discharge | Mm3 /cm.2 | 0,0384- 0,0480* | 0,0096- 0,012* |
| Commercial glyphosate | L/ha | 8 – 10 | 2,5 |
| Droplet size | Micras | 300 – 1000 | 300 - 1000 |
| Optimum time for spraying | Day/night | 5:30 a 10:0 A.M. 4:00 P.M. a 3:00 A.M | 5:30 a 10:0 A.M. |
| Magnitude of recovery | % of area sprayed | 75 % - 80 % | 75 % - 80 % |
| Pump pressure | Lb/ r cm.2 (psi) | 20 - 25 | 20 - 25 |
| Width of swathe | M | 25 - 30 | 25- - 30 |
| Drift projected | M | < 5 - 7 | < 5 - 7 |
| T.V.B nozzles. | Mm orifice | 2 | 2 |
| Ambient temperature | °C | > 30 C. | > 20 C. |
| Relative humidity | % | 75 - 90 % | 75 - 85 % |
| Windspeed | m/s | 0 - 2,0 | 0 - 2,0 |

*Due to the magnitude of recovery, the effective doses calculated as 20% less than that discharged

for coca-leaf crops in less than a year old, use 8 L of glyphosate diluted in 15, 413 L of water

Full coca-leaf crops more than one year old, use 10 L of glyphosate, diluted in

13,423l of water

In both formulation, add 236 cm³ of Cosmoflux

Source: this study

**Chart 4**

**COMPOSITION OF THE MIX IN LITRES AND GALLONS**

The load depends on the type of aircraft available for operations

| CROP | DOSE L/HA | MIX L/HA | AIRCRAFT LOAD/GALS | % SLOPE |
|---|---|---|---|---|
| COCA | 8 - 10,0 | 23,65 | 250 | > 30 % |
| COCA | 8 - 10,0 | 23,65 | 350 | 10 - 30 % |
| COCA | 8 - 10,0 | 23,65 | 800 | < 10 % |
| OPIUM POPPY | 2,5 | 51,09 | 200 | > 30 % |
| OPIUM POPPY | 2,5 | 51,09 | 250 | 20 - 30 % |

Source: Antinarcotics Police.

3.2.2.3. Opinions, and proposal to improve spraying operations

*Residuality*

The concept of residuality is very broad. If the idea is to assess the persistence of molecules and the biocide activity of the herbicide, it is easy to state that glyphosate is not residual, because the parental molecule deactivates itself and metabolizes in a few days in tropical soils.

The presence of renewed populations of weeds in coca-leaf products in plots treated a few weeks before is also reliable testimony that the molecules of the herbicide deactivate themselves in a short time and they do not leave residues which hamper plant growth.

The persistence of the effects of glyphosate must be understood as the time necessary for crops treated to recover after pruning, during the 24 hours following treatment. If the plant is pruned, the process of recovery may take 4-6 months.

*Reinstallation of new crops*

The installation of new crops in some plots treated a few weeks before with doses of 4.8-5 kg/ha (10-10.6 L), is successful, and this is definitive evidence that the herbicide does not disable the land for new crops. It is calculated that after 4-18 months, depending on the manner and timing of sowing, the harvesting process may begin. If the crops come from crops which have been pruned immediately after the application of herbicide, the recovery period may be less than six months.

*Symptoms of ill effects caused by glyphosate on coca-leaf crops*

Two weeks after the treatment date the following symptomatic manifestations should be evident. It should be noted that the presence of new shoots may occur in the plants treated and pruned within 12 hours, or in plants which due to failures of application or some other reason, are not reached by the glyphosate spray. Symptoms of damage are slower to appear in woody plants more than two years old.

- Foliar chlorosis
- Defoliation
- Necrosis of secondary branches
- Necrosis of main stems
- Necrosis of roots

- New shoots
- New buds
- Effect on weeds
- Effect of drift on surrounding vegetation.

Two weeks after the application, there should be strong symptoms of damage to un-pruned plants. After 8-12 weeks, the degree of effect should be total, and necrosis should be complete, including their root systems.

It is possible that defoliation, as the first visible symptom of the effect, meaning becoming visible two weeks after treatment. Initial symptoms of necrosis may also be present 8-10 days after treatment.

The application of a dose equivalent to 4 kg of active ingredient per hectare, may produce some degree of control of use of 5-6kg of active ingredient, if conditions of application comply with at least 80% of each of the parameters given above.

If conditions of application are not lower than 90% of compliance with the parameters indicated in Chart 3, the percentage of control will come close to 80%, with treatment of 3-4 kg of active ingredient per hectare after 12-16 weeks in un-pruned plants.

Weeds present in the soil of coca-leaf plots are also affected by glyphosate spraying, but, unlike the coca-plants themselves, the gramineous weeds begin to show significant recovery after 1-2 months. But if environmental conditions are favourable (rain), a sprayed area will again contain vegetation a few weeks later.

The damage attributable to drift over surrounding trees around the coca-leaf plantations is identifiable after 2-3 weeks, but does not seem to have lethal effect on the majority of species. In several observations, it was evident that the defoliation was greater and more pronounced in the single species of "Guarumo", a silver-leafed plant of the *Cecropia* genus. After 12 months between the trees recover their foliage.

*Procedures to improve operating capacity of aerial spraying.*

There are many reasons for designing procedures which will increase the operational efficiency of aerial spraying, and with aircraft available for aerial eradication with glyphosate, without exceeding technical or economic thresholds.

Taking advantage of the fact that there is no technical problem in reducing the volume of the application in the final mix, without affecting the efficiency or the parameter to deposit 25 - 50 drops of 300-1,000 micra diameter per square centimetre of foliage, spraying equipment can be adjusted to reduce the discharge of the mixture to no more than 7-8 gallons (26-30 L), to take advantage of the capacity of the operating aircraft, about 450 gallons.

The average diameter of most spraying particles and should be 30-1000 micra. This is a good strategy to reduce the magnitude of drift.

Treatment and estimated time for recovery of plants pruned after application of the herbicide allows the calculation that it will not be necessary to re-spray for the three months, or before 6-12 months in the case of pruned plants.

*Basis for a specific alternative*

There is increasing evidence that the "growers" proceeded to install new crops when the effect of glyphosate has caused the death of rather more than half of the plants, and this allows consideration of the idea that it would not be necessary to make efforts to kill around 100%, so that the growers would be forced to replacement, investing in new costs and time. In theory, it is possible to expect that company crops sprayed six months before will include some of the following categories

- The magnitude of damage was high, and forced the growers to abandon
- The damage was small and partial, and crops are in a recovery process

- Crops are in production with new branches, emerging from pruned stems
- There are new crops in the initial stage of development. This suggests that the coca-leaf growers have started new crops, using the same ground

All of the foregoing is certain, and allows the advantage to be taken of a specific situation in order to set a target of the destruction of no more than 70-80%, thus reducing cost, without forcing the growers to abandon them or to renew them with new crops.

There are several alternatives to achieve this, including the use of spraying operations arranged to leave areas with small discharges of the mix, by plugging some of the nozzles, and this would also reduce the expense of the herbicide, and increase the capacity for coverage over the area in each flight. The following data to estimate of the percentage magnitude of the increase

Aircraft with a 54 nozzle boom

- Use 40 nozzles, treat 10% more than hectares calculated
- Use 43 nozzles, treat 20% more than hectares calculated
- Use 38 nozzles, treat 30% more than hectares calculated

**3.2.3 Verification**

The purpose of this stage is to evaluate the efficiency and effectiveness of spraying operations. The procedure is explained in Chapter 2, and in Record 6 "Programs for inspection, verification and control" of this EMP.

Figure 1 also shows the decision tree for development of each activity in detection, spraying and verification.

**3.3. Compliance with their safety standards**

Using intelligence reports received, the Base Commander will coordinate with the illicit crops eradication area for the movements of fixed wing aircraft with FLIR intelligence equipment, so that during the morning hours, they can go to the spraying area in order to detect the presence of guerrilla groups.

*3.3.1. Air safety standards for pilots*

For this type of operation, pilots must have taken and passed the spraying course normally given by Colombian Agriculture and Livestock Institute - ICA.

Crews must have their flying -time record for this equipment up-to-date, as well as the medical licence, and be entirely clear about their functions for each operation.

*3.3.2. Safety standards for aircraft operations*

Bases must have manuals for spraying equipment published by the manufacturer, and manuals for the aircraft used for spraying and escort duties.

Personnel engaged in operations must be aware of the effect of the products used in spraying, on plants, animals and humans, and rules to be observed for permanent and safe application

The fumigating pilot must be aware of flying techniques and application product for safe operations and on the yield and limitations of operation of the aircraft used.

- At the end of the day's operations, the aircraft flight log will be completed, detailing hectares sprayed, place of application, and number of flights made, and any contingencies arising. At the same time, maintenance personnel should be allowed to correct any failures reported, and to wash the spraying equipment in general.

- Auxiliary personnel assigned to spraying work (those working tanks, mixers, etc), should be trained, in order to avoid accidents and damaged equipment.

- There should be an anticorrosion and decontamination program for the equipment used on the aircraft.

- Each base must have a spray aircraft inspector or technician, specific to the aircraft type.

- Spray aircraft must be operated on landing strips which comply with technical conditions

- Once the aircraft has finished spraying, it must go for refuelling, and remain permanently on standby

- All aircraft must have the SATLOC analysis system installed and functioning, both in spraying and reconnaissance. This is a legal requirement, and more exacting that the PECIG for geo-referencing the areas sprayed.

- The method to be used by fumigation aircraft will either be "racecourse" or parallel lines. Depending on this method, safety measures should be applied is established for escort aircraft, determining altitudes independently depending on the nature of each type of aircraft and specific mission missions.

### 3.3.3. Operating safety standards for helicopters

- The Police Aviation Division helicopters will provide support and security, search and rescue in the program, and must have the equipment required for this mission.

- Each helicopter will carry binoculars, bullet-proof vests, machetes, a chainsaw, first aid equipment, smoke grenades, air-ground radios, and other equipment considered necessary for this type of operation.

- The Head of Zone or the Company Commanders will be responsible for conducting and arranging the operation, maintaining permanent communications with the Illicit Crops Eradication area of DIRAN.

- Three helicopters in the first security ring of the operation will provide firepower in support, and search and rescue during spraying operations. The must be a minimum basic package of helicopters to be able to conduct spraying operations under the expected standards of protection and effectiveness.

- Helicopters should not land on crop areas unless there is at least one other escort aircraft providing security.

- Helicopters engaged in spraying areas must at all times keep their doors open and secure, and the gunnery officer and the technical officer in position and ready with minigun and M-16 machine guns.

- Artillery officers will have complete set of implements for the work (bullet-proof vests, helmet, communication with the crew)

- Helicopters must install additional earphones for the exclusive use of the Company Commander commanding the operation.

**3.4. General recommendations**

- There should be a paramedic or combat medic in all spraying operations

- Always leave reinforcement personnel available to attend to any requirement whenever a spraying flight departs.

- All aircraft will receive daily maintenance

- Instructions given to ground personnel in the Antinarcotics Group with regards to helicopter operations, leading, safety measures, etc

- When a flight begins, the anti-collision light should be switched off after leaving the terminal

- If possible, spraying should not be combined with any other type of operation

- Full availability must be maintained for aircraft and crew for the execution of this plan

- Spraying equipment must be calibrated daily, and aerial spraying monitoring equipment must be calibrated once a month.

- Bullet-proof vests must be used by all personal taking part in the aerial spraying program.

- If weather conditions are adverse at the base, but favourable in the illicit crop area, an aircraft should be sent to make reconnaissance and report whether it is feasible to spray that area, or definitely cancel or postpone spraying.

- ARAVI standards require that a flight order be prepared for all aircraft.

- The mixer (water and glyphosate) must be used to facilitate the refuelling of fumigating aircraft, complying with environmental health and hygiene regulations.

- Account will be taken of the Environmental Audit, Colombian Agriculture and Livestock Institute - ICA and other environmental authorities, following parameters established in the environmental model.

**3.5. Communications**

DIRAN contact points

Phones Bogota

| | |
|---|---|
| Antinarcotics Division | 368 7164 |
| Antinarcotics SubDivision | 221 4005 |
| Aviation Area | 276 7995 |
| Illicit Crops Eradication Area | 413 5173 |

## 4 SCHEDULING

The spraying of illicit crops is permanent, because the crops are a crime, and this is the chosen method for the authorities to eradicate them

## 5. FOLLOW-UP AND MONITORING

Follow-up is the responsibility of the DNE Social Management and Environment Department and DIRAN, including coordination with the control bodies, who will make regular inspections of installations, operations and working areas, as established in the Program Records for inspection, verification, control and monitoring and environmental follow-up.

## 6. ACCOUNTABILITY

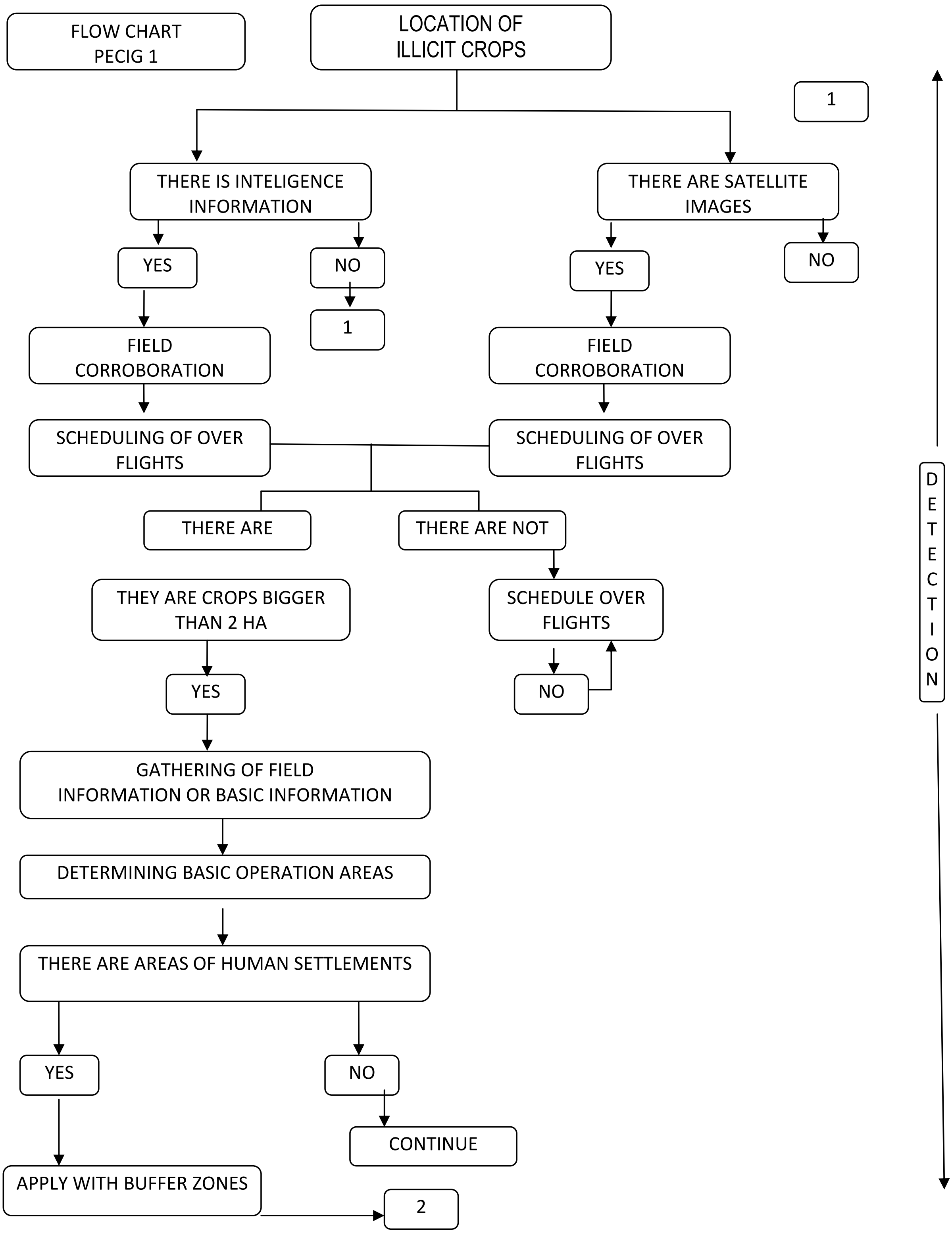
The illicit crops eradication work will at all times be coordinated by the Head of the Illicit Crops Eradication area.

The appropriate development of the integral security of the program is the responsibility of the Commanding Officer of the operations base, accountable to DIRAN.

## 7. COSTS

Costs correspond to the costs of the program. There is no additional environmental cost, because the above specifications can and will be applied in the execution of spraying operations.

**END OF PROGRAM RECORD**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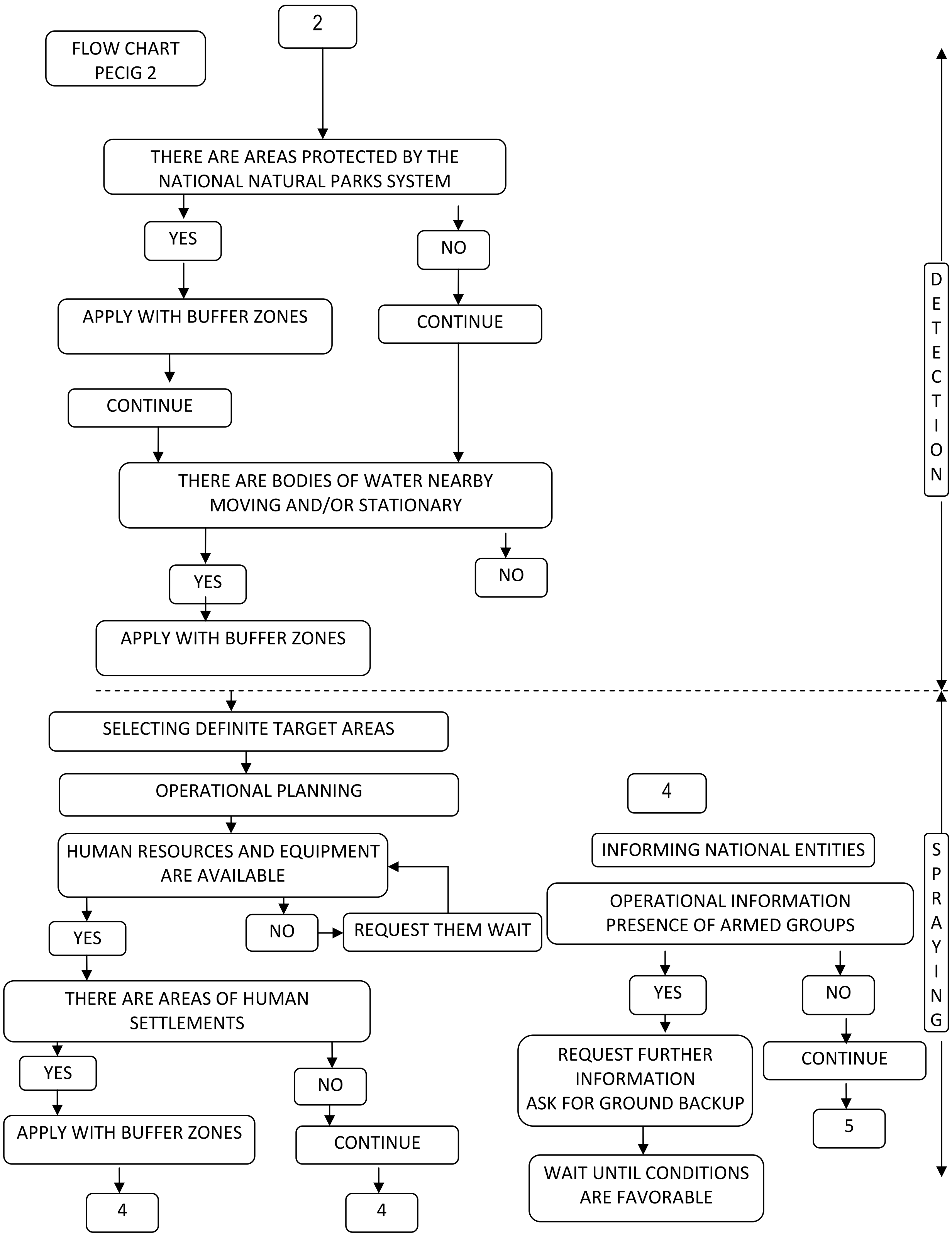
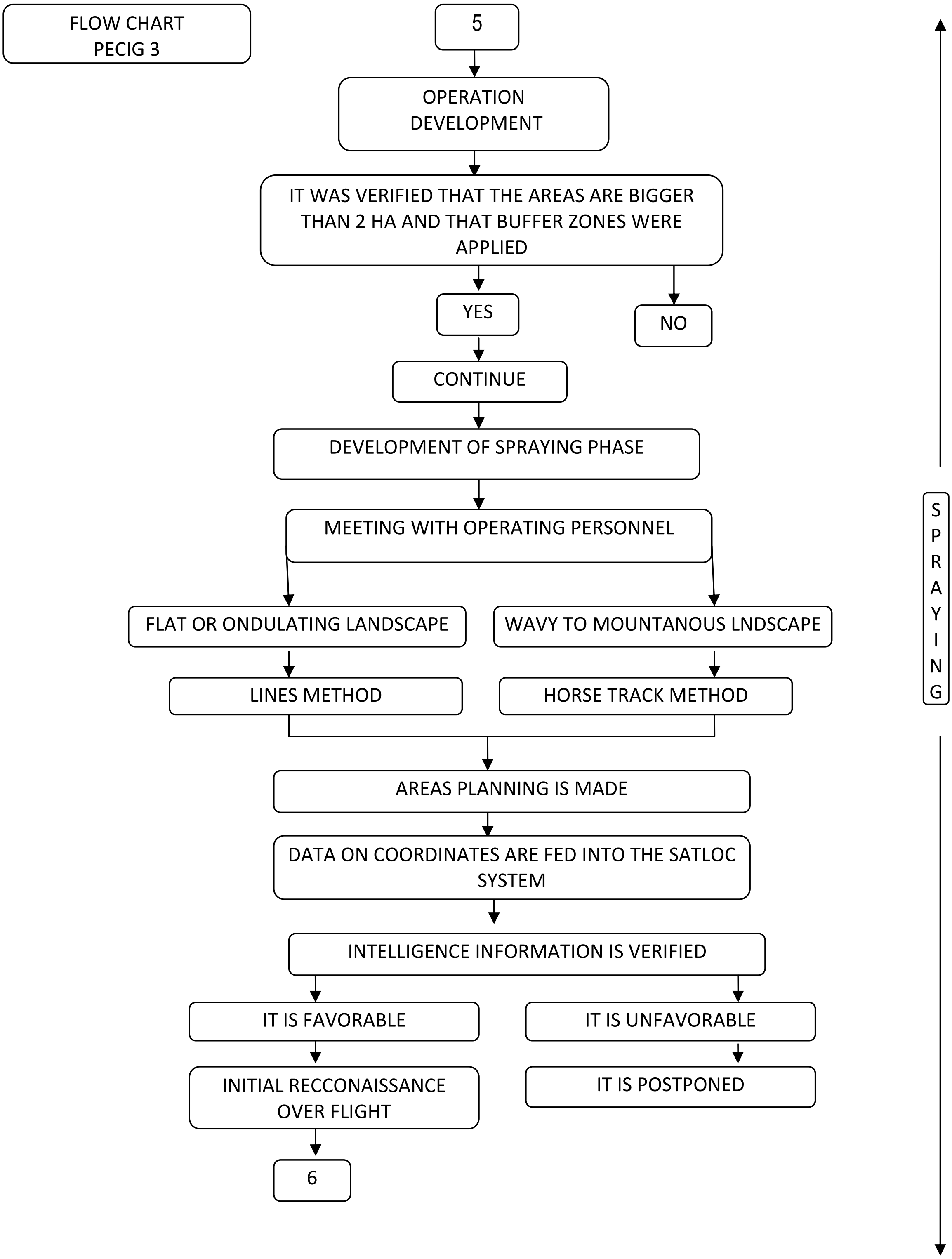
GATHERING OF FIELD
INFORMATION OR BASIC INFORMATION
DETERMINING BASIC OPERATION AREAS
THERE ARE AREAS OF HUMAN SETTLEMENTS
YES
NO
CONTINUE
APPLY WITH BUFFER ZONES
2
DETECTION


FLOW CHART
PECIG 2
2
THERE ARE AREAS PROTECTED BY THE NATIONAL NATURAL PARKS SYSTEM
YES
NO
APPLY WITH BUFFER ZONES
CONTINUE
CONTINUE
THERE ARE BODIES OF WATER NEARBY MOVING AND/OR STATIONARY
YES
NO
APPLY WITH BUFFER ZONES
DETECTION
SELECTING DEFINITE TARGET AREAS
OPERATIONAL PLANNING
HUMAN RESOURCES AND EQUIPMENT ARE AVAILABLE
YES
NO
REQUEST THEM WAIT
THERE ARE AREAS OF HUMAN SETTLEMENTS
YES
NO
APPLY WITH BUFFER ZONES
CONTINUE
4
4
4
INFORMING NATIONAL ENTITIES
OPERATIONAL INFORMATION PRESENCE OF ARMED GROUPS
YES
NO
REQUEST FURTHER INFORMATION ASK FOR GROUND BACKUP
CONTINUE
5
WAIT UNTIL CONDITIONS ARE FAVORABLE
SPRAYING


FLOW CHART
PECIG 3
5
OPERATION DEVELOPMENT
IT WAS VERIFIED THAT THE AREAS ARE BIGGER THAN 2 HA AND THAT BUFFER ZONES WERE APPLIED
YES
NO
CONTINUE
DEVELOPMENT OF SPRAYING PHASE
MEETING WITH OPERATING PERSONNEL
FLAT OR ONDULATING LANDSCAPE
WAVY TO MOUNTANOUS LNDSCAPE
LINES METHOD
HORSE TRACK METHOD
AREAS PLANNING IS MADE
DATA ON COORDINATES ARE FED INTO THE SATLOC SYSTEM
INTELLIGENCE INFORMATION IS VERIFIED
IT IS FAVORABLE
IT IS UNFAVORABLE
INITIAL RECCONAISSANCE OVER FLIGHT
IT IS POSTPONED
6
SPRAYING

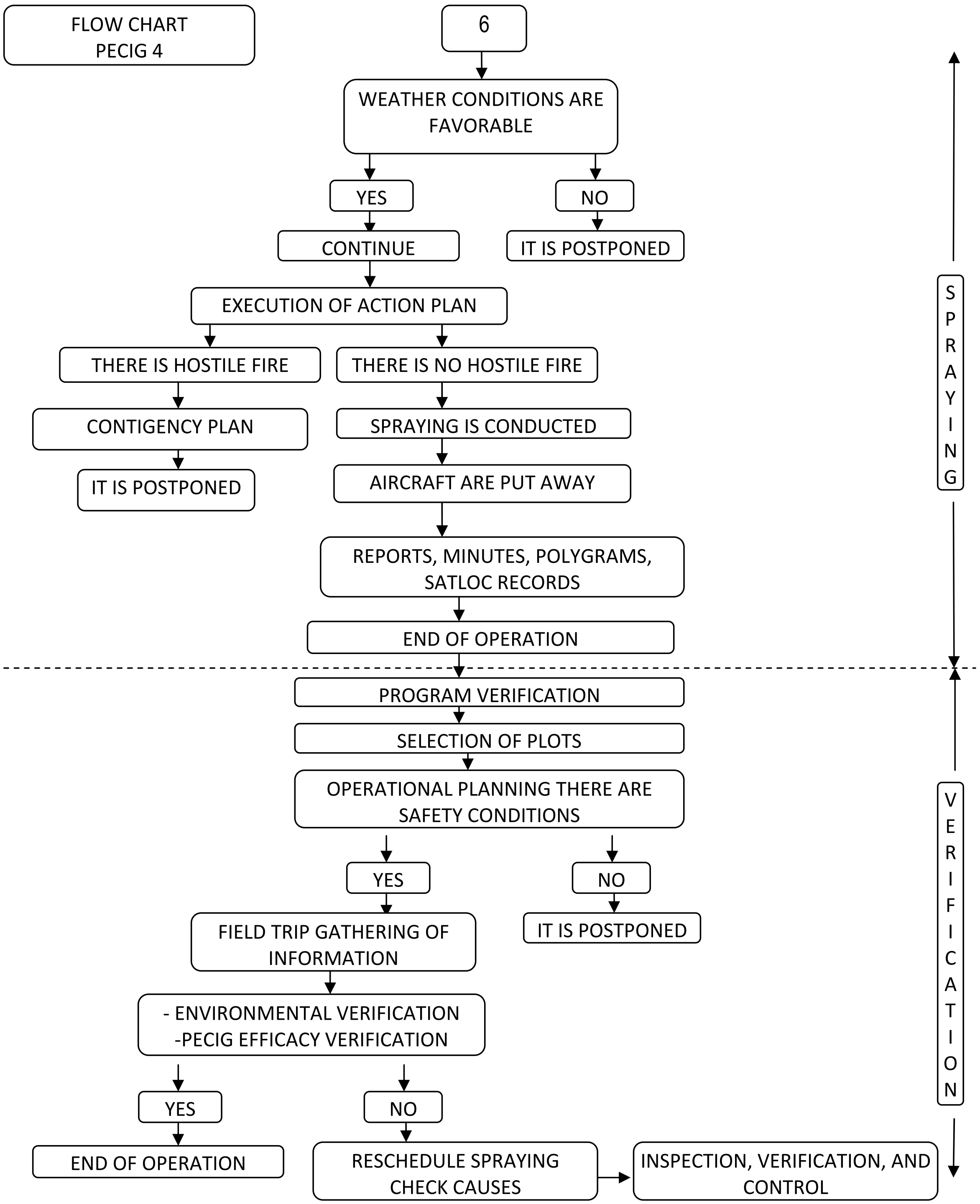



Figure No. 1
FLOW CHARTS PROGRAM FOR ERADICATION OF ILLCIT CROPS BY SPRAYING WITH GLYPHOSATE - PECIG

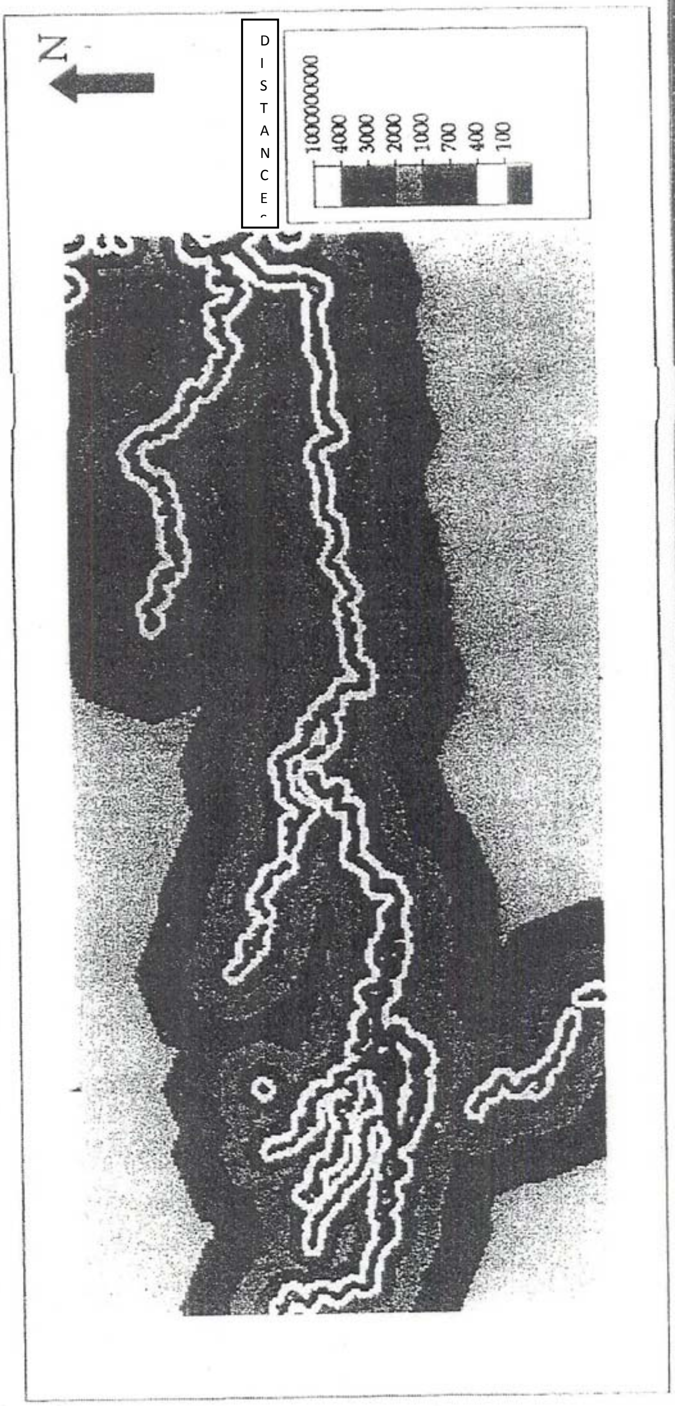



Figure No. 2

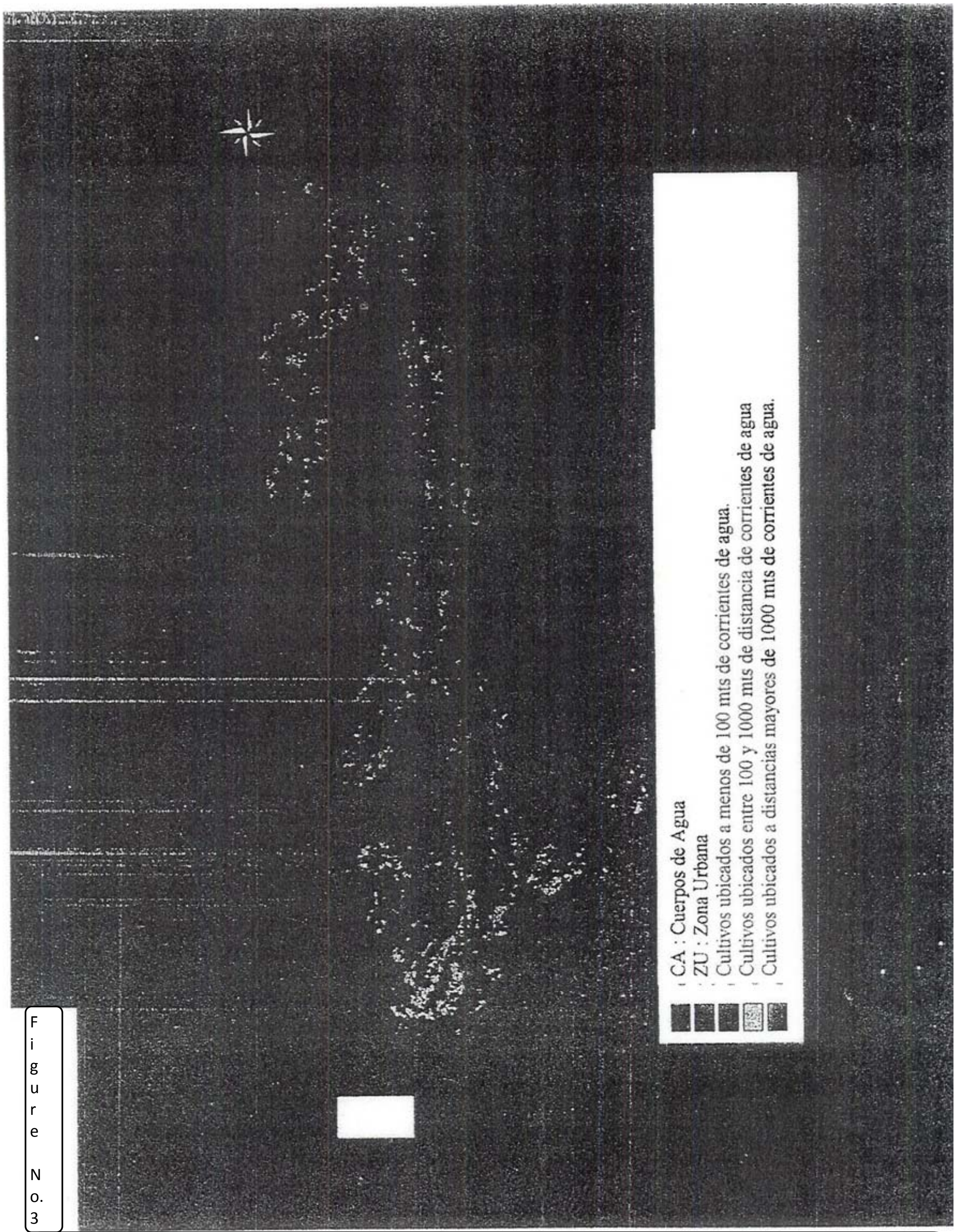



Figure No.3

LEGEND
CA: Bodies of Water
ZU: Urban Areas
Crops located at less than 100 meters from bodies of water
Crops located between 100 and 1000 meters from bodies of water
Crops located over 1000 meters from bodies of water

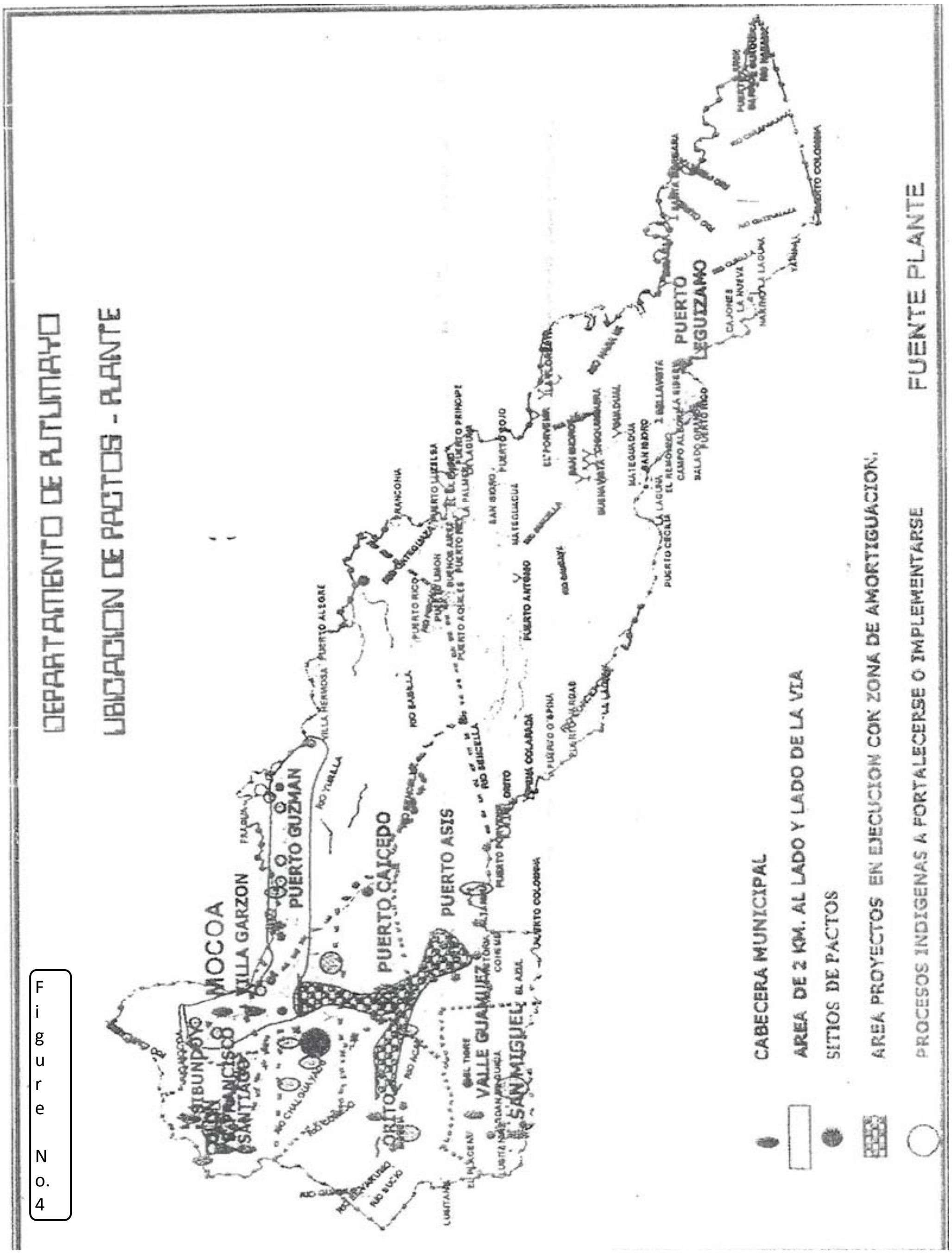



Figure No. 4

PUTUMAYO PROVINCE
LOCATION OF PRODUCTIVE PROJECTS – PLANTE

MUNICIPALITY CAPITAL
AREA OF 2 Km ON EACH SIDE OF THE RAOD
AGREEMENTS AREAS
AREA OF ONGOING PROJECTS – BUFFER ZONE
PROCESSES WITH INDIGENOUS COMMUNITIES TO BE STRENGTHENED OR IMPLEMENTED

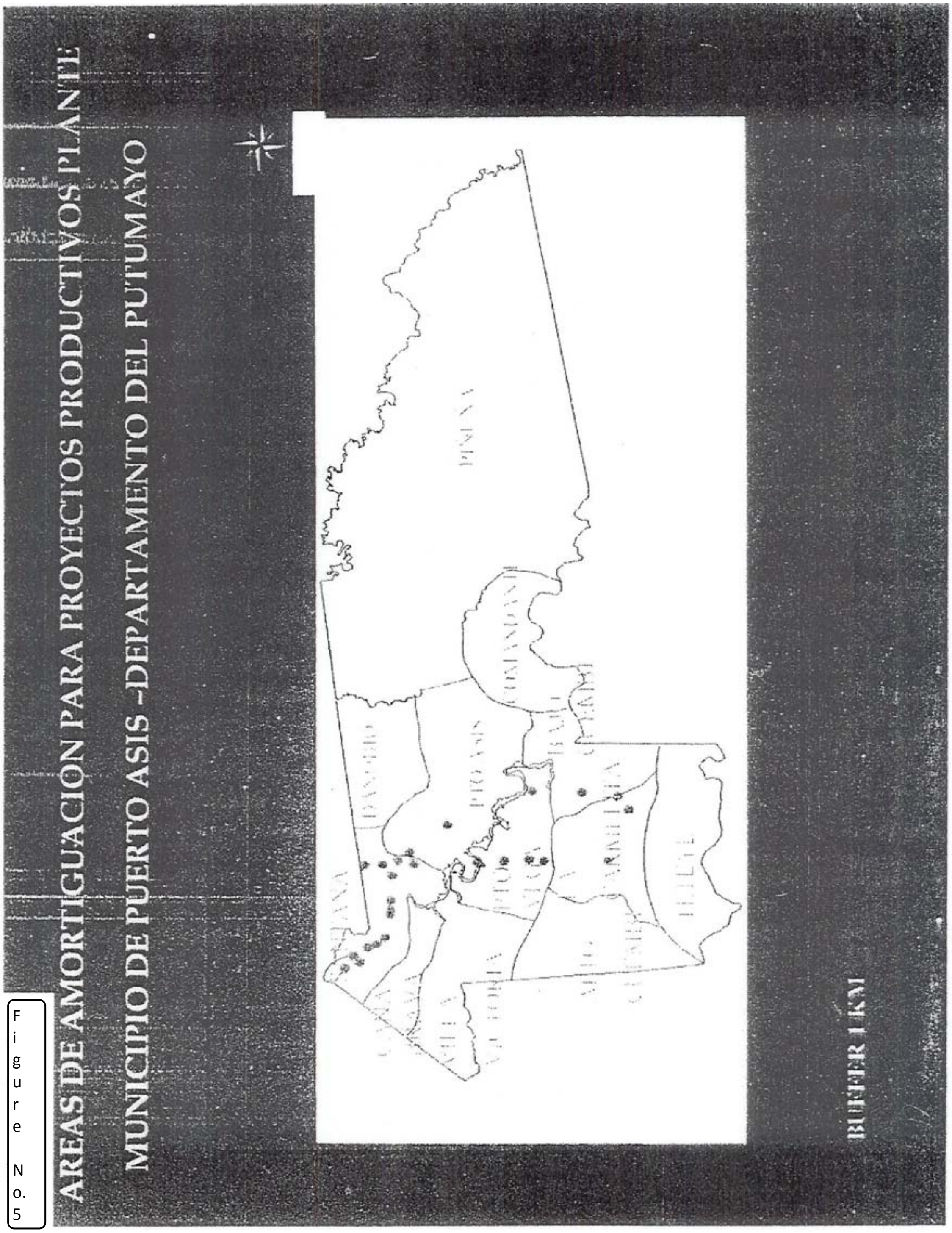



Figure No.5

BUFFER ZONES FOR PRODUCTIVE PROJECTS -PLANTE

MUNICPALITY OF PUERTO ASIS – PUTUMAYO PROVINCE

| PROGRAM FOR THE MANAGEMENT OF GLYPHOSATE AND COADJUVANTS IN OPERATION BASES | RECORD 2 |
|---|---|

## 1. DESCRIPTION OF THE ACTIVITY

The degradation of environmental conditions in and around the operations bases and neighbouring areas originates in residues caused by cleaning work on spraying equipment after each daily run, and the continuous accumulation of empty containers and packing materials for the glyphosate and other substances used in the formulas in the illicit crops control program. These processes may cause contamination of water and soils[37], principally, and may affect the health of base operators.

The possible contamination by formulations for the use of glyphosate may originate in defective functioning of spraying equipment, or in the way in which the spraying is conducted. This is a preventive operation, designed to avoid the consequences of defective spraying, and although the degrading impact on the environment is evident on the area of influence of the illicit crops, the task of equipment calibration must be conducted within the area of each operations base.

Within the base, a series of tasks related to the handling of glyphosate take place - such as storage, the preparation of the mix, the loading of aircraft, the unloading of excess materials, and the handling of residues of contaminating products. The standardized handling methods must include all procedures required to prevent contamination of the operations base area, and avoid the occurrence of any environmental impact which would damage the health and welfare of human populations working there, or living in the geographical area of influence.

A second factor of importance is related to the work of the maintenance of spraying equipment, and the process of calibration before spraying operations. The personnel directly involved in these tasks are the ground operations group, under

[37] Decree 2811/1974 states that “contamination is understood to be …..”

the direction of the expert responsible for the process of calibration, and the pilots responsible for operating the aircraft selected. It should be noted that the aircraft pilots must have attended one or more talks and technical workshops related solely and specifically to the pesticide spraying process in phytosanitary work.

## 2. OBJECTIVES.

There are two very specific objectives for operations conducted in operations bases for glyphosate spray aircraft.

- Prevention and mitigation of impact in the base operations area, and in the health and welfare of personnel responsible for making the mixing and maintenance of the spraying equipment, due to mishandling of glyphosate and coadjuvants used in the formulation for its use, including Cosmoflux.

- Guarantee of the correct calibration of equipment or spraying equipment, so that discharges of the herbicide will match the technical parameters required, and that the dose of glyphosate and its coadjuvants will be the smallest required to guarantee the destruction of the illicit crops, in quantities and magnitudes sufficient to disable the production of the illegal plantation completely. This objective, however, maintains the unchanging condition that herbicide spraying may not go outside the safety margins provided for in each phase or action of the spraying process, and that the magnitude of drift or any other damaging impact will not contaminate stillwater bodies or currents of water, and will not cause degradation of other components of the ecological system linked to the illicit crops, and niches inhabited by human populations.

## 3. ACTIVITIES

### 3.1. Handling of glyphosate

3.1.1. Storage

The following general measures are recommended for application in each base for the storage of the herbicide and its coadjuvants

- A well-ventilated covered space should be made available, with a hard surface (concrete floor) to store drums and packages of all kinds. Metal platforms can also be used, with two mobile leaves placed at an angle to each other, in order to facilitate drainage of possible spills. The storage site should be protected appropriately to prevent and hamper the entry of unauthorized personnel

- The raw materials storage area should have shelving and divisions to ensure that products are appropriately separated with sufficient currents of air, ventilation and lighting.

- For the process of preparation of the mix, there must be a platform with a concrete floor, easy to wash, located outside away from the landing strip. A concrete channel 30 cm wide should be constructive around the area to collect up possible spills.

- The preparation area for agricultural chemicals must be well ventilated and easily washed

- At the end of the channel, at the lowest part, et al will be built to collect up product, with sufficient capacity to store in volume of glyphosate normally stored on the base (for security and safety reasons, only one week´s supply of herbicide is stored at a time) they should also have independent spaces for the following purposes:

    - Space for administration and attention to officers and visitors, away from the areas used for the management, handling, preparation and storage of pesticides.

    - There should also be an area for the storage and consolation of equipment, spares and protective devices.

    - Room with two-door wardrobes, for operators´ use.

- Showers and toilets.

- Area for washing machinery, equipment and contaminated clothing, and some treatment of waste and residues. These areas should be equipped with separate installations.

- Area for first aid supplies and implements.

- Other requirements of the competent authorities, justifiable due to the particular nature of the phytosanitary activities, or the kind of products handled.

- It would be desirable for storage spaces and compartments to be separated by galvanized chain link fencing, with 3-inch pipe or section structures, except where special conditions of humidity and temperature other than those prevailing in the surrounding environment prevail.

  - It would be advisable to set up signposting for areas in order to prevent accidents and to restrict mobilization to the areas mentioned (see Educational Communication Program-Record 10)

  - In order to minimize accidents, the supply of herbicides should be effected taking account of all safety measures (see Integral Safety at Bases Record).

  - A ditch should be constructed to collect up rainwater, discharging into the base rainwater systems discharge system (see Wastewater Management Record).

  - It is recommended that some firefighting equipment be available, with sufficient capacity to attend to possible risks in the operation.

  - It would also be appropriate to maintain sufficient equipment to attend to the needs of collecting up spinet herbicide spillages on the soil and in water.

Figure 1 shows the general scheme of an operations base, without taking account of the wastewater treatment plant, which would be built outside it.

### 3.1.2. Preparation of the mix

The process of preparation of the mix of glyphosate in the illicit crops control program should be developed exclusively in installations controlled by the Police. The following specifications and rules should be observed when preparing the mix,

- The operation follows standard, mandatory regulations contained in Ministry of Health Decree 1843/1991, and add certain Colombian Agriculture and Livestock Institute - ICA regulations, although the Colombian Agriculture and Livestock Institute - ICA regulations apply especially in the case of registered by discharge operations on agricultural crops (Resolution 3079/1995)

.

- Equipment must be in perfect working order, to avoid any kind of hazard to the operator, or damage in the community or the environment, and must be permanently maintained, in accordance with technical specifications supplied by the manufacturer or its representative in Colombia.

- Washing equipment should take place in specially-assigned places, avoiding risks to operators and contamination of water sources. Wastewater should also be discharged into the treatment system (see Wastewater Management Program-Record 5).

The mixture should be prepared following the doses established for an optimum effect on illicit crops, without causing damage to the environment. The date of application, the characteristics of the mix with water and the coadjuvant and total volume of discharge are shown in Chart 1. The volume of mix applied or discharged with reference to the type of crop, that is, the effective mix discharge is 23.65 L/ha for coca-leaf, calculating for a 28-nozzle room with holes 2 mm, 1.6 mm and 1.2 mm in diameter.

### 3.1.3. Herbicide load on aircraft

Although police operations in the illicit crops control program are regulated by an exceptional provision of law, some of the proposed provisions of Decree 1843/1991 continue to be applicable. For the main operations base, two special conditions will apply. First, the need to have an operating platform for the preparation of formulations of the pesticide used, which must be located outside away from the landing strip, and built of compacted materials and paved concrete, in "a total area in accordance with the operating capacity, and with drainage effective drainage range slopes towards the waste treatment system". Further, this platform may not be accessed by unauthorized personnel.

For the loading system of the pesticide, the installations of the operations base should have a closed-circuit system which allow the transfer of the product from the mixing tags to the spraying equipment fitted to the aircraft, without causing spillage or environmental contamination.

**Chart 1**

**DOSE OF APPLICATION AND COMPOSITION OF THE MIX USED, BY TYPE OF CROP**

| **MATERIAL** | **COCA l/ha)** | **OPIUM POPPY (l/ha)** |
|---|---|---|
| Commercial glyphosate formulation | 8-10 | 2.5 |
| Coadjuvant Cosmoflux 411 F | 0,23 | 0,5 |
| Water | 15,42 - 13,42 | 47 |
| **MIX RATIOS (%)** | | |
| Commercial glyphosate formulation | 34 - 42 | 5 |
| Coadjuvant Cosmoflux 411 F | 1 | 1 |
| Water | 65 - 57 | 94 |
| **DISCHARGE OF MIX PER HECTARE (L/ha)** | | |
| DISCHARGE OF MIX per hectare | 23,65 * | 50 |

Source: Antinarcotics Police Directorate 2001*Calculation in accordance with the recommendation of Colombian Agriculture and Livestock Institute - ICA, 10 L/ha of commercial formulation diluted in 13.423 L per hectare, and 8 L/ha of commercial formulation diluted into 15.42 L.

**3.1.4. Personal equipment**

Following Articles 176-181 of Decree 1843/1991, environmental and personal protection protective measures must be applied, and compliance will be supervised by the Ministry of Health or it is delegate, which will have powers to determine the existence of risks, and give mandatory instructions on specific measures or devices to be applied in order to eliminate or control the risk of sickness or accident. They may also prohibit any act or omission which reduces the effectiveness of the means of control of risk control for human and environmental health.

The basic equipment required for operations of those is that indicated in the Integral Safety Program (see Record 11)

Colombian law also requires the availability of toilet facilities, medical control and care services, and other sundry obligations to be met by operating personnel, as detailed in the Integral Safety Program (see Record 11)

**3.1.5. Deactivation, elimination, destruction, disposal of wastewater, non-usable pesticide residues, and empty packaging and containers.**

The elimination of glyphosate-contaminated liquid and solid residues is shown in the Wastewater Management Program (see Record 5), and the Solid Waste Management Program (see Record 4) of this EMP.

### 3.1.6. Training courses and processes

Following current regulations, operating personnel must have access to theoretical and practical training courses or processes, for a total of minimum of 60 hours accumulated over one year. Content and form are detailed in the Educational Communication and Training Program. This task is the responsibility of the entity contracting the services of the personnel, and if they have met this requirement, this requirement is more of an informative nature.

### 3.1.7. Technical manual for aerial spraying

Operating personnel, including pilots, must be fully aware of the reasons and technical basis of each phase of glyphosate spraying, and the importance of margins of drift and evaporation - simply as examples - because these procedures give a better understanding of the validity of thresholds permissible for each task. Experience in other phytosanitary work is very positive with regard to the value of some reference publications.

### 3.1.8. Other general recommendations

The following additional measures are recommended in order to enhance the efficiency of spraying operations:

- Do not combine nozzles of different diameters, because this will not give uniform spraying

- Clean nozzle filters after each operation, because they fill up with dust from takeoff and landing.

- In principle, nozzles should be inclined at 180° to guarantee droplet size.

### 3.2. Calibration of spraying equipment

One of the objectives of PECIG  is to prevent negative impact on components of ecological systems intervened with illicit crops of coca-leaf, opium-poppy or marijuana. One good measure to assist compliance with this purpose is to effect spraying within the guidelines in the reference parameters designed for this (see Spraying Operations Management Program, Record 1), and to minimize in advance a good part of the dangers of the adverse effects due to the employment of badly-calibrated equipment, or equipment in poor working order. The greater magnitude of drift is due, in a large number of cases, to spraying effected with winds which are beyond limits.

Although the illicit crops eradication program has a long history in Colombia, there have always been (and possibly, there always will be) doubts about the convenience or otherwise of spraying. There is a wide range of arguments, but principally, there are allegations of damage to flora surrounding the crop as a result of the partial drift of some of the herbicide sprayed.

3.2.1. Characteristics and aircraft for glyphosate spraying

The aircraft selected for this glyphosate spraying operations are TurboThrush T-65, OV-10 and Air Tractor which can be fitted with spraying equipment and which can be directly calibrated from the aircraft and control system, as is the case of the procedure recommended for some new versions (Del Norte Calibration Procedures). In this particular case, the procedures used are summarized in the description below, showing that it is an activity which is almost entirely conducted by the pilot in command of the aircraft.

3.2.1.1. Parameters selected for Del Norte test

Width of swathe 170 feet (51 m) OV 10)

Discharge flow 2.5 gallons per acre (6.17 gallons per hectare, 23.38 L//hectare)

Calibration No. The pilot uses the value in the flow metric sensor

Pump pressure: 55 psi

Airspeed 208 mph

Procedure for electronic calibration (T-65 and OV-10)

1. Check the inside of the mix-tank, to ensure that the recirculation system is working correctly.

2. Drain liquid from the tank and booms

3. Fill tank with 300 gallons of water, and mark with a sticky tape where the surface of the 300 gallons of water reaches

4. Measure and mark the position of extension of the strut

5. Spray with water in a straight line until the panel spraying meter in the cabin shows 200 gallons, at a height of 30 m for coca-leaf and 15 for opium poppy

6. Land and park aircraft in the same spot on the ramp

7. Ensure that the extension of the strut is the same as before taking off.

8. Refill the tank with water up to the mark previously placed

9. Measure and note the number of gallons of water added to the tank

10. If a difference detected, adjust the calibration numbers on the device to compensate the difference

11. Make test flights as required, until achieving the correct calibration. DIRAN will demarcate or set zones for this activity to be conducted

12. After calibration with a long spraying passes, the aircraft should be calibrated for short spraying passes, simulating real conditions. More calibration passes may be required until the correct mark is achieved.

During calibration process, anti-foam material must be used possible.

After the calibration process it may be necessary to recalibrate, using glyphosate.

A log should be kept of all the information obtained in the calibration process, including the name of the person performing it, the pressure, pump pressure, spraying time, and gallons sprayed.

It should be noted that the volume of gallons sprayed is indicated by measures measurements made at the time of reloading the tank, and during the calibration process. The flow rate for spraying appears in the Del Norte or SATLOC device on the cockpit panel.

### 3.2.1.2. Traditional calibration processes

**The aircraft**. T-65 and OV-10, fitted with appropriate spraying equipment and high-precision systems to identify treatment plots.

**Calibration**

The process of calibration of calibration of spraying equipment should be a routine task, conducted as frequently as necessary to obtain relative security that any abnormal occurrences during spraying are not due to malfunctioning or deficient calibration of spraying equipment.

PECIG is an operation of great importance to Colombia. This fact, and the need for preparation and tests before each operation were decisive in the preparation of a summary of technical and operating reference parameters, although they do not include the explanations of the scientific basis for the parameters selected.

Before each spraying cycle, it would be advisable for technical personnel working with DIRAN to check the operational condition of spraying equipment, and to proceed to effect calibrations as necessary.

The calibration or recalibration of equipment can be conducted in the installations of the operations base itself, on the ground, with an overflight at 30 m altitude for coca-leaf and 15 m for opium poppy, so that over time, calibrations can be achieved for different environmental conditions (wind, relative humidity, time of day, etc), using the aircraft selected for routine spraying with glyphosate. It is essential that the calibration process should be under the personal direction of a specialist, whose special training enables him to interpret the numerical results, and to pass judgment on the comportment of one or another reference parameter. The work includes the collection of data related to the number, size and arrangement of marks left by particles when deposited on sensitive paper cards or Kromekote paper, approximately 7.0 x 10 cm wide and long, placed in a straight line some 70-100 m long, at intervals of 1 m. The line must be transverse to the direction of the aircraft flight. Contrast-dyed water should be used (methylene blue or red), to identify the droplets sprayed on the paper. Subsequently, the result should be evaluated and the width of the spraying swathe is defined, with the number of drops per square centimetre and the estimated deposit of the formulation, with respect to 1 ha of surface. It is possible the process of recalibration may be necessary, again requesting the collaboration of specialists.

For the purposes of calibration, account should be taken of operating parameters for spraying, as described in the Aerial Spraying Management Program (Record 1).

**5. FOLLOW-UP AND MONITORING**

- Weekly inspection of storage and pumping installations to detect possible herbicide leaks
- Verification of the collection of residues and materials used in spill control

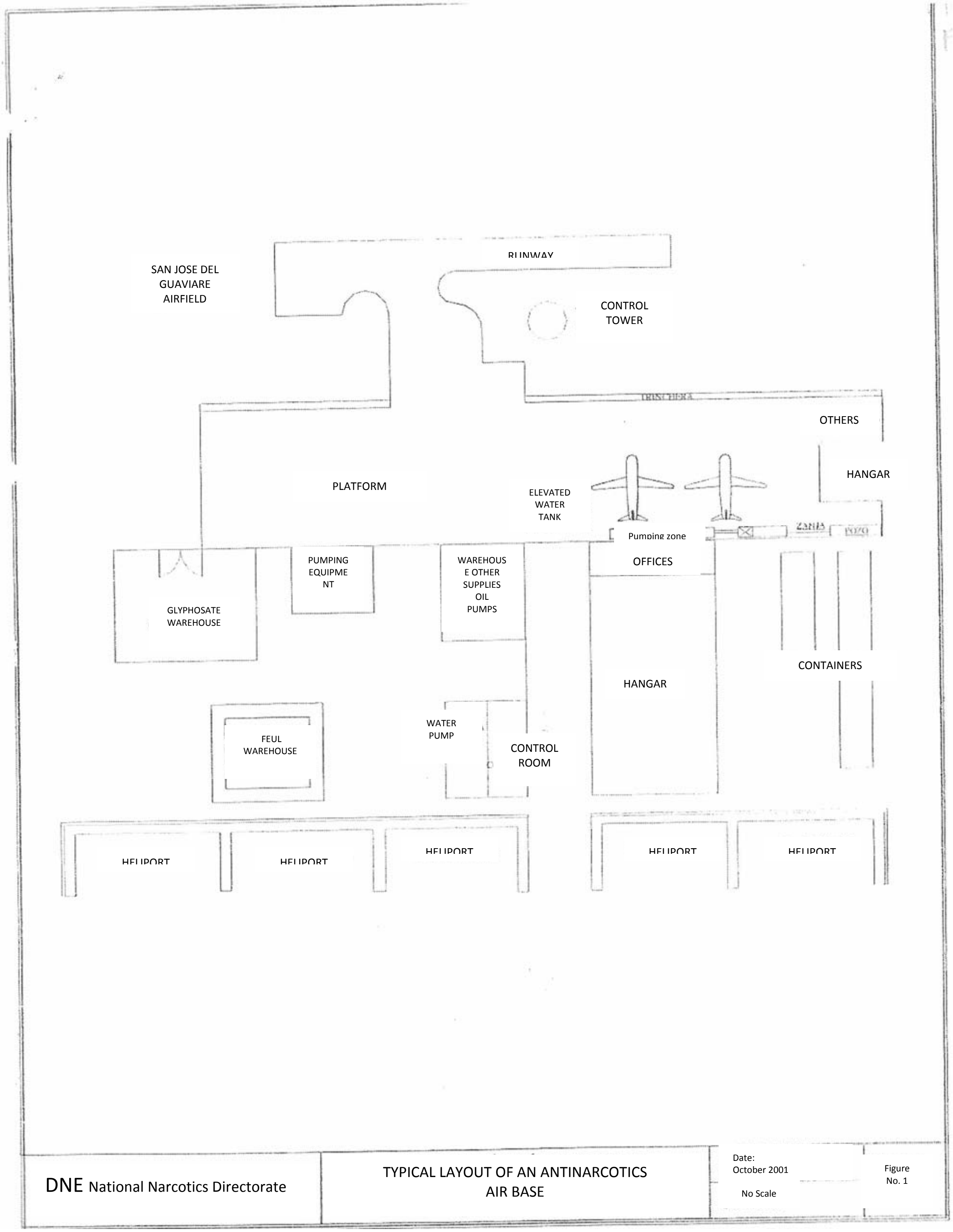
**6. ACCOUNTABILITY**

Antinarcotics Police, Head of the Illicit Crops Eradication area, Base Commander.

**7. COSTS**

The cost of this program is included as part of the normal operating cost of PECIG . Environmental specifications not in principle generate any additional cost

**END OF THE PROGRAM RECORD FOR THE HANDLING OF GLYPHOSATE AND COADJUVANTS IN OPERATIONS BASES**


SAN JOSE DEL GUAVIARE AIRFIELD
RUNWAY
CONTROL TOWER
OTHERS
HANGAR
PLATFORM
ELEVATED WATER TANK
Pumping zone
OFFICES
PUMPING EQUIPMENT
WAREHOUSE OTHER SUPPLIES OIL PUMPS
GLYPHOSATE WAREHOUSE
CONTAINERS
HANGAR
WATER PUMP
FEUL WAREHOUSE
CONTROL ROOM
HELIPORT
HELIPORT
HELIPORT
HELIPORT
HELIPORT
DNE National Narcotics Directorate
TYPICAL LAYOUT OF AN ANTINARCOTICS AIR BASE
Date: October 2001
No Scale
Figure No. 1

| PROGRAM FOR THE MANAGEMENT OF FUEL, VEHICLES, EQUIPMENT AND TRANSPORT | RECORD 3 |
|---|---|

## 1. DESCRIPTION OF THE ACTIVITY GENERATING IMPACT

Aerial spraying operations require the transport, storage and loading of fuel and lubricants for aircraft and land vehicles in PECIG at each operations base, and regular maintenance for aircraft, vehicles and machinery. Also, the transport of glyphosate from port to operated operations bases is usually effected by truck. DNE and DIRAN have supplied information that requires the following equipment:

EQUIPMENT USED IN OPERATING PRAISE

EQUIPMENT

| |
|---|
| OV-10 or T-65 aircraft (spraying) |
| Caravan aircraft to transport personnel or as an ambulance service |
| SAR helicopter on standby |
| Support helicopter on standby |
| Jeeps for local movements |
| Trucks to transport materials locally |
| Pumps |
| Minor tools |
| Articulated trucks to transport glyphosate(rented). |

The operation and maintenance of aircraft, vehicles, machinery and equipment may cause a negative impact on two components, namely:

- During operations and in transits inside the base, there will be atmosphere-contaminating substances emitted such as nitrogen oxides (NOx), sulphur oxides (SOx), carbon oxides (COx), and hydrocarbons (HC), and there may be an increase in levels of sound pressure.

- Further, maintenance may cause contamination of the soil from used greases and oils, changing amount of parts such as filters, bushings, condensers, cables and fuel supplies. Fuel supplies are also associated with possible contingencies

Additionally, vehicles in bad condition increase the risk of accidents and endanger the safety of personnel working in operations.

The possible problems which may be caused by misuse of fuels would arise from storage and spills. Nonetheless, these might also be caused by accident, or by terrorist action. The elements affected would be the soil, flora, water and fauna.

**2. OBJECTIVES**

The objective of the management plan program for fuel, equipment and transport is to prevent and mitigate impact associated with the storage of fuels and the operation and maintenance of machinery and vehicles used to transport glyphosate and fuel.

**3. ACTIVITIES**

3.1. Measures for the general transport of equipment, materials and individuals, and the maintenance of equipment

The activities in this objective are:

- *Proper selection of vehicles.* For the transport of personnel, materials and equipment, recent-model vehicles, machinery and equipment should be used, in order to reduce the probability of accidents, and to comply with quality standards (Decree 948/1995, and regulatory resolutions on mobile sources).

- *The maintenance of spray aircraft* and helicopters working in the program will be regularly conducted in PECIG and hangars at each base. For security reasons, each antinarcotics base will have a system of fuel storage for aircraft and helicopters. The regularity of aircraft maintenance will be that necessary to secure optimum working order, and to avoid accidents, in accordance with current aeronautical regulations.

- *The maintenance of vehicles*, machinery and equipment working in each base will be conducted regularly as recognized and specialized mechanical centres, or at workshops or service stations in municipalities or cities near each base. The regularity of maintenance of vehicles will be necessary to guarantee permanent and proper synchronization. Preventive checks will be made on vehicles every 5000 km, and they will be tuned every 20,000 km.

- *Daily check* on equipment at the base, to detect possible leaks or spillage of fuels and lubricants in vehicles.

- *External maintenance*. Supplies of raw materials and the transporters of herbicide and its guidance will be required to comply with the same standards of maintenance and operation as the PECIG´own machinery, in accordance with Ministry of Health regulations.

- *Parking of aircraft and vehicles*. Spray aircraft and helicopters will be parked at places specially indicated inside the operating bases, adopting appropriate security measures with police personnel. Land vehicles will also be parked in the covered spaces, and will be under guard inside each base. The parking areas will be paved, with appropriate rainwater drainage, and grease traps prior to discharge into the local sewerage or rainwater collecting network

**3.2. Specific measures for the storage and handling of fuels**

As noted, the fuels required for aircraft and land vehicles will be stored and supplied directly to each base, for security reasons. It may also be acquired in commercial aerodromes. For this purpose, the will have to be a system storage and temporary supply system available inside the base, with the following meeting the following requirements.

- *Preparation of a covered area with a hard zone (concrete floor). The supply of fuels.* Around this hard zone, a 30 cm concrete channel will be constructed at one side to connect possible fuel spillages. At the end of this channel, at the lowest point, there will be an oil and grease separator for separation from fuel (see Figures 1 and 2). This place will also act as a provisional storage site for used oil.

- Construction of a concrete perimeter wall, with capacity to retain 120% of the volume of fuels in store.

- There may be alternatives for the storage structure, which may vary as a function of the local topography and security conditions in relation to possible terrorist attack. The only condition is that there should be sufficient additional volume to store the fuel stored in the event of attack or accident, such that fuel can be collected, and will not flow out of the hard compartment.

- Signposting areas to prevent accidents and restrict mobilization in these areas.

- Supplies of fuels must be effected in observance of also safety measures, in order to minimize accidents.

- Construction of a ditch to collect rainwater with the oil and grease trap.

- Maintain sufficient firefighting equipment for any eventuality.

- Maintain sufficient equipment to correct collect possible fuel spills (pumps and barrels).

### 3.1. Special measures for the transport of glyphosate

Normally, glyphosate can be carried by land or in critical areas by air. Generally, it is taken to the antinarcotics bases in articulated trucks or other large trucks depending on the volume transported. The following should be the minimum requirements taken into account for contracting transport:

*General requirements:*

- The carrier must have a haulage licence
- The vehicle must have a health licence for transport, issued by the regional transport health authority where the vehicle is registered
- Preparation of a duplicate manifest is delivered by the seller or distributor and received by the person driving the vehicle
- Content of the manifest: date, place of delivery, data of the carrier, identification of the vehicle, date information on the material to be transported, destination of the material
- Instructions on the material to be transported delivered to by the seller of the material and received by the driver, together with the manifest.
- Contents of the instructions: identification of the product, precautions of the product, emergency measures, addresses of those institutions close to the route.
- Log. The purpose of the log is to record the delivery of material to be transported, delivery of the manifest, and instructions regarding the material, with the signature of receipt to satisfaction by the carrier
- Policy. The contractor must have an insurance policy for a value of not less than 1% of the value of the goods to be carried

*Requirements of the vehicle*

- Physical separation of the cargo area and the cabin
- The cargo area must be in corrugated metal sheet, or smooth wood free of obstacles
- The cargo area must have a canvas cover or metal cover. The tank may be high-density polyethylene plastic.
- The cabin must be equipped with the following items: first aid kit, medicaments related to the therapy of the product, portable international warning signs. The vehicle must carry the "danger" symbol on visible parts, sized 20 x 50 cm, with reflective paint.

*Prohibitions during transport*

- The vehicle may not carry products or goods other than pesticides at the same time.
- The pesticide may not be transported with any individual located in the unloading or loading zone
- Pesticides may not be carried in the cabin

*Loading and unloading operations*

The unloading of the 55-gallon drums from the trucks will be effected by forklift, in order to avoid possible accidents.

Likewise, to prevent problems due to deterioration of the drums, or breakage or contamination, there must be a stainless steels or high-density polyethylene plastic tank.

Steel-coated tanks or galvanized tanks or galvanized tanks may not be used for transport

Trucks may not be parked close to restaurants, schools, crops, animals, watercourses or lakes.

**4. SCHEDULE**

The Program will commence when operations begin and continue throughout the duration of operations

**5. FOLLOW-UP AND MONITORING**

Daily inspections of equipment, characterization of the effluent to the grease trap, every time there is a spill; the parameters to the measured are oils and greases, and DQO.

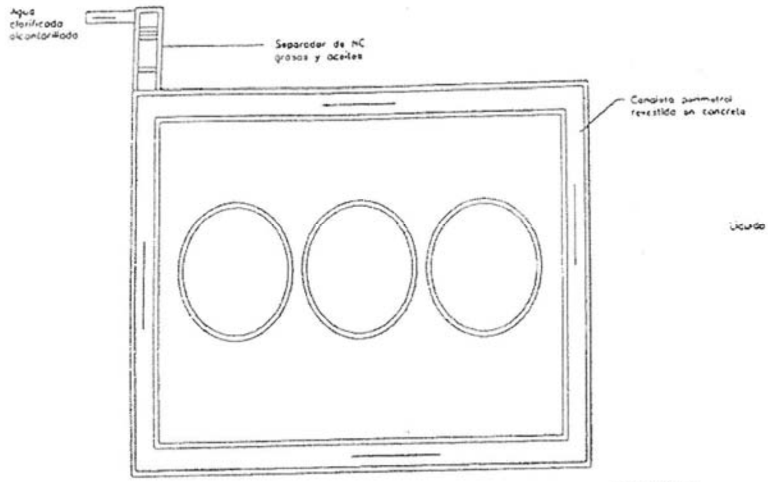
**6. ACCOUNTABILITY**

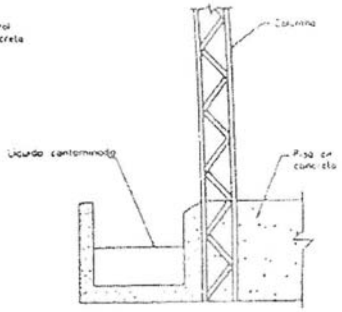
The Antinarcotics Division of the National Police DIRAN

**7. COSTS**

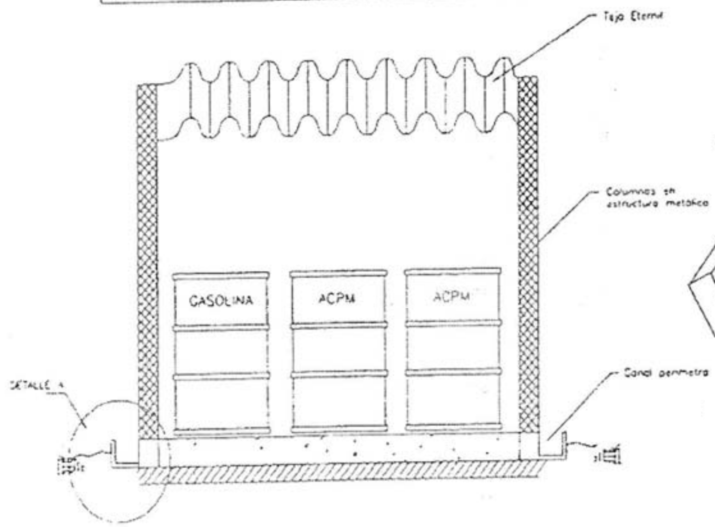
COP 1.5,000,000 a year for characterization of the water. The construction of the storage and supply system, and the maintenance hangars, are activities proper to PECIG in each base, and their costs form part of the normal investment of the project, that is, they are not costs attributable to the EMP.

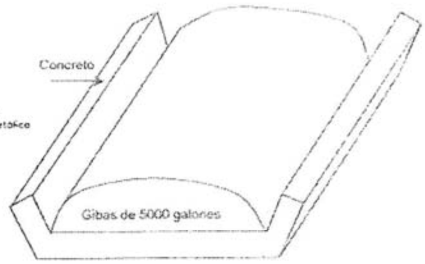
**END OF THE PROGRAM FOR THE MANAGEMENT OF FUEL, VEHICLES, EQUIPMENT AND TRANSPORT.**



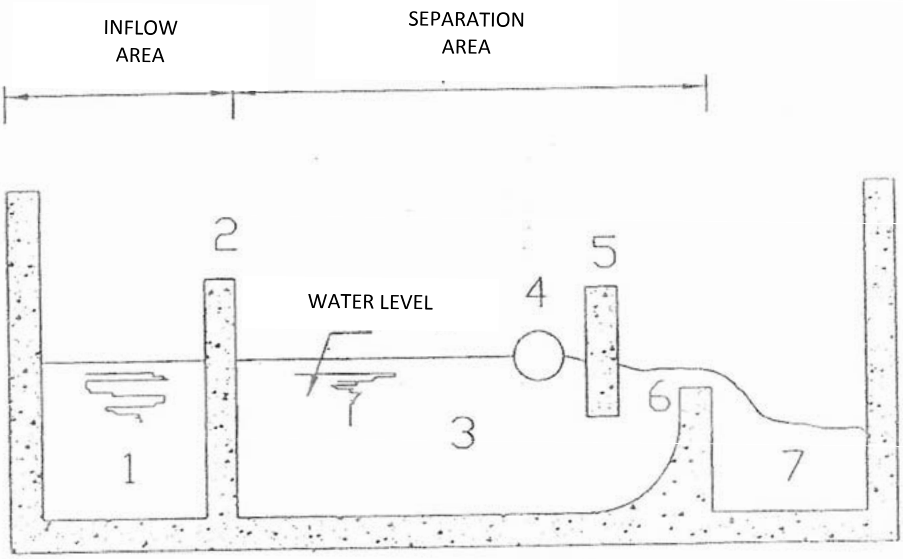

FOR SOLID WASTES

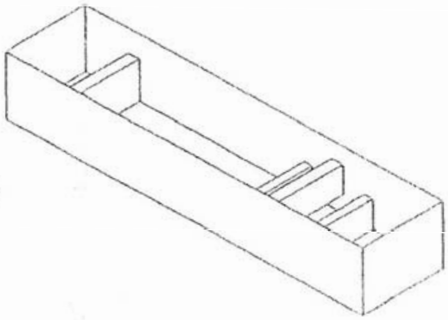



SAFETY ALTERNATIVE
USED IN SOME BASES

| | | | |
|---|---|---|---|
| DNE National Narcotics Directorate | MANAGEMENT OF FEUL<br>Deck for management of fuel in mobile operations bases | Date:<br>October 2001<br>No Scale | Figure<br>No. 1 |



1. Inflow Chamber
2. Flow distributor
3. Separating Channel
4. Foam Dissipater
5. Oil Retaining Device
6. Outflow Section
7. Pouring of the flow

| | | | |
|---|---|---|---|
| DNE National Narcotics Directorate | MANAGEMENT OF FEUL AND OILY WATER | Date: October 2001<br>Sin Escala | Figure No. 2 |

| PROGRAM FOR THE HANDLING OF SOLID WASTE | RECORD 4 |
|---|---|

## 1. DESCRIPTION OF THE ACTIVITY

Activities proper to the antinarcotics operations base of the Police, and glyphosate spraying operations generally three types of solid waste: domestic, special, and glyphosate-related.

The domestic solid waste is generated in quantities, quality, nature, composition and volume by the activities of personal, accommodation or any similar establishment, and are formed by organic matter (food residue), mainly paper, cardboard, glass, plastic, etc.

According to the normal population of operations base with a per capita production of an average of 0.4 kg/individual/day of domestic solid waste, the production would be 48 kg/day and 336 kg/week

Special solid waste is formed by empty packaging, oil, grease, used lubricants, epoxy paint containers and polyurethane-based paint containers, vinyl paint, solvents, accelerants, sealants, materials contaminated with used oil, fuel, or oil derivatives, metal shavings, rubber packing, packaging and crating materials used, and lead acid batteries, in general. The production of 60 kg/day and 40 and 20 kg/week is estimated for these this form of waste (Chart 1)

Glyphosate-linked solid waste is composed of empty plastic drums and other types of glyphosate containers and those of the coadjuvants. For all bases, a total generation of 2850 plastic 55 gallon drums and 3619 5-gallon plastic containers is estimated. The distribution by bases is shown in Chart 2. The average daily production of all bases is therefore 8 x 55-gallon drums and 10 x 5-gallon plastic containers. Nonetheless, as the spraying does not take place every day because of weather factors, public order, and so on, daily production may vary considerably.

The following toxins and contaminating items require special handling:

- Lubricating oils and greases. Lubricating oils and greases are 85% by volume composed of organic compounds, mostly aromatic, polynuclear, and present in raw materials, and 15% are additives containing sulphur, nitrogen and trace metals which are introduced during use as lubricants of metal parts.

- Residues from the handling of glyphosate, being impregnated with the herbicide and all its coadjuvants.

Inadequate disposal of this waste may cause contamination of the soil, water and air, the appearance of disease-carrying vectors, and problems of odour and unsightliness.

## 3. ACTIVITIES

### 3.1. General specifications

The following are some of the general measures to be followed in handling, collecting, carrying and disposing of solid waste. Subsequently, we will give some specific measures for each of the categories of solid waste.

**Chart 1**

**TOTAL SOLID WASTE GENERATED**

| Type | Phases of process | Waste matter | quantity |
|---|---|---|---|
| Domestic | operations bases | organic matter, paper, cardboard, glass, plastic, rubber, wood, other | 336 kg/week |
| Special | Construction operation:<br>Stores operation:<br>Sundry resources | Construction waste<br>Packaging waste<br>Mixes and other forms of waste oils and greases,<br>Metal shavings from maintenance Laboratory analysis | 420 g/week |
| | | | |
| Special glyphosate | Glyphosate packaging | 55-gallon plastic drums | 2850 drums |
| . | Cosmoflux 411F containers | 5-gallon plastic containers | 3619 containers. |
| | | | |

Source: This study

The production of each of these types of waste per base is very different, since it depends on the number of individuals living there, the number of vehicles, the number of aircraft and flights undertaken.

- Refuse, particularly in offices, camps, restaurants and maintenance workshops, should be kept in an appropriate manner, separating domestic waste from special waste.

- Provisional containers for domestic and special waste should be covered with a lid

- Waste material should never be allowed to be burnt

- Refuse may not be accumulated in public places, nor at places of work, or in ditches, etc.

- No kind of waste which is environment should be located in an environmentally sensitive place for partial or permanent disposal. A site should be chosen as protected from the action of the wind, at a distance from water sources or currents, where there is no interruption to natural drainage or watercourses, and if there is, to design control measures such as external channels and locate them at prudent distances from places where there are groups of human populations.

- The number of sterile dumps and in general places for disposal and storage of solid waste should be kept to a minimum.

- In general, all receptacles containing some kind of special or hazardous waste should be marked, showing the characteristics of the product and the danger involved if the receptacle is opened.
- A recycling plan should be implemented, in which put materials such as paper, metal and glass (recyclable) should be separated from other waste. Appropriate receptacles will be provided for recyclable material, to create a suitable environmental awareness.

- Warehouses will be used for the temporary storage of waste separately from the special solid waste (drums and containers of the herbicide), and for recoverable and recyclable solid waste (see Figure 1). The conventional non-recyclable or re-usable solid waste will be placed in plastic bags for adequate handling and the control of vectors, and kept temporarily in covered containers, until taken to the place of final disposal. Each compartment for special residues will have 55 gallon drums not contaminated with glyphosate for temporary disposal of the classified waste. Non-recoverable waste will be taken directly to the dump, or to the sanitary infill.

### 3.2. Handling of domestic solid waste

This classification includes waste produced in offices, camps, cafeterias or restaurants, or any toilet or washing washroom facilities, and will receive the treatment described below. The classification covers:

- Food
- Prepacked food cans
- Paper and cardboard
- Used textiles
- Glass
- Plastic and glass receptacles

Depending on distribution of the working areas in the operations base, receptacles will be located in each case for collection and classification in situ of domestic waste. In addition, personnel working at the base, security personnel and visitors will be given instructions with regard to classification at the places of origin, in order to facilitate handling. The receptacles will be emptied as follows: organic nonrecyclable waste, comprising food scraps, will be disposed of in the sanitary infill in the nearest town. Other waste will be taken every day to the temporary disposal site, and subsequently to the dump.

Waste temporarily stored will be disposed of in drums or plastic containers, in an enclosed, tiled space, (zinc, asbestos or all cement tiles), with grill type ventilation or chain-link fencing. There will be plans and mechanisms for supervision and control of hygiene, in order to avoid unpleasant odours or the proliferation of insects or rodents (see Figure 1).

The final disposal of this waste will be achieved as shown in Chart 2.

Recyclable solid waste (Glass, paper, cardboard, wood, etc) will be delivered to the recycling cooperatives of the town and/or surrounding area. The recyclable material should be placed in a collect and collection site set aside for the purpose, meeting the following conditions:

- Dry plastic, free of organic material, organized in bags
- Paper, free of organic material, in blocks
- Broken or whole glass, without extraneous objects, in bags
- Metal and scrap without extraneous material, washed and in bags
- Cardboard free of grease, in blocks

### 3.3. Handling of special solid waste

The handling of this type of waste includes the program for withholding at source, involving classification, recycling, re-use and final disposal.

Special solid waste must have separate and careful treatment due to the high potential for contamination. Used oils, lubricants, acids and batteries, amongst others, are hazardous waste. The following measures should be taken to evacuate this waste in an appropriate manner, without causing damage or contamination to the environment.

**Chart 2**

**CATEGORY DESICCATION OF DOMESTIC WASTE AND MEANS OF DISPOSAL**

| TYPE OF MATERIAL | DISPOSAL AND FINAL TREATMENT |
|---|---|
| Paper and cardboard | Transport in drums, recycling |
| Plastic | Transport in drums and recycling |
| Wood | Transport in drums and recycling |

| | |
|---|---|
| Rubber | Transport in drums and recycling |
| Metals | Transport and recycling |
| Glass | Transport and recycling |
| Leather | Transport and recycling |
| Food waste | To the community, for animal husbandry, or sanitary infill |

*Used greases and oils*

Burned or used oils from machinery, vehicles, plant or workshops must be stored in metal or plastic 55 gallon metal or plastic drums in good condition, with anticorrosive paint, which can be sealed.

Empty oil cans must be packed in plastic bags, which will be sealed when full, deposited in metal drums for sealing, and taken to the special waste section in the domestic waste dump.

*Sanitary infill*

The solid waste management program will be complemented with workshops on environmental education, addressed to operators and employees on the base (see Environmental Education Program).

*Separation*

The classification and separation of this waste will be effected at the point of origin, so that subsequent work will not be completed or require more time than necessary. For this, there will be specific receptacles in different areas, with standard colours: recyclable (green), special (red), oily (black), and for infill or incineration (yellow).

Used metal equipment or parts will be classified as follows:

Type A: New

Type B. Used, in good condition for reuse

Type C. Used, in a fair state for less demanding use

Type D. Used, in poor condition, to be used as supports, accessories, etc, for sale in lots, or

disposal.

Materials such as filters and batteries will have a special collection point within the fuel stores, so that they are not mixed with other waste for subsequent recycling.

*Disposal*

Once waste has been classified, quantified and stored, it can be sent for final disposal. The alternatives for this are recycling, depending on the type of waste produced. Disposal of waste is not need not be effected in a secure sanitary infill, nor will incineration be required, given the characteristics of the products and the quantities to be produced

For recycling action, the following procedures and activities will apply:

- Metal, plastic and rubber waste will be reused, if possible in other program activities, or stored until sufficient quantities obtained for disposal.

- For containers and other materials that have had contact with chemicals or hydrocarbons, there must be decontamination or treatment prior to sale, taking account of the manufacturer's recommendations for each product.

- Acid from laboratory tests must be bottled in acid-resistant receptacles, and properly marked, showing the corrosive potential of the product, deposited in metal drums and taken to the special waste point in the domestic waste sanitary infill.

- Used batteries have considerable quantities of heavy metals, such as lead, which has a high potential for contamination. Batteries must be handled in accordance with their composition. Where possible, they should be sold to local recycling cooperatives. The production of batteries is likely to be very low, being limited to vehicles and engines on the base. If the product cannot be sold to recyclers, it should be disposed of in corrosion-resistant metal drums, firmly sealed and disposed of at the special waste point in the domestic waste infill.

Waste which cannot be recycled will be disposed of as follows:

- Oil, grease and hazardous waste: oils use oils and greases will be eliminated by specialized companies, authorized to do so. The containers for hazardous substances will be returned to the supplier

- Wood and metal waste. Each material will be selected and separated, and sold for recycling or use.

- Where possible, the use of hazardous substances will be avoided, since they may become toxic elements upon disposal.

- In particular, the use of substances or products which contain the following will be avoided:
  - Asbestos
  - Chlorated substances
  - Lithium-based batteries
  - PCBs
  - Mercury.

If it is unavoidable to use these substances, use will be the responsibility of the contractor, and with the prior authorization of the environmental authority

- Accidental spills of special chemicals will be reported to the contractor responsible for this activity, who will be responsible for the control and handling and restoration of the areas affected.

### 3.4. Glyphosate-linked solid waste

As indicated, glyphosate is to be handled in 55-gallon plastic drums in which the glyphosate comes, and Cosmoflux 411F in its 5-gallon plastic receptacles.

From a technical point of view, there are several recommendable procedures for deactivating pesticide waste, though some of them may not be applicable due to problems of an economic or functional nature, or because the nature of risks involved does not merit such demanding procedures. The following are the commonest methods:

*Disposal in natural or artificial depressions in the soil*. This is a system of storage in places which do not facilitate dragging from water currents, but which allowed solar radiation and evaporation to accelerate deactivation of pesticide wastes. It is difficult to find an appropriate place inside an operations base, but in some cases there may be somewhere close by where it would be feasible

*Burial.* If there is space available, and the use of sanitary infill is can be facilitated, this is an applicable system but, as in the previous case, water run-off must be avoided

*Incineration.* Incinerators are useful to eliminate solid and combustible waste, but account must be taken of the problem of emissions of gas and unpleasant odours.

*Chemical deactivation.* In cases where the quality of toxic wastes permits, oxygenating agents can be used, with the addition of chlorine, and the use of caustic substances, coagulants, or ion-exchange substances

*Use of volcanic craters*. There have been some positive experiences with the use of volcanic craters as a place to eliminate pesticide waste. The main problem is the cost of transporting materials to be deposited into the crater centre.

The elimination of containers for glyphosate, the emulsion, and any other product added to the formulation is one of the problems of greatest concern. Article 153 of Law 1843/1991 specifically indicates that empty packaging and containers for pesticides may not be reused, and that any treatment given to them must be approved in advance by the health authorities.

Although the plastic containers used in the sale and transport of glyphosate may be used for other purposes, government regulations are firmly opposed to this, in order to avoid any risk of contamination. As a suggestion, and taking account of the glyphosate is not a highly toxic pesticide, it would be possible to justify some use as such as receptacles in which to collect refuse, provided that they are thoroughly washed, deactivated with a caustic soda solution, with multiple perforation of the base and sides (in order to avoid their use to carry water or other liquids).

There is always the possibility of recycling, either as raw materials or as containers for reuse by the same company that produces the glyphosate. This is the alternative selected by DIRAN, and there is an agreement with Monsanto (Compania Agricola Colombiana), the importer, and they regularly collect up containers and take them to their the following specifications must be met for this to occur:

- Storage in one of the warehouse compartment for the temporary disposal of recyclable waste

- When there is a sufficient quantity of containers, the glyphosate distributor Monsanto will be advised, so that it can collect them and take them to its specialized deposits

- The water used in washing the containers at the base will be reused in the aircraft tanks

- It is not recommended that drums be sold or given away to the local inhabitants, for the reasons given above, and because in general, smallholders wash the pesticide receptacles in streams and rivers, thus contaminating surface waters.

**4. SCHEDULE**

This is a normal and permanent activity in each operations base

Environmental education workshops will be held regularly, as indicated in the Educational Communications Program Record.

## 5. FOLLOW-UP AND MONITORING

- Daily inspections of the temporary storage facility for waste
- Weekly inspections of all base installations to check compliance in activities
- Weekly follow-up of the recovery and recycling program

## 6. ACCOUNTABILITY

The Commanding Officer of each DIRAN operations base

## 7. COSTS

COP15,000,000. This includes the construction of the warehouse and the supply, painting and installation of classification drums in each base. If there is already a warehouse there, or part of a hangar can be set up for the storage of this kind of waste, the cost will be much lower, or non-existent.

| END OF THE PROGRAM RECORD FOR THE HANDLING OF SOLID WASTE. |
|---|

| WASTEWATER MANAGEMENT PROGRAM | RECORD 5 |
|---|---|

## 1. DESCRIPTION OF ACTIVITIES

Wastewater generated at the Antinarcotics Police operations base is of three main types:

- Domestic wastewater, generated by base personnel during operating time (10 working hours), which may be of the order of 38.8 m³/day during operations (90% of consumption)

- Water from watching the installations, part of which will filter or evaporate off, and the rest will go to the rainwater network

- The rainwater will go to a collection system independent of sewage, and is evacuated away from the operations base

- Water from washing the aircraft tanks contaminated with glyphosate.

The typical composition of domestic wastewater appears in Chart 1. The composition of wastewater from washing and general maintenance of the installations will have a higher content of solids in suspension, detergents, and perhaps oils and greases. Rainwater carrying sediment from the soil will have high concentration of total solids and solids in suspension. Water from washing on aircraft tanks will have the remains of glyphosate and detergents.

Each type of water has different impact. The high level of organic and bacterial contamination from domestic wastewater may affect the health of workers exposed, or increase problems of contamination of water currents close to the area, if discharged into them. Water from washing and general maintenance of the installations will have moderate DQO, and greater turbidity, and its principal effect will be aesthetic. Rainwater carrying sediment, when reaching the local run-off network will cause an increased in turbidity of water, and slight sedimentation. The water from washing on aircraft tanks may affect operators´ health, even though the high degree of dilutions can mean that its expected high impact will be insignificant.

Given that the greater part of operating bases are located close to existing airports, equipped with their own sewage systems, or which form part of a municipal sewage system, the measures for the collection and treatment of domestic wastewater shown below only applied to new bases constructing in places which do not have a public sewerage system in which to be discharged.

**2. OBJECTIVES**

The general objective of the wastewater management system is to mitigate impacts associated with production and base operation. The actions in particular are:

- To provide a proper form of management of liquid waste, in order not to cause additional contamination in local and regional water source resources.

- To avoid the discharge of wastewater and to maintain the natural conditions of water quality in the water currents located in the area of influence of the operations base

3. ACTIVITIES

The objectives of quality in respect of wastewater in the operations base are those indicated in Chart 2.

**Chart 1**

**TYPICAL COMPOSITION OF DOMESTIC WASTEWATER**

| PARAMETER | CONCENTRATION | | |
|---|---|---|---|
| | HIGH | MÉDIUM | LOW |
| Total solids (mg/l) | 1200 | 700 | 350 |
| Total dissolved | 850 | 500 | 250 |
| Fixed | 525 | 300 | 145 |
| Volatile | 325 | 200+ | 105 |
| In suspension | 350 | 200- | 100 |
| Fixed | 75 | 50 | 30 |
| Volatile | 275 | 150+ | 70 |

| PARAMETER | CONCENTRATION | | |
|---|---|---|---|
| | HIGH | MÉDIUM | LOW |
| Sedimentable solids (mg/l) | 20 | 10 | 5 |
| DBO (5 días, 20 °C) | 300 | 200 | 100 |
| DQO | 600 | 400 | 200 |
| Total nitrogenNitrógeno total (como N) (mg/l)<br>Organic<br>Ammoniac | 85<br>35<br>50 | 40<br>15<br>25 | 20<br>8<br>12 |
| Total phosphorus (as P) (mg/l) | 20 | 10 | 6 |
| Chlorides (mg/l) | 100 | 50 | 30 |
| Alkalinity (as $CaCO_3$) (mg/l) | 200 | 100 | 50 |
| Grease (mg/l) | 150 | 100 | 50 |
| Calcium (as Ca) (mg/l) | 110** | - | 10* |
| Magnesium (as Mg) (mg/l) | 8** | - | 10* |
| Sodium (as Na) (mg/l) | 100** | - | 23* |

**Chart 2**

**CONDITIONS OF EFFLUENT**

| REFERENCE | VALUE |
|---|---|
| PH | 6,5 – 9 |
| DBO (mg/l) | 16 |
| DQO (mg/l) | 30 |

| | |
|---|---|
| Total solids (mg/l) | 300 |
| Suspended solids (mg/l) | 100 |
| Oils and greases (mg/l) | None |
| Tensoactives (mg/l) | 0,5 |
| Total coliforms (NMP/100 ml) | 1.000 |
| Fecal coliforms (NMP/100 ml) | 5.000 |

Source: CAR, 2000.

**3.1. Design parameters for wastewater treatment systems, for domestic wastewater.**

An operations base has average permanent daytime population of employees in all areas of 120. Working hours are 10 hours a day

*Demand and design flow*

The typical consumption of water and various activities and contaminating loads are shown in the chart 3.

Estimating the demand and flow for the group mentioned, and taking account of the warm climate in the area, the situation is as follows:

Equivalent demand per employee 150 L/inhabitants/day

Return coefficient 0.9

Design flow 38.8 $m^3$/day or 0.45 m/second

**Chart 3**

**TYPICAL CONSUMPTION OF WATER AND LOAD CONTAMINANTS**

**TYPICAL CONSUMPTION**

| | | |
|---|---|---|
| Accommodation | Consumption per resident | 200 L/inhabitant/day |
| Camp | Consumption per resident | 150 L/habit and/day |
| Office | Consumption per user | 70 L/inhabitants/day |
| Restaurant | consumption per plate served | 11 L/plate |
| Health centre | consumption per person | 200 L/person/day |

**CONTAMINATION LOAD**

| | |
|---|---|
| DBO | 54 |
| DQO | 91 |
| Suspended solids | 105 |
| Total nitrogen | 4.8 |
| Total phosphorus | 1.4 |
| Detergents | 0.32 |

*Location of the residual waste water treatment system*

The wastewater treatment system should be located where it will not cause damage that could cause contamination in any well, spraying or other source of water supplies. Further, it should be located in a place where the slope specified for the evacuation of the effluent treated can be achieved. The location should be such that it has an adequate land area, and is easy to access.

### 3.2. Wastewater management

The management of liquid waste will be focused on the following components:

- Segregation of currents
- Treatment of effluent
- Final disposal

### 3.2.1. Segregation of currents

The segregation of currents inside the operations base is intended to separate the various drainage systems, such that rainwater will not be contaminated, and will be returned directly to the natural medium

Therefore, the operations base must have the following water management systems:

- Domestic wastewater
- Rainwater
- Special liquid waste from washing aircraft tanks

### 3.2.2. Treatment of effluent

*Rainwater*

Rainwater (roofs, parking areas, etc) will be drained straight into natural drainage. The system proposed collector rainwater from the following areas.

- Platforms, gardens and sporting facilities
- Internal roadways, roofs of buildings, administration, hangars, workshops and parking area

In general, the system for collecting rainwater will be formed by rectangular and trapezoidal ditches, as indicated in Figure 2

The water collected in the workshops and stores, and amongst other areas, is prone to contamination, and will be carried away in a ditch system to the final treatment system, after passing through grease traps in accordance with the scheme of Figure 1.

The entire rainwater system will contain the following structures

- Box ditches
- Km-type grid ditches
- Perimeter ditches all round the working area

*Liquid waste from aircraft tank washing*

The wastewater use for the washing of spraying equipment and aircraft used in the application of glyphosate is in always the most important concern at the operations base. The applicable provisions of Decree 1843/1991 of the Ministry of Health do not give details of the procedure of the most efficient procedure, but suggest that waste be subjected to treatment prior to the exhibition "so the effluent will not pass permissible officially permissible limits", and these limits vary depending on the type of use of the receiving body of water, established in Decree 1541/1974. Among the possible systems that can be used, the following:

*Biological systems*. This is a suggestion suited to installations in which liquid and solid pesticides are handled (solid pesticides do not apply to the operations bases). It involves the use of filters, sedimentation tanks and aerobic and anaerobic digestion, four times which are for which exceed one or two weeks

*Deep burial.* This maybe an appropriate procedure if deep wells of use. It is possible to find an appropriate place, taking care not to contaminate underwater aquifers

*Chemical deactivation*. In cases in which the quality of toxic waste allows, oxygenating agents can be used, with the addition of chlorine, and the use of caustic substances, aquariums, or ion-exchange substances.

The most appropriate method in the case of the bases, is to collect up the water which runs off the leading, washing and maintenance platforms for the spray aircraft through channels or ditches which discharge their content into pools stabilization pools, and then after some time, discharge them into an area of land specially selected to act as the place of degradation due to the effect of environmental factors. Figure 3 shows a scheme of stabilization pools. It is estimated that two pools in a chain, of 6 m³ each, communicated through a spillway and duct or channel, may meet the needs of deactivation 2 GB deactivate the rest of glyphosate-contaminated waste.

*Treatment system for domestic wastewater.*

Given the characteristics of climate, and temperature in anaerobic processes which improve the rate of biodegradation, and principally, the time over which the bit of the operations base will be used, and the costs implied in constructing a treatment system each time in rules is made to another site, the proposal is that a mobile compact mobile treatment system should be implemented. Such a system requires permanent maintenance, but at a low-cost, because it only requires a small number of low-qualified personnel, and can be dismantled and set up again somewhere else. Therefore, the recommendation is that this system of treatment of domestic wastewater should be implemented in all operations bases.

It is to be understood, however, that adequate and constant maintenance must be guaranteed in order to avoid biological destabilization of the process, and consequently, the proliferation of unpleasant odors as a result of hydrogen sulfide release.

The operations sites are not of the same size or permanence over time. In some cases, most workers live in neighboring cities or police barracks. In others, sites have duration of few months while the illicit crops problem is controlled. In these conditions, it will not be necessary to build permanent systems of sanitation and waste water systems. Based on the daily population volume of the site, the Anti-Narcotics Police (DIRAN) may equip each site with portable toilets connected to a septic tank with biological filter and a discharge system in the filtration field. In this case, the septic tanks should be located not less than 50 meters away from a body water or accommodation.

As an alternative to implementing a compact treatment system, there are commercial plants that meet the above requirements. Such is the case of the ACUASEG-A-40 treatment plant, whose technical characteristics appear after the technical and financial offer of ACUATECNICA LTDA.

*Description of the system:*

The proposed system is comprised of the following items:

INLET MANIFOLD: is a by-pass for plant feeding

INLET BOX: built in carbon steel, dimensions 0,5 x 0,7 x 1,0 m

AIR REACTOR: cylindrical, horizontal position, mounted on Ski profiles, dimensions: 2,0 diameter and 8.0 m long. This shape allows transfer to other sites. Capacity: 41 m3.

SETTLER: rectangular, pyramid background, dimensions: 2.5 m long, 1.0 m wide and 3.0 m high (includes 1.0 m of pyramid trunk). Capacity: 9 m3.

CHLORINATION CHAMBER: rectangular, 0.5 m3 capacity, located at effluent outlet. Dimensions: 1.0 m long x 0.7 side x 0.5 m high.

AIR PIPE: galvanized tubing main network, 2” diameter.

AIRLIFT PUMP: allows mud recirculation

BLOWER: capacity of up to 2500 cubic feet of air/m3 water/day; must be coupled to a three-phase power motor of 220/440 V.

DIFFUSERS: have a capacity of 10 cubic feet/minute, made in high resistance ABS plastic and implemented with a non-clog isolation membrane.

SKIMMER: in form of adjustable funnel, made of carbon steel and mounted on the settler, leads water to drain and shut-off valve through a tube.

Other elements:

Platform and access staircase for inspection and monitoring.

Control board.

The Annex shows in detail the technical characteristics of each component of the treatment system.

This system is designed for a design capacity of 40 m3/day and a maximum capacity of 50 m3/day.

The following are the expected load and main features:

- DBO load: 13 kg/day
- SS load:  15 kg/day
- Average retention time: 20 hours
- Maximum airflow: 2.500 cubic feet of air/m3-day
- Recirculation between 50% and 120%
- Total efficiency of the system: 95% DBO and SS removal

The overall system is built in rated steel.

### 3.2.3 Final disposal

Once the effluent meets the conditions required in the dumping site, the discharge can be effected, depending on the use of the receiving water flow, as provided for in Decree 1541/1978 and 1594/1984.

## 4. TIME SCHEDULE

The wastewater treatment and tank wash systems must be constructed before starting operations in the site.

## 5. FOLLOW-UP AND MONITORING

- Verification of the treatment system construction and compliance with sanitary regulations and efficiency specifications.
- Verification of the correct construction of home residual waters collection, treatment and disposal, taking washing and rain waters to be generated during the time of permanence of the operation activities in the site.
- Quarterly sampling of basic sanitation parameters (DBO, DQO), total and suspended solids, pH, total and fecal coliforms), to test the efficiency of the treatment system and compliance of dumping regulations

## 6. ACCOUNTABILITY

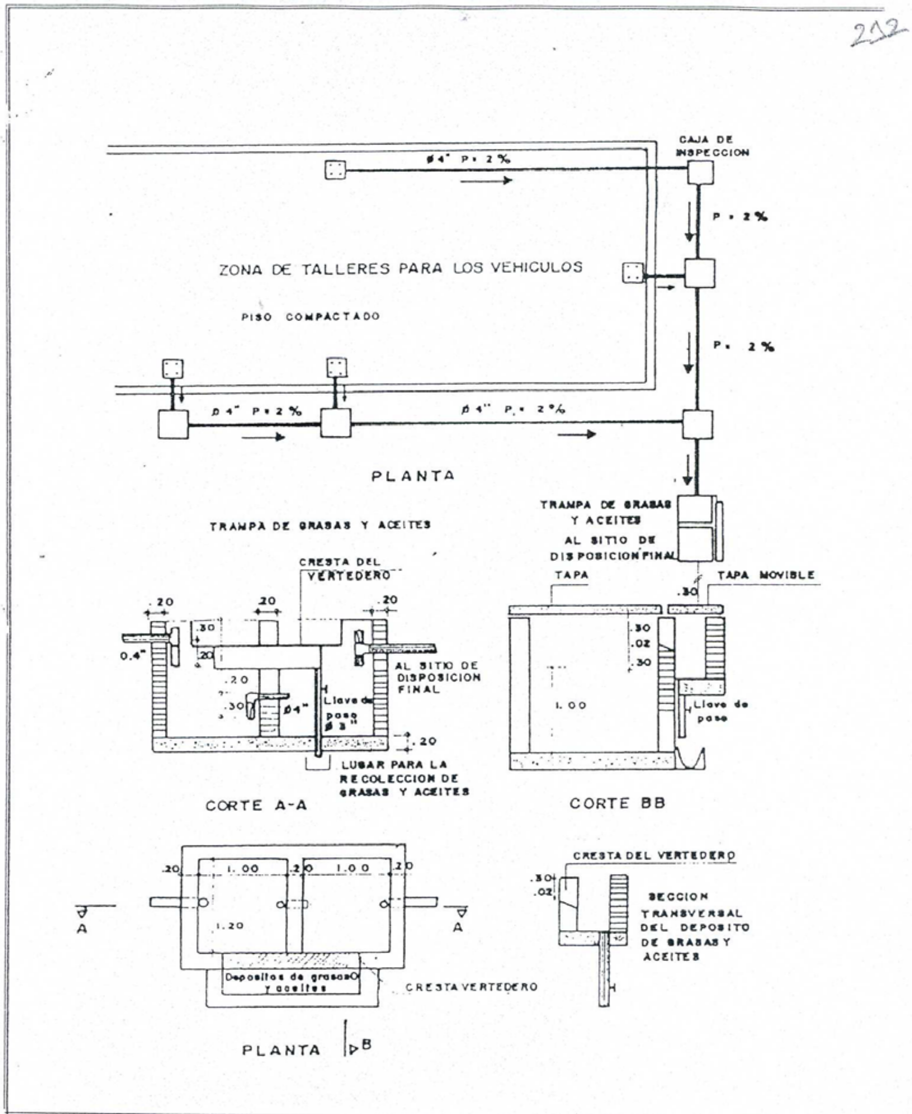
DIRAN (Anti-Narcotics Police) will be responsible for the execution of the above.

## 7. COSTS

The cost of the domestic wastewater treatment system will be COP 61.220.000. The cost of the stabilization wells for tank wash waters will be COP 500.000. Plant maintenance is estimated in COP 7.665.00 and COP 10.000.000 in monitoring per year. In total, the operating and maintenance cost for the first year of treatment will be COP 70.385.000

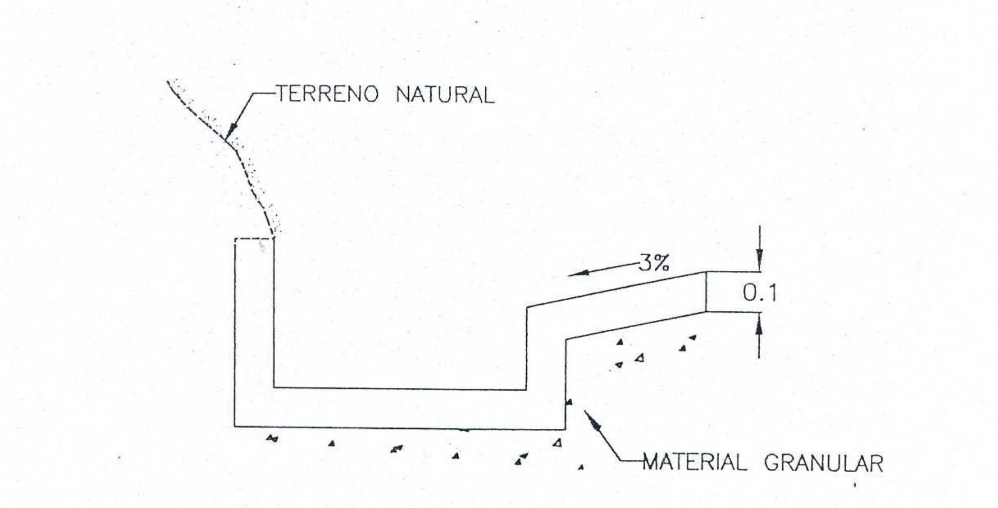
**END OF WASTEWATER MANAGEMENT PROGRAM**

212

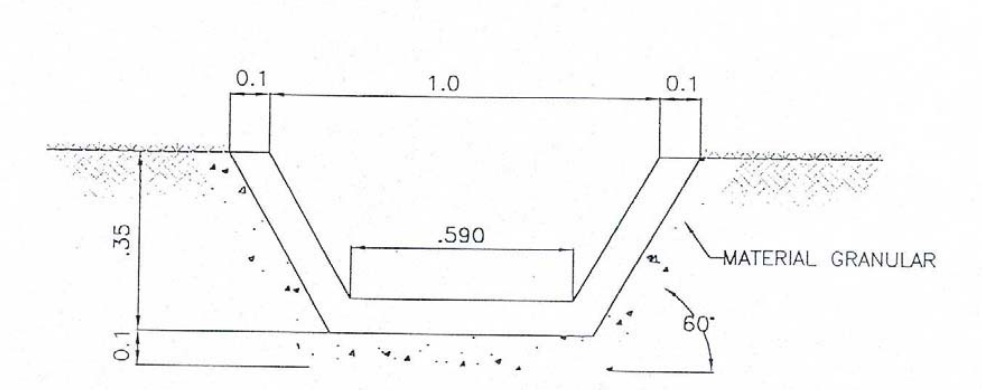


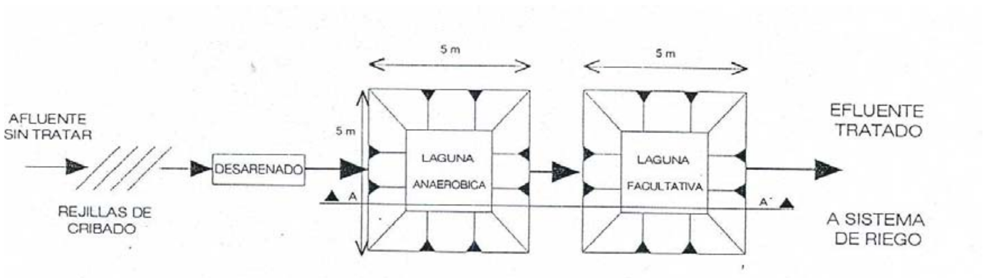

| | | | |
|---|---|---|---|
| DNE DirecciónNacional de Estupefacientes | SISTEMA DE RECOLECCIÓN Y SEPARACIÓN DE GRASAS Y ACEITES EN TALLERES | Fecha: Octubre del 2001<br>Sin Escala | FIGURA<br>No. 1 |

RECTANGULAR DITCH




TRAPEZOID DITCH

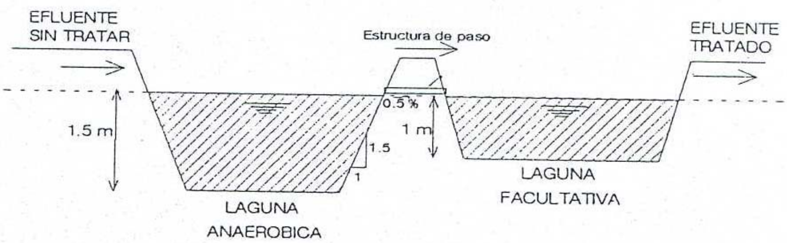





PLANT

UNTREATED by-pass
TREATED

EFFLUENT structure EFFLUENT


EFLUENTE
SIN TRATAR
Estructura de paso
EFLUENTE
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0.5 %
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ANAEROBICA
LAGUNA
FACULTATIVA

CORTE A - A´

| INSPECTION, VERIFICATION AND CONTROL PROGRAM OF SPRAYING OPERATIONS | RECORD 6 |
|---|---|

1. **DESCRIPTION OF THE IMPACT GENERATING ACTIVITY**

One of the objectives of the Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate –PECIG- is to eradicate illicit coca, poppy and marijuana crops by aerial spraying same with glyphosate herbicide.

The irregular performance of this activity may cause undesired impact on the biological conditions and communities located in the glyphosate spraying,  areas, as well as their economic activities.

**2. OBJECTIVE**

The Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate –PECIG- must complete an inspection, verification and control program for each aerial spraying operation of glyphosate in order to:

- Verify on site, the effectiveness of the application of environmental management measures during the PECIG operation.
- Evaluate, based on design, by efficiency and effectiveness indicators, the application of PECIG´s environmental measures.
- Evaluate the efficiency in the adoption of corrective measures, in case damages derived from eradication activities occur.

## 3. ACTIVITIES TO BE PERFORMED

### 3.1 PECIG´S VERIFICATION MEASURES

Aerial spraying must be verified in order to prove its efficiency and effectiveness, that is, whether it meets its primary objective of destroying illicit crops, and if not, or if its effectiveness is too low, it would not be worth causing the inherent social and environmental impact, however small it may be.

The specific objectives of these measures are:

- To proof the biocide action of the herbicide (glyphosate), on illicit crops, and therefore, their effective death.
- To evaluate compliance of technical parameters of the operation, specifically those related to the compliance of buffer and exclusion zones.

The above technical verification includes the following activities:

2. Selection of areas to be recognized
3. Selection of the sample
4. Assessment of operation efficiency
5. Selection and call of participants
6. Final report.

#### 3.1.1 Selection of areas to be surveyed

The Verification Program must be conducted on coca, poppy or marijuana plots sprayed in each operation. For logistical reasons, the PECIG has arranged the project zones in 9 nuclei, as shown in Chart No. 1

## CHART. 1

## SURFACES COVERED WITH COCA CROPS ACCORDING TO 2000 CENSUS RESULTS PER NUCLEUS

| **NUCLEUS** | Total area (ha) | % national | Area of industrial crops | % nucleus | Municipalities affected |
|---|---|---|---|---|---|
| Putumayo-Caquetá | 96.694 | 59,2 | 57.174 | 64,4 | 27 |
| Meta-Guaviare-Vaupés | 34.878 | 21,4 | 16.859 | 48,2 | 24 |
| Sur de Bolívar-Antioquia-Córdoba | 11.959 | 7,3 | 4.859 | 42,0 | 49 |
| Cauca-Nariño | 10.906 | 6,7 | 3.899 | 66,5 | 21 |
| La Gabarra | 6.103 | 3,7 | 1.472 | 24,1 | 15 |
| Arauca | 1.234 | 0,8 | 636 | 51,6 | 5 |
| Boyacá-Santander | 743 | 0,4 | 257 | 34,6 | 31 |
| Sierra nevada Sta. Marta | 522 | 0,3 | 133 | 25,5 | 5 |
| Chocó | 250 | 0,2 | --- | --- | 2 |
| TOTAL | 163.289 | 100,0 | 85.419 | 56,3 | 183 |

Source: SIMCI, Census, August 2000

### 3.1.2 **Selection of the sample**

The size of the sample to be verified shall be determined by statistical methods according to the safety factor of the zones to be sampled, operating costs and variability of the sample universe; it is recommended to apply a statistical error of 0,05% and a confidence level of 90%. The sampling unit shall be the plot selected based on SATLOC and/or DELNORTE records selected randomly, in order to guarantee the greatest impartiality in the verification process.

### 3.1.3 **Eradication efficiency**

To determine the effective death of the illicit coca crops, the following methodology is observed:

- In the first phase, an overflight is made of the sector based on the flight track selected and the percentage of effective or eradicated death is determined for the plots involved, based on the *in-situ* sample and over flight.
- This assessment is made by three experts who qualify the spraying quality and effectiveness: one from DIRAN-CNC, other from DNE and one of Technical Audit.
- To check qualification, an "in-situ" or plot verification is made (on the plots that form part of the selected sector). The verified plots are taken from previously selected "Satloc" flights.
- Inside lots, experts are distributed and each makes a count of a given number of plants, determining the quantity of death and alive plants. The qualification is expressed in percentage. This sampling is made in 3 different sites in each plot.
- Based on the sampling, the sample is statistically evaluated and the percentage of effective death of the is determined (subsample). The sum of all plots is the basis to qualify the sector.
- When flying over the selected sectors, evaluators determine which area still has illicit crops and, based on the sample, the area remaining with illicit crops is projected and determine (estimates per nucleus or department)
- Finally, growth or reduction trends of illicit crops are recorded for each sector.

The preparatory work in space-maps is done 1 month in advance of the operation, between Anti-Narcotics Directorate, Illicit Crops Eradication Area and environmental Audit.

### **3.1.4 Selection and call of participants to the verification process**

In order to determine a reliable and consensual estimate of the area effectively eradicated, each participant entity must appoint and designate its delegates. The entities invited to participate in the verification process of eradication of illicit crops are the following:

- Anti-Narcotics Police
- National Narcotics Directorate (DNE)
- Likewise, the Ministry of Environment, the Ministry of Health, the Colombian Agriculture and Livestock Institute, the Procurator´s Office, the Attorney General's Office, and the Alternative Development Plan are invited to participate as observers.

Invitations are made by the National Narcotics Directorate (DNE), in coordination with the Anti-Narcotics Police (DIRAN).

### 3.1.5 Equipment and materials

*Air equipment:*

- Twin Otter aircraft for transportation of the commission staff
- S.AR. UH – IN helicopters
- Huey II helicopters
- Black Hawk helicopters for V.I.P. transportation /Protection
- PNC Huey II helicopters
- PNC Bell 2123 helicopters
- Turbo Thrush aircraft with GP.P.S
- OV-10D with FLIR.

*Materials and elements*

- Bulletproof vests
- Binoculars
- GPS
- Video recorders
- Photographic cameras
- MP8 videos
- Super HGV400 Photographic rolls
- Cartography
- Forms

## 3.2 ENVIRONMENTAL VERIFICATION MEASURES

In parallel with the verification activities directly related with the spraying efficacy on illicit crops, an environmental assessment must be made in order to determine the real environmental impacts caused by the spraying, in particularly, damage of the herbicide on human settlements and other types of adjacent areas, taking field data to be used as success indicators of the operation.

The environmental verification will be made on the same areas to be recognized and on the same samples determined for self-verification of PECIG (see sections 3.1.1 and 3.1.2 above). In all other aspects, the following methodology will be observed:

### 3.2.1 **Verification of effectiveness of application of environmental management measures**

The environmental management measures during aerial spraying can be summarized as follows (see Development plan of spraying operations – **Record2)**

- Flight operational measures aimed at preventing and reducing environmental impacts: flight altitude, flight speed and wind speed.
- Respect for exclusion areas: natural parks, human settlements (small villages, rural districts¸ reservations**,** towns) water currents used for water supply of urban aqueducts.
- Regarding isolation strips of bodies of water, Nature Parks System areas, human settlements, vegetation other than illicit crops and areas of socio-economic interest. The dimension of the buffer strips may be redefined by DNE based on proposed indicators for PECIG. Otherwise, those indicated in **Record** 2 of this EMP will be used.
- When verification shows the generation of impact or failure in procedures, measures established in the various programs of this EMP will be adopted.

The operating data can be taken from the flight recordings of each operation. Information regarding exclusion and buffer strips can be taken from the same records and from the field verification described in the following section. Other verification tool will be exchange of information of flight records originated in the SATLOC system and satellite information of the SIMCI project, which will serve as basis to determine whether there has been aerial spraying in exclusion areas, and to make information feedback and take the corrective measures as necessary.

The above data must be entered in a from similar to annex (IVC-01) where the indicators to be used in the assessment are shown.

### 3.2.2 **Efficiency and effectiveness assessment of environmental management measures**

To evaluate the efficiency or damage level of spraying operations on human settlements and other types of vegetation, the following methodology will be observed:

- As with technical verification, environmental assessment must be made by other three experts of the Technical Audit team.
- Contrary to the experts responsible for verifying the percentage of death coca plants, environmental experts must focus their attention to the border areas of the sprayed lot, where they will make the following observations:

a) Assessment of natural vegetation adjacent to the sprayed site, to determine where there was damage caused (such as overspray). Make an inventory of the type of damaged vegetation and the damage see by the expert. The types of wild vegetation could be:

*Types of coverage: Evergreen euatorial forest, sub-Andean forest, Andean forest, high-Andean forest, tropical semi-deciduous or deciduous forest, natural plains, moors and sub-moors.
***Successional stadium**: Intervened and non-intervened primary forest, late secondary forest, medium secondary forest, early secondary forest, plains or grazed *páramos*, etc.
*Observable damage: Wilted leaves, defoliation, necrosis, rosetting, terminal bud burning.
*Approximate area damaged (in hectares)

b) Assessment of lawful crops next to illicit crops. Inventory of crops damaged and damages observed, as provided in Resolution No. 017/2001 of CNE as follows:
*Type of crop: permanent, transitory (including pastures), others
*Crop density: number of plants per square meter (estimate an average, except for pastures).
* Stadium of the vegetation cycle: newly planted, half cycle, read to be cropped, in production (in the case of permanent or semi-permanent crops and pastures).
*Damage observed: plant death, wilted leaves, defoliation, necrosis, rosetting, terminal bud burning.
*Approximate damaged area of each crop (in hectares). However, contrary to the count method used for coca, in these cases, the damaged area must be estimated in different grades (% of death or wilting).

c) Assessment of recovery level (regeneration or restoration) of vegetation after plot spraying, by count and determination of species starting colonization. This count must be made in sample areas of 10 square meters or less, at expert´s option. Also, a qualitative presence of insects and birds in the area and the presence of insects in the soil.

d) Identification of the number of housing units in the plot affected by the spraying operation, for their location under or near the aircraft track and estimation of the number of persons living in each unit.

e) Identification of lentic water bodies (lakes, water holes and the like) located in the aircraft track, as well as ravines or rivers which might have received herbicide.

The corresponding information must be completed in a form similar to IVC-01 attached.

The *Operation Global Efficiency Index €* consisting of the relationship between the damaged surface not subject to PECIG and the surface with illicit crops effectively sprayed. The result, expressed in percentage, is an indicator of the external factors generated by the spraying:

- If E <10%, the efficiency can be considered high, since it means that the damaged area not covered by illicit crops is very low or, in other terms, that the herbicide has fallen almost completely on the illicit crop.
- If E is between 10 and 30%, it can be considered that the efficiency is moderate.
- If E is between 30 and 50% it can be considered that efficiency is low.

- If E > 50% it means that efficiency is very low, or, in other terms, that the damaged area not covered by illicit crops is higher than the sprayed area with illicit crops.

**3.2.3 Efficiency of the corrective action**

If the existence of damages caused by the eradication activities is established, PECIG must adopt the corresponding correction measures, such as mitigation or compensation, based on CNE Resolution No. 017/2001. and in accordance with the procedure set out in this Resolution and summarized in the Social management Program of this EMP.

The information contained in the ICV-01 form will apply only to inspection visits and samples, verification and environmental control, to evaluate the environmental efficiency of the program as a whole, but in no case it will be used to accept or acknowledge any third party damage which must follow the procedure of Resolution 017/2001 as said above.

The National Narcotics Directorate (DNE) and the Anti-Narcotics Police (DIRAN) shall submit an annual report to the Ministry of Environment, with copy to the Environmental Authorities of the corresponding nucleus, on the outcome of the assessment of environmental efficiency, and the complaints made by individuals and Environmental Authorities, as well as of the damages actually remedied as per Resolution 017/2001 of CNE.

Along with the information on technical verification, the environmental assessment will also form part of a database to be integrated into the Geographical Information System, which will allow to establish the recovery dynamics of sprayed areas, and the dynamics of the illicit crops.

**3.3 FINAL REPORT**

The results of the verification program must be presented in a document containing:

- Participants in the verification activities
- Verification records (see form attached)
- Methodology of the process
- Results
- Recommendations
- Photographic or video record of sampled plots and sectors.

### 3.4 **MULTI-TEMPORAL ANALYSIS**

As a complement to the verification process described above, a multi-temporal analysis of the sprayed areas and of the dynamics of the illicit crops is recommended. This analysis must be supported with the following instruments:

a) Annual censuses of illicit crops areas per town, department and nucleus (region), based on satellite images, aerial photographs and field testing, using the same system used at present by SIMCI (see attached document: *Metodología para el monitoreo de cultivos ilícitos en Colombia mediante interpretación de imágenes satelitales,* SIMCI, 2001).

b) Results of the control program, verification and control of spraying activities as described in this **RECORD.**

This analysis must yield the following results as minimum:

- **Variation over space and time** of illicit crops areas in Colombia, by municipality, department and nucleus.

- **Variation over space and time** of areas under aerial spray with glyphosate, by municipality, department and nucleus, based on DIRAN´s annual reports.

- Effect of the aerial spraying program of glyphosate on the expansion of illicit crops areas, by municipality, department and nucleus.

- Consolidation of the environmental effects of the program of illicit crops eradication by aerial spraying with glyphosate, particularly in the following aspects:

*Damage to lawful crops area

*Damage to pastures area
*Damage to forests and other forms of vegetation
*Number of households and rural subsistence farmers damaged (including *settlers* ***and the*** indigenous population)

- Number of proven cases of health damages reported by sanitation posts and hospitals located in the spraying areas, attributable to the aerial spraying operations.

The above must be included in the Annual Inspection, Verification and Control Report of the Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate –PECIG.

## 4. SCHEDULE

The Inspection, Certification and Control Program will be conducted throughout the year, after the spraying operations, in the zones and plots established according to the above methodology. Spraying and verification time must not be less than one month nor more than two.

## 5. FOLLOW-UP AND MONITORING

Follow-up and monitoring of this activity will be given by report verification per operation and the multi-temporal annual reports.

## 6. ACCOUNTABILITY

The following will be accountable for the operations:

- National Narcotics Directorate (DNE)
- Anti-Narcotics Police (DIRAN)
- SIMCI PROJECT (UNDP-DNE-DIRAN)

## 7. COSTS

Environmental costs will consist of salaries and administration expenses of an environmental expert team and a project manager, estimated at COP237,000.000 per annum. All other operating costs of the Program (transport, aircraft, technical verification experts, etc.) are PECIG´s ordinary expenses and therefore, are not considered EMP costs.

**END OF INSPECTION, VERIFICATION AND CONTROL SPRAYING OPERATIONS PROGRAM**

**SAMPLE VERIFICATION REPORT FORM FOR ILLICIT CROP SPRAYING**

**ANTI-NARCOTICS POLICE**

MINUTES No.____/ ON SPRAYING VERIFICATION ON COCA CROPS BY AERIAL SPRAYING IN THE DEPARTMENT OF ______________

==================================================

In ________ on ___ of ____, 201__, there met at the Anti-Narcotics Base of _____, the Joint Verification Commission comprised by the following persons:

| | |
|---|---|
| | Head of the Eradication of Illicit Crops Area |
| | Coordinator of the Verification Group |
| | Environmental Auditor |
| | National Narcotics Directorate (DNE) |
| | Member of the Verification team |
| | Member of the Verification team |
| | Member of the Verification team |

1. OBJECTIVE

To make field verification and to verify the effective death and present condition of coca shrubs aerial sprayed with Glyphosate, between ________and _______ in the Department of _______________

2. GENERAL

To meet the above, the commission proceeded with activities in the following conditions:

- Day_____ Month _____ Year_____.
- Travel of the joint commission from Bogotá, D.C. to the Anti-Narcotics Base of ________.
- Introduction of the Commission to the Base Commander and installment of the Commission.
- Meeting of Police officers and Environmental Audit for setting up the Verification Program of sprayed crops between the months of _______ and _____ in the Department of _______.
- Submission of the pre-selected statistical sample
- Analysis of system files of the Satloc flight selecting sprayed crops coordinates as per system, as shown in Chart No. 1

**CHART. 1: Plot selection per date and coordinates**

| PLOT No. | SPRAYING DATE | VERIFICATION DATE | SATLOC COORDINATES | G.P.S. FIELD COORDINATES | AREAS (has) | LOCATION | PHOTOGRAPH |
|---|---|---|---|---|---|---|---|
| | | | | | | | |

- Coordination with Air Service staff for displacement of fixed-wing and rotatory-wing aircraft selected for the study.
- Coordination with the base Commander for displacement of operating staff to support ground staff.

3. **RESULTS**

- All security measures required for helicopter displacement of the Joint Verification Commission to the surveyed area, taking the corresponding security measures.
- Number of descents of the Joint Verification Commission made to the previously selected plots for the survey, thus establishing the results of the aerial spraying done.

Chart No. 2 shows the possible criteria for assessment of the Verification Program in the coca shrubs.

**RESULTS OF FIELD VERIFICATION**

| PLOT NO. | FIELD GPS COORDINATES | AREA | RESULTS OF EFFECTIVE % OF ILLICIT CROPS DEATH | COMMENTS<br>YES OR NO |
|---|---|---|---|---|
| | | | Density: _____ plants/ha<br>Defoliation _____ % plant<br>Chlorosis _____% plant<br>Rossetting _____% | **Pruning:** _________<br>Death<br>Descending _______<br>Ascending _______ |

| | | | | |
|---|---|---|---|---|
| | | | Necrosis:<br>Terminal buds _____<br>Branches ______<br>Stems _____ | Crop:<br>Alternate ______<br>Related _____<br>Regenerated<br>Plantation_____ |

- The verification process was conducting following the procedure of the joint verification of illicit crops control endorsed by the Anti-Narcotics Directorate, Environmental Audit and the Anti-Narcotics Police.

## 4. CONCLUSIONS

*Efficacy of aerial spraying:* Effective death of coca shrubs located in the ______ region varies between ___ and ___% for plots sprayed between _______ and ____, considered as.

Evidence of pruning: _________________________________________________

Evidence of plot abandonment: ________________________________________

Crop behavior in present conditions: ___________________________________

Topography: ______________________________________________________

Presence of obstacles (trees) hampering efficacy of illicit crops spraying: ___

_________________________________________________________________

Regeneration of natural species: ______________________________________

Evidence of damage to flora and fauna caused by spraying:__________________

Types of predominant soils in the surveyed area:___________________________

In communication No. _____ of (date) _______ Environmental Auditor was requested to attend to the verification of the spraying of illicit crops.

In communication No. _____ of (date) _______ National Narcotics Directorate was requested to attend to the verification of the spraying of illicit crops.

There being nothing further to report, this verification is closed. This document is signed by the parties once they read and approve same.

________________________

ENVIRONMENTAL AUDITOR

________________________

D.N.E.

________________________

INVITED OFFICER

________________________ ________________________

HEAD OF ARECI VERIFICATION COORDINATOR

**INSPECTION, VERIFICATION AND ENVIRONMENTAL CONTROL FROM OF AERIAL SPRAYING WITH GLYPHOSATE**

**FORM IVC-01**

| **1. APPLICATION EFFECTIVENESS OF ENVIRONMENTAL MANAGEMENT MEASURES** | | | | | | |
|---|---|---|---|---|---|---|
| TYPE OF MEASURE | | Regulation | | Real | | Complies (Y / N) |
| | | Coca | Puppy | Coca | Puppy | |
| Operational | Flight altitude (meters) | <30 | <15 | | | |
| | Aircraft speed (miles/hr) | 120-150 | 130-150 | | | |
| | Wind speed (m/s) | <2,05 | <2,05 | | | |
| Exclusion areas | Water bodies | Yes | | | | |
| | Nature Parks | Yes | | | | |
| | Human settlings | Yes | | | | |
| | Aqueduct supply basins | Yes | | | | |
| Security strips (Alert system) | Lentic water bodies (m) Lotic water bodies (m) | 100 | | | | |
| | Nature National Parks areas (m) | No | | | | |
| | Human settlings; small villages, rural districts¸ reservations, towns (m) | 1000 | | | | |

| | | | | |
|---|---|---|---|---|
| | Plantations other than illicit crops (m) | 5-10 | | |
| | Socio-economic areas (productive projects, social pact zones) (m) | 1000 | | |

| 2. EFFICIENCY ASSESSMENT OF ENVIRONMENTAL MANAGEMENT MEASURES | | | | | |
|---|---|---|---|---|---|
| **Affected element** | **Type of coverage or crop** | **Successional stadium or crops cycle** | **Damage observed** | **Affected area (ha)** | **Owner *** |
| Natural vegetation (CNV) | | | | | |
| | | | | | |
| | | | | | |
| Crops or pastures (CP) | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Extent of natural recovery | <u>Biological type</u> | **Number/m2** | **Extent of recovery (high, medium, low)** | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Human settlings | **Housing units (#)** | **Persons (#)** | **Extent of damage (high, medium, low)** | | |
| | | | | | |
| Efficiency | Natural vegetation area affected + crops and pastures affected divided by area of sprayed illicit crop and multiplied by 100 E = $(A_{CVN} + A_{CP})/A_{CI}$ **100 | | | E = | |

* Indicate whether it is the same (M) or different (D) than the illicit crop

** Aci: sprayed illicit crops area

| RESEARCH PROGRAM FOR REPRESENTATIVE AND DEMONSTRATIVE PLOTS | RECORD 7 |
|---|---|

## 1. DESCRIPTION OF PROGRAM ACTIVITIES

Although available theory (see environmental impact chapter in this document) on glyphosate effects concludes that glyphosate does not act on seeds in the subsoil nor is absorbed by roots, nor it has prolonged residual action to sterilize soil, some stress that the herbicide generates considerable damage on soil and on its biological communities. This is notwithstanding that glyphosate is one of the herbicides with higher use in Colombia for controlling clean crops weed, as well as in crops such as sugar cane and oil palm, and that Colombian Agriculture and Livestock Institute - ICA has approved its use in Colombia.

For this reason, Article 7 of resolution 0341/2001 of the Ministry of Environment provides for the investigation on demonstrative and representative plots to enable to solve doubts of the scientific community on the real effect of glyphosate on soil, on **plant succession processes** and soil microorganisms.

## 2. OBJECTIVES

- To study the regeneration and ecological dynamics of sprayed zones by **demonstrative and representative** plots of nuclei of higher concentration of illicit crops obtained in censuses.

- To determine residues of glyphosate in soil and its affectation in physical-chemical-biological properties of same, using the same demonstrative plots.

In this sense, the investigation is aimed to raise, on a sample of sprayed zones with PECIG glyphosate and non-sprayed zones, an inventory of biological communities of soil and their vegetation, at different times lapsed since its application. On the other hand, the residue survey of the herbicide aims to establish the adsorption level by soil solution and its compounds, as well as on **groundwater.**

## 3. ACTIVITIES

The activities proposed for the development of an investigation methodology are the following:

### 3.1 Sampling strategy

According to requirements of the Ministry of Environment, the investigation must meet two requirements: to be **representative and demonstrative**.

***Representative values***

To achieve a representative value for national coverage or PECIG, and regional level or of each nucleus or coca plantation area. Also, to consider the number and size of plots.

Station is the area where investigation plots are to be located. No permanent premises are necessary, but conveniently distributed plots and barbed-wire fenced where periodical samples can be taken.

In each station, the following criteria will be taken into account:

* that soils correspond to soil types common in the region or nucleus,
* that climate corresponds to the predominant climate in the nucleus,
* that proposed measurements and inventories are possible to make (access)
* that security issues do not prevent making measurements and inventories.

For security reasons, it is suggested that areas where plots are to be located are in or near operations or in institutional State´s areas. In order to guarantee security and permanence in the investigation, it is necessary to make tests in State owned areas such as Autonomous Regional Corporation (environmental), CORPOICA, Universities, Research institutes, Armed Forces, etc. Some possible places to conduct these tests are:

* Macagual Research Centre, owned by CORPOICA, Department of Caquetá

* Acacías Prison *(Colonia Penal de Acacías)*, owned by INPEC, department of Meta,

* Research Centre of *Universidad de la Amazonía,* owned by *Universidad de la Amazonia,* Department of Caquetá.

The definition of the sample site requires visits and agreement by entity owners.

- *Size.* To establish the plot size, the "minimum area" criterion is proposed to be used, that is, the area in which the number of species becomes constant or increases mildly (aerial curve vr. number of species becomes asymptotic). In tropical zones, the minimum area may vary between some tenths to hundredths of meters, depending on the type of medium. However, it is suggested that the plot area is not less than 100 nor more than 200 m2. The entity to conduct the research may propose alternatives to allow the reasonable assessment of the ecological dynamics of sprayed plots.

- *Number.* Regarding number of plots, a total of 10 is recommended, which will be subject the treatment described below under 3.2

Plots will be rectangular in form, compass surveyed, wired-barbed fenced and georeferenced (Figures 1 and 2)

**3.2 Treatment**

The 10 plots must be initially in pastures or temporal crops. No forest area must be logged.

- One of the 10 plots will be left for evolution of natural succession, with no application of glyphosate.

- The remaining 9 plots will be subject to the following treatment:

  * Six months old, 3 coca crop plots sprayed with glyphosate, with twice the dosage used in spraying operations.
  * Six months old, 3 coca crops sprayed with glyphosate, with the same dosage used in spraying operations,

* Six months old, 3 coca crops sprayed with glyphosate, with half the dosage used in spraying operations,
*In the witness plot and in one of each of the other tress groups, a 5 m deep phreatimeter, 2" diam PBC tube will be installed to take samples of ground water samples for analysis.

The same treatment must be replicated in poppy nuclei stations. Each plot will be wire-barbed fenced to avoid entry of animals. After glyphosate application, all plots will be left to natural evolution, that is, will not be subject of cultural measures, in order not to alter the evolution conditions post-spraying. This type of treatment is proposed, since, while it is true that applied dosages in spraying of illicit crops are more or less constant, it may happen that, in the case of dumpling, for example, higher glyphosate amounts be discharged on the soil.

**3.3 Soil samples and analysis groundwater**

A compound sampling in each plot (in 10m grids in side) will be made *before spraying and one quarterly in the rest of the year,* at 10 and 30 cm deep, taking into account the following parameters. Physical determinations will be taken from upper 10cm.

3.3.1 Chemical determinations:

The basic objective is to establish glyphosate concentrations and AMPA, its main metabolite, in soil and water. The laboratory methods to be used might be different according to the available technological developments. However, the following are some proposals on the matter:

*Measurement of glyphosate with high performance liquid chromatography (HPLC) or gases/masses.*

HPLC methodology is applicable for water samples and determination in soil samples expressed in a liquid matrix, from saturation extract. The analytical method consists in detecting the presence of glyphosate and its main metabolite, amino-methylphosphonic acid (AMPA). The analysis is based on EPA 547 methodology, using HPLC equipment.

*Determination of the adsorption of glyphosate and AMPA in soils*

Each soil sample from the study area is added three levels of glyphosate concentrate (proportional to those applied in field), and the same three levels of soil sample form AMPA. Each soil sample corresponds to 1 g and is allowed to incubate for two weeks, stirring periodically. Subsequently, it is centrifuged and the supernatant is removed.

The soil is washed with distilled water, then re-centrifuged and the supernatant is removed again. This procedure is repeated until a given volume us reached. To remove the excess, soil is washed twice with ethyl alcohol. The concentration of glyphosate and AMPA adsorbed is equal to the difference between the two components sorbed in the treated sample and in the untreated sample.

*Determination of glyphosate and AMPA retention level after washing*

In each of the representative samples, the soil is prepared in such a way as to obtain, in addition to the original level (N0-without the addition of glyphosate and AMPA), three levels of initial concentration (N1, N2 and N3) of glyphosate and AMPA adsorbed.

For concentration levels 1 to 3, soil samples are taken from 120 g and incubated at room temperature for 24 hours with 100 ml of glyphosate and AMPA in different concentrations to be established.

*Determination of lixiviation level of glyphosate and AMPA in soils*

The field experiment is based on a lysimeter study that involves collecting percolating water extracted under low voltage (0 to 5.4 kPa) with the help of sensors for glass fiber strands installed in undisturbed soil.

In two subplots for treatment with and without application of glyphosate, two catchers are installed in fiberglass strands placed at the center of each subplot at depths of  30 and 100 m.  The catcher located at 30 cm allows collection of gravitational water and the other catcher collects water that drains groundwater.

The process is made comparing plots not affected by the application of glyphosate with plots affected with application. With the exception of organic matter, this part is made based on the study of ion movement in ground with the use of microlysimeters, and installing a battery of same in permanent study plots for soil extraction. Contents are then analyzed with HPLC technique.

### 3.3.2 Physical determinations

In order to understand the dynamics of glyphosate and its effect on physical and chemical properties of soil, it is recommended to study the degree of impact on nine soil physical parameters. It is intended to assess the impact of the application by comparing affected plots and unaffected plots by the presence of glyphosate.

Laboratory tests for this type of determinations are:

*Textural analysis.* Procedure performed by granulometric analysis using the Lowy Pipette technique.

*Structural analysis.* Soil structural stability is evaluated by determining the degree of aggregation, aggregate stability and the nature of empty pore space. The technique corresponds to the Yoder screening method.

*Consistency analysis.* The consistency limits, also called Atteberg limits are working rates which are affected by water content in soil. The limits correspond to the plastic limit, liquid limit and plasticity index.

*Total porosity.* Is an index of the relative volume of soil pores. A procedure originated from derivative formulas.

*Apparent density.* Is the relationship between the soil mass and the apparent volume of the unit itself. The apparent volume includes the volume of solid particles of soil and pore space. The procedure corresponds to the cylinder methods.

*Retention of soil moisture.* Is the amount of water that soil can store and is known as moisture holding capacity. The action of adhesion, cohesion and capillary voltage forces generate the soil moisture. The procedure is to use dishes and pressure cookers to generate different pressures that generate moisture retention curves.

### 3.3.3 Groundwater

Each quarter, until 12 months after spraying, a sampling an analysis of groundwater extracted from each of the 4 wells in each station is done. The parameters to determine are:

Measurement of residual glyphosate by the high performance liquid chromatography (HPLC) technique.

## 3.4 Sampling and analysis of vegetation

It is necessary to know the behavior of vegetation over time when glyphosate is applied, determining the successional process. To this effect, a quarterly inventory of all existing vegetation in each plot will be made, including the control plot, determining abundance-dominance levels.

The information collected from each subplot will be the following:

*Species,* which if field is not identified, a sample should be collected for botanical identification in herbarium.

*Number of individuals* per species (in herbaceous, it will estimated by direct counting in small areas and extrapolating to the entire area, if not uniformly distributed.

*Height and DBH* when greater than 10 cm.

With the information obtained, diversity, frequency, abundance and dominance levels of each species are calculated, as well as its spatial distribution through idealized profiles.

## 3.5 Biodiversity sampling and analysis of microorganisms

As for soils, a compound sample is taken in 10cm grids in side, 10cm deep, every three months. An analysis of the number of cells per gram of soil of the following microorganisms is made for each sample:

Bacteria

Mycelial fungi (*Hyphae* meters)

Yeast

Algae and cyanobacteria

Protozoa

The number of cells per gram of soil of nitrogen-fixing bacteria will be established.

The number of viable microorganisms per gram of soil analysis will be established.

For the total count of cells present in each sample of soil the counting method by direct microscopic observation will be used.

For the total recount of viable cells, the plate counting methodology or the most probable number (MPN), as appropriate.

As for soil and water, a vegetation and microorganism sample and inventory will be done for each plot (in 10 m grids per side) *before spraying and one quarterly for the rest of the year.*

### 3.6 Analysis of the information

Based on the quarterly analyses, a comparative analysis of the situation of soil, water and plant and microbial communities in each plot will be made, in order to detect, by statistical methods, significant variations between the various treatments. At the end of three years, a final report comparing all plots and nuclei and their results will be prepared and forwarded to the Ministry of Environment, re respective CAR and agencies.

## 4. SCHEDULE

Basic research will take place over one year. In the first quarter the station site is selected, plot design is made and plots are installed. Then, in each quarter, information will be taken and analyzed. The first sampling will be made before spraying. The second sampling will be made 5 days after spraying, and subsequently, every three months.

## 5. FOLLOW-UP AND MONITORING

- Plots selection and assembly
- Sampling and quarterly analysis (5)
- Analysis reports of quarterly data (5)
- Final report at national level

## 6. ACCOUNTABILITY

The research contractor of the permanent monitoring of the Anti-Narcotics Directorate (DNE), Anti-Narcotics Police (DIRAN) and Environmental Audit will be the person responsible for this program.

## 7. COSTS

The cost per station will be COP 150.000.000 distributed as follows:

| | |
|---|---|
| Plot establishment: | $ 2.000.000 |
| Phreatimeters: | $ 4.000.000 |

| | |
|---|---|
| Soil analysis: | $ 48.000.000 |
| Water analysis: | $ 24.000.000 |
| Vegetation inventory: | $ 24.000.000 |
| Microbial analysis: | $ 48.000.000 |
| Total: | $ 150.000.000 |

**END OF PLOT RESEARCH PROGRAM**

| BASIC ENVIRONMENTAL MONITORING PROGRAM | RECORD 8 |
|---|---|

## 1. DESCRIPTION OF THE ACTIVITY

Aerial spraying of illicit crops with glyphosate generates potential environmental and social impacts, and its magnitude and importance depend to a large extent on the spraying technique used and the conditions of the area, particularly soil use, topography and weather conditions.

For each of these activities under the Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate –PECIG, those performed in the operation sites of the Anti-Narcotics Police and those of spraying as such, the specification Records of the EMP include a set of technical and environmental specifications intended to prevent, mitigate, correct and compensate potential impact. The reason for this is that a program of this nature generates, necessarily, environmental and social impacts needed to know in order to take decisions on changes in methods, areas or operating parameters. Only monitoring and follow-up may provide the information to feedback the program.

## 2. OBJECTIVE

**The** purpose of this activity is to monitor the various activities of the Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate –PECIG- in order to measure the real impact caused by them on the environment, especially on soil, water, vegetation, land uses and on the health of the population in the sprayed areas, and take appropriate control measures.

## 3. ACTIVITIES TO BE PERFORMED

According to the results of the Environmental Impact Assessment (EIA), the main impacts of the project may be on soil, vegetation, wildlife, water quality and health of the exposed population in sprayed areas.  Consequently, the monitoring program should emphasize these variables.

### 3.1 Soil monitoring

#### a) Soil quality

The best to determine the actual impact on the ground is by conducting research in experimental and representative plots of various PECIG areas where it is possible to measure the residual herbicide in the soil at different times after application.  For this purpose, a special research program in representative and demonstrative plots have been designed, which, by its nature, is included in a separate Record of this EMP (see Record7). Based on each quarter results, a contamination level of glyphosate resulting from the division of the mean level found in each plot by the maximum tolerable level for  worms in soil, I addition of other indicators foreseen in the research design will be determined.  Also monitoring will be conducted to determine residual herbicide in soil, following parameters of Record7 - Research program for representative and demonstrative plots.

#### b) Soil microorganisms

Within the same research in plots, biomass of microorganisms and/or worms in soil will be determined at different times after application.  The measurement indicators and the corresponding methodology is shown in Record7 - Research program for representative and demonstrative plots. Based on the results of each quarter, a contamination level with glyphosate will be determined, resulting from the division of the mean level found in each plot, by the level found in the control plot.

### 3.2. Water quality monitoring

PECIG contemplates the exclusion of water bodies and a security zone around them, where no glyphosate spraying should be done. However, given the speed with which glyphosate is dissolved in water and is adsorbed by sediments and degraded by microbial action, the sample of a stream that has been accidentally reached by the spraying, several hours or days later would not yield positive results to a possible contamination with glyphosate.

For the above reasons, water monitoring has been approached from two perspectives:

- Identification of possible bodies or water currents that might have been hit by sprayed glyphosate, by running effect, performed during the inspection, verification and control process following sprayings, as provided for in Record6.

- Installation of a phreatimeter battery in each research station in experimental and demonstrative plots, where migration of the herbicide to the groundwater layer is measured.

Based on the results of each quarter, a contamination level of glyphosate will be determined, resulting from the division of the mean level found in each plot by the maximum tolerable level for fish. It also contemplates other indicators of Record7, Plot Research.

### 3.3 Monitoring of natural vegetation

The aim is to measure the real impact of spraying the remaining native forests and other vegetation in sprayed areas. To this effect, as in the case of water, the procedure will include three complementary approaches:

- Identification and determination of forest areas affected, measured in terms of area and number of trees and the degree of damage (death, temporary defoliation, other), according to the methodology established in: Inspection, Verification and Control spraying Operations (Record6). This will make it possible to establish the area (n ha) and biomass (in # of trees) actually affected by the spraying operations.

- Determination of the spraying effect on plant succession of recovery of the areas occupied with illicit crops, starting with the pioneer herbaceous vegetation that grows immediately after spraying. As in the case of soil, the best way to determine this effect is through research in demonstrative and representative plots of the conditions of each nucleus, making an inventory of vegetation that grows at different times after spraying, and comparing this evolution with what happens in control plots that have not been sprayed. This will make it possible to establish the effect of glyphosate on natural vegetation succession, that is, on the possibilities to regenerate natural forest, based on the floristic composition compared between the various plots with different horizons over time. Record7 describes the methodology of the proposed research.

- Determination of allowable residues in plant tissues, according to the provisions of FAO standards.

Based on the results of each quarter, a contamination level with glyphosate will be determined, resulting from the division of the level found in each plot by the level of the control plot.

### 3.4 Land use

Although land use depends mainly on many factors other than spraying with glyphosate (see Chapter on impact assessment), the National Narcotics Directorate with the support of the United Nations, have set up the Integrated Illicit Crop Monitoring Program – SIMCI – based on the interpretation of satellite images,, whose objective is to map the annual evolution of land use in illicit crop areas. The methodology of this project, included in annex No. 1, should produce the following results by year:

- Digital mapping in space-maps based on satellite images of the industrial and rural plots of illicit crops in each of the nuclei or zones plots under the eradication program with glyphosate.

- Quantification of areas occupied by illicit crops of industrial and rural nature, at municipality, departmental and nucleus level.

- Comparison of change in land use (in hectares and percentage) produced in the year under monitoring with respect to the previous year, also at the municipal, departmental and nucleus level, considering the following categories of which SIMCI is mapping:

Primary forest

* Secondary forest

* Stubble

* Pastures

* Illicit crops

* Other crops

* Economic infrastructure (road, airports, etc.)

* Surface water

* Areas of human settlements

- Consolidated charts at national level, of illicit crops area and their annual variation.

### 3.5 Rural economy

Drift can cause lawful crops near illicit crops to be hit by glyphosate, with the consequent losses in agricultural production. The monitoring of this impact is done in two complementary ways:

- Identification and determination of areas in affected lawful crops, measured in terms of area or number of plants, whether temporary or permanent crops and the degree of damage (death, defoliation, other), according to the methodology established in “Inspection, verification and control of spraying operations” (Record6). This will make it possible to establish the area (in ha) and biomass (in # of plants) actually affected by the spraying operations. The same procedure applies to forests and other types of vegetation.

- Annual inventory of the number of complaints for damage to crops in each municipality where the PECIG operates, and complaints actually recorded and paid for, according to statistics maintained by DIRAN and DNE, as per resolution No. 017/2001 of the Anti-Narcotics Council (CNE).

As a result of the inspection data and field verification, an index of overall efficiency of the spraying operation will be estimated, by the ratio of the affected area by lawful crops in forests by the sprayed area in illicit crops. The higher the ratio is, the lower the efficiency. Based on the above information, annual consolidates nationwide will be made.

### 3.6 Health of the local population

The monitoring of the effect on the health of the population exposed in the sprayed zones must be closely related to the epidemiological monitoring provided in the Social Management Program (Record 9). According to this Program, monitoring should refer basically to verify that epidemiological monitoring objectives of the social management program were met in the following aspects:

[Page 234]

- Number of epidemiological monitoring campaigns established jointly with departmental health authorities and in effective operation, every year.

- Number of training seminars for hospital and health centre staff in physiological and sanitary aspects linked to the possible effects of glyphosate and number of staff attending same.

- Number of suspicious events due to spraying activities, reported by the health authorities (or number of cases of diseases reported and audited).

- Treatment expenses (in current pesos) paid by the DNE or DIRAN effectively proven of diseases caused by glyphosate.

At the same time, a morbidity chart and total number of consultations per month will be made. By dividing the number of inquiries for proven diseases caused by glyphosate over the total number of consultations, the frequency of diseases caused by glyphosate will result, and will be a global indicator of its relevance.

### 3.9 Educational communication

Follow-up will be made on the following indicators, amongst others, based on the goals set in the Educational Communication Program (Record10):

- Number of seminars, workshops and training courses for pilots, operation site staff, medical and paramedical staff of hospital and health centers.

- Number of press reports on eradication activities with glyphosate and its complementary or compensatory activities.

- Number of the DNE magazine volumes.
- Permanent operation of the DNE website.
- Appropriate signage for each operating site.

### 3.10 Management plan

It is also important that monitoring provides follow-up of the overall PECIG environmental management, in order to determine compliance level with the Management Plan. According to the environmental management program, this monitoring should relate, especially to the following aspects:

- Creation and operation of the Environmental Sub-Directorate and Social Management of DNE for PECIG.
- Percentage or level of performance for all programs of the Environmental Management Plan.
- Level of compliance with coordination activities established by DIRAN, the social support organizations (PLANTE, Solidarity Network, Ministry of Health) and the Interinstitutional Technical Committee and territorial bodies.
- Level of compliance with environmental management functions and social management established in the EMP.

## 4. SCHEDULE

The monitoring activity should be permanent during the eradication with glyphosate. The Environmental Sub-Directorate and social management of PECIG will prepare a detailed monitoring system for each year which will be submitted …

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… to the Ministry of Environment. According to this program, it will send quarterly reports to the Ministry and to the CAR offices in each nucleus.

## 5. FOLLOW-UP AND MONITORING

Follow-up and monitoring will consist in the regular verification by the program audit team and environmental management of compliance with the specifications defined in this EMP.

Chart No. 1 shows a summary of the indicators to be obtained by PECIG´s environmental monitoring program.

## 6. ACCOUNTABILITY

The DNE, through the Environmental Sub-Directorate and Social Management or its delegate will be the entity responsible for this activity. However, DNE may sign agreements with AGUSTIN CODAZZI GEOGRAPHIC INSTITUTE OF COLOMBIA - IGAC, INSTITUTE OF HYDROLOGY, METEOROLOGY AND ENVIRONMENTAL STUDIES - IDEAM, the Ministry of Environment, the CAR offices, universities and other research entities to execute same, or subscribe it with private entities.

## 7. COSTS

The cost of environmental monitoring is already included in the corresponding programs, as follows:

- Soil: Considered in the plot research program
- Water: Considered in the plot research program
- Vegetation: Considered in the plot research program and inspection, verification and control.
- Use of soil: Considered in the ordinary SIMCI Project budget.
- Rural economy: Considered in the inspection, verification and control program.
- Health and sanitation: Considered in the social management program (health care activity)
- Management plan: Considered in the environmental and social management

**END OF THE BASIC ENVIRONMENTAL MONITORING PROGRAM**

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## CHART. 1

### MAJOR ENVIRONMENTAL INDICATORS FOR PECIG ENVIRONMENTAL MONITORING PROGRAM

| **SOILS**[8] | **WATER** | **NATURAL VEGETATION** | **SOIL MICRO ORGANISMS** | **SOIL USE** | **RURAL ECONOMY** | **HEALTH POPULATION** |
|---|---|---|---|---|---|---|
| **MAJOR INDICATORS** | | | | | | |
| Residual glyphosate concentration and AMPA [1] | Concentra-tion residual glyphosate and AMPA[1] | # species[1] | Bacteria***[1] | Digital maps crop areas[2] | Licit crop area (ha) affected for temporary crops according to damage level[3] | Epidemiological monitoring campaigns (#)[4] |
| Adsorption level of glyphosate and AMPA[1] | | # individuals/ specie[1] | Mycelial fungi***[1] | Industrial and rural illicit crop areas per municipality, department and nucleus (ha)[2] | Number of plants affected (#) for permanent crops according to damage level[3] | Training seminars (#) and number of attendees[4] |
| Retention level of glyphosate and AMPA[1] | | Height**[1] | Yeast***[1] | Forest, stubble, pastures, illicit crops, other crops per municipality, department and nucleus (ha)[2] | # of claims filed[4] | # of suspected cases reported[4] |
| Retention level of glyphosate and | | DAP**[1] | Algae and cyanobacteria ***[1] | Changes in vegetation every year, regarding previous year (in % | # of proven and paid for claims[4] | Treatment expenses paid for by DIRAN ($)[4] |

| | | | | | | |
|---|---|---|---|---|---|---|
| AMPA[1] | | | | and ha). | | |
| Lixiviation index glyphosate and AMPA[1] | | | Protozoa***[1] | | | |
| i. SECONDARY INDICATORS | | | | | | |
| Texture[1] | | | Biomasa lombrices (g/kg de suelo) | | | |
| Structure[1] | | | | | | |
| Consistency[1] | | | | | | |
| Porosity[1] | | | | | | |
| Density[1] | | | | | | |
| Humidity retention[1] | | | | | | |
| **GLOBAL AND MANAGEMENT INDICATORS** | | | | | | |
| N = Np/Nmx [6] | N =Np/Nmx [6] | N=Np/Ntes [6] | N =Np/Ntes [6] | IEG = (SCL+ABA) / SCI [5]<br>SCL = Licit crops area. ABA = Affected forest area. ACI = Illicit crops area spayed | | F=Cgr/Ctot[7] |
| Environmental Subdirectorate and Social Management in operation | | | | | | |
| Compliance % of EMP programs | | | | | | |
| Number of interinstitutional coordination meetings | | | | | | |
| Number of seminars, workshops and training courses | | | | | | |
| Number of press reports | | | | | | |

| |
|---|
| Number of DNE publication volumes |
| Permanent DNE´s web page in operation |
| Adequate signage of each operation site |

* Glyphosate metabolite (aminomethylphosphonic acid). ** For shrubby and tree-like species. *** Number of cells/g

[1]: Measured in plots. [2]: Satellite determined (SIMCI). [3]: Determined in program´s inspection, verification and control visits.

[4]: Determined in social management program. [5]: IEG = Global efficiency index of spraying operation, as per results of inspection, verification and control visits. [6]: N = Contamination level. Np = Level in each plot. Nmx = Maximum tolerable level for worms in soil or fish in water. Ntes = Control plot level (for all parameters measured). [7]: Fg = Morbidity frequency due to glyphosate. Cr = Glyphosate visits. Ctot = Total consultations in hospital or health center. [8]: Texture, structure, consistency, porosity, density and humidity retention will be determined and used once to establish differences that explain soil behavior for glyphosate contamination.

## ENVIRONMENTAL INDICATORS AND INDEXES APPLICABLE TO THE PROGRAM FOR THE ERADICATION OF ILLICIT CROPS

| COMPONENT | INDICATOR/INDEX | | | RANGES | | REGULATION | METHODOLOGY | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | TERM | VALUE | UNIT | MIN | MAX | | | |
| WATER | | | | | | | | |
| | Plaguicide concentration (Glyphosate) | 0,01 | Mg/Ltr | 0,1 | | Decree 475 10/03/1998, Arti.13 | Analytical methods. Field samples max. 3 days after application. Continue monitoring if plaguicides persist | LANIA Laboratories Protocol (Colombian Agriculture and Livestock Institute - ICA) |
| | Max. contaminant level of glyphosate (MCL) | 700 | µ g/L | <700 | | U.S. EPA | Analytical methods | |
| | Glyphosate | 0,1 | µ g/L | <0,1 | | European | Analytical | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | concentrate | | | | | Union | methods | |
| | Expected mean in superficial water | 0,0011 | μ g/L | 0,001 1 | | U.S. EPA | Analytical methods | |
| | Hydrogen potential | 6,5-9 | ph | 9 | 6,5 | Decree 475 10/03/1998. Art. 10 | pH indicators. Analytical methods | PECIG must have reference pH value of the zone to be assessed, since Amazonic ecosystem waters may exhibit lower pH values than those stipulated in the norm. |
| AIR | | | | | | | | |
| | Particles suspended in glyphosate | 100 | g/m3 | 400 | 100 | Decree 02 of 11/01/1982. Art. 31 | Analytical methods.<br>Concentration = Volume or weight of contaminant mixture/volume | Samplings hours after application |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | unit of air where it is contained | |
| VEGETATION | | | | | | | | |
| | Number of individuals | # of plant p/species | units | | | | Determine abundance. Field sampling | Determination of successional dynamics |
| | Density | # of individuals per area unit | units/ha | | | | Field sampling | Applies coverage adjacent to illicit crops |
| | Mixture quotient | # of species identified regarding # of individuals recorded in inventories | | | | | Field sampling | Determination of successional dynamics |

| COMPONENT | INDICATOR/INDEX | | | RANGES | | REGULATION | METHODOLOGY | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | TERM | VALUE | UNIT | MIN | MAX | | | |
| | | | | | | | | |
| | Successional dynamics | Bioindicator | # of species over time | | | | Field sampling. Determine progression. | Reference level based on floristic inventories or status before PECI application |
| SOIL | | | | | | | | |
| | Successional dynamics | Bioindicator | # of species over time | | | | Plant bioindicator (*yarumo, balso,* pioneering species, etc.) Field sampling | Reference level based on floristic inventories |
| | Bioedaphic biodiversity | Bioindicator (annelid insects) | # of species over time | | | | Bioindicators (worms, spiders, termites, ants). Field sampling | Reference level based on floristic inventories |
| | TD50 (typical | 47 | Days | 90 | 30 | | Field samples, satellite or aerial | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | mean life) | | | | | | monitoring | |
| | Expected mean | 0,063 | µg/L | | | U.S EPA | | |
| | Change in use of soil | Coverage | Ha/year | | | | Satellite monitoring, field sampling | |
| | Degradation rates | Degraded area/sprayed area | Number | 0,3 | | | Satellite monitoring, field sampling | |
| HUMAN HEALTH | | | | | | | | |
| | Morbidity -mortality statistics | # of persons exposed/ # of persons affected | # of cases | | | | Statistical analysis of Health Services | |
| | Assessment at exposure level for diet | 0,125 | mg/kg body weight/ day | Acute | | EPA | Exposure for applicators | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Assessment at exposure level for diet | 0,0323 | mg/kg body weight/ day | Chronic | | | Exposure for applicators | |
| | Assessment at exposure level for diet | 0,097 | mg/kg body weight/ day | Acute | | | Exposure for children | |
| | Assessment at exposure level for diet | 0,052 | mg/kg body weight/ day | Chronic | | Codex Alimentarius | Exposure for children. Maximum residual levels (MRL) were used to estimate intake. | |
| | Theoretical maximum daily intake (TMDI) | 23,8 | µ/kg body weight/ day | 23,8 for adults | | | Multiply glyphosate MRL times daily average consumption data and add all food that might have had treatment. | |

| COMPONENT | INDICATOR/INDEX | | | RANGES | | REGULATION | METHODOLOGY | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | TERM | VALUE | UNIT | MIN | MAX | | | |
| | Theoretical maximum daily intake (TMDI) | 51,9 | µ/kg body weight/day | 51,9 for children | | | | Children 1-6 yrs old |
| | Dermic | 12 | µ/kg body weight/day | 12 | | | | 10 min mixture/load. Assessment of an adult applicator working 8 hr/day, 65,4 kg and breathing 1,3 m3/hr with moderate exercise in the open. |
| | Inhalation | 6,2 | µ/kg body | 6,2 | | | | Assessment during 8 hours of |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | weight/day | | | | | application |
| | Exposure peak | 56,2 | µ/kg body weight/day | Acute | | | | Adult worker |
| | Re-enter to treatment areas | 0,52 | µ/kg body weight/hour | 2,6 | 3,9x10 -3 | US EPA 1997 | | Adult assessment |
| | Re-enter to treatment areas | 55,2 | µ/kg body weight/hour | 55,2 | | US EPA 1997 | | Re-entry assessment for children |
| | Exposure for spectator | 4,4 | µ/kg body weight/day | 4,4 | | US EPA 1997 | | Estimated for a child, assuming 10% of acute exposure peak of applicator during 8 hours |
| | Swim in recently treated | 0,64 | µ/kg body weight | 0,64 | | | | Adult assessment |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | waters | | | | | | | |
| | Swim in recently treated waters | 2,3 | µ/kg body weight/day | 2,3 | | | | Child assessment |
| | Exposure for wild fruit consumption | 45 | µ/kg body weight | 45 | | | Estimated consumption of 150 gm per adult and 30 gms for children 1-6 old | |
| | No Observed Adverse Effects Level (NOAEL) | 175 | µ/kg body weight/day | 175 | | US EPA, 1997 | | |
| | Margin of exposure (MOE) | 3370-5420 | µ/kg body weight | 5420 | 3370 | | | |

| COMPONENT | INDICATOR/INDEX | | | RANGES | | REGULATION | METHODOLOGY | COMMENTS |
|---|---|---|---|---|---|---|---|---|
| | TERM | VALUE | UNIT | MIN | MAX | | | |
| | Admissible daily intake (ADI) | 0,3 | µ/kg body weight | <0,3 | | Codex Alimentarius 1997 | Addition of glyphosate and amino-etilphsponic acid | |
| AERIAL APPLICATIONS | | | | | | | | |
| | Mean volumetric diameter of sprayed drops (VDM) | 300-2500 | micra | 3000 | 300 | EMP | Technical applications – Principles and Fundamentals. Novartis. 1998 | Values endorsed by Colombian Agriculture and Livestock Institute - ICA, Agricultural Inputs Division. EMP |
| | Real theoretical deposit | 10 - 30 | | | | EMP | | Values endorsed by Colombian Agriculture and Livestock Institute - ICA, Agricultural Inputs Division. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | EMP |
| | Wind speed | <4 – (2,05) | | | | EMP | | |
| | Temperature | 30 | | | | EMP | | |
| | Aircraft speed for application | 140 – 8 | | | | EMP | | |
| | Drift | Bioindicator | specie | | | | Bio-indicator (Plant species such as *yarumo, balso* epiphytes, lichens | |
| | Drift | <5 | Meters | 5 | | EMP | Field assessment | |
| | Dosages for coca | 10,4 | L/ha | 10,4 | 7,5 | EMP | Mixture control | EMP. Glyphosate commercial formulation |
| | Dosages for poppy | 2,5 | L/ha | 3 | 2 | EMP | Mixture control | EMP. Glyphosate commercial formulation |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mixture volume coca | 23,5 | L/ha | 50 | 23,5 | EMP | Mixture control | |
| | Mixture volume poppy | 50 | L/ha | 50 | 40 | EMP | | |
| | Exclusion areas restrictions (security band) | 100 | M/ha | 100 | | Decree 1843/1991, Artc.87 | Field assessment. Satellite monitoring | Include special treatment areas (Nature Parks, Sanctuaries, reservations, etc.) |
| | Efficiency of applications | >at 80 | | | 80% | Verification protocol | Field assessment. Samplings. | Spraying steps assessment |
| | PECI efficiency | Eradicated area/ net sprayed area | hectares | 1 | 0,75 | | Field assessment. Samplings. Satellite monitoring | |

<table>
<tr><td colspan="9">CLAIM FORM FOR DAMAGES OF LICIT CROPS</td></tr>
<tr><td colspan="3">Name and surnames of applicant</td><td colspan="6"></td></tr>
<tr><td colspan="3">Identification No</td><td colspan="6"></td></tr>
<tr><td colspan="3">Damaged property</td><td colspan="6"></td></tr>
<tr><td colspan="3">Location of damaged property</td><td>Rural district</td><td colspan="2"></td><td>Municipality</td><td colspan="2"></td></tr>
<tr><td></td><td></td><td></td><td>Dept</td><td>Plane coordinates</td><td>N:</td><td></td><td>E:</td><td></td></tr>
<tr><td colspan="3">Type of property*</td><td colspan="6"></td></tr>
<tr><td colspan="3">Other type of property or tenure*</td><td colspan="6"></td></tr>
<tr><td colspan="3">Economic activity of property</td><td colspan="6"></td></tr>
<tr><td rowspan="3">Damage caused</td><td>Crop 1:</td><td></td><td>Area M2</td><td></td><td># of plants</td><td>Quality*</td><td colspan="2"></td></tr>
<tr><td>Crop 2:</td><td></td><td>Area M2</td><td></td><td># of plants</td><td>Quality*</td><td colspan="2"></td></tr>
<tr><td>Crop 3</td><td></td><td>Area M2</td><td></td><td># of plants</td><td>Quality*</td><td colspan="2"></td></tr>
<tr><td>Spraying date</td><td>Day</td><td></td><td>MONTH</td><td></td><td>YEAR</td><td></td><td>TIME</td><td></td></tr>
<tr><td>Date of claim</td><td>Day</td><td></td><td>MONTH</td><td></td><td>YEAR</td><td></td><td>TIME</td><td></td></tr>
<tr><td>Purpose of petition</td><td>Repair</td><td></td><td>Estimated value</td><td></td><td>Other</td><td colspan="3"></td></tr>
<tr><td></td><td>Which?</td><td colspan="7"></td></tr>
</table>

| | | | | |
|---|---|---|---|---|
| Address for correspondence: | | | | |
| Documents and evidence attached | 1) | | | |
| | 2) | | | |
| | 3) | | | |
| | 4) | | | |
| | 5) | | | |
| | 6) | | | |
| Signature of applicant | | | | |
| Receiving officer | Name: | | Title: | |
| Signature of officer | | | | |

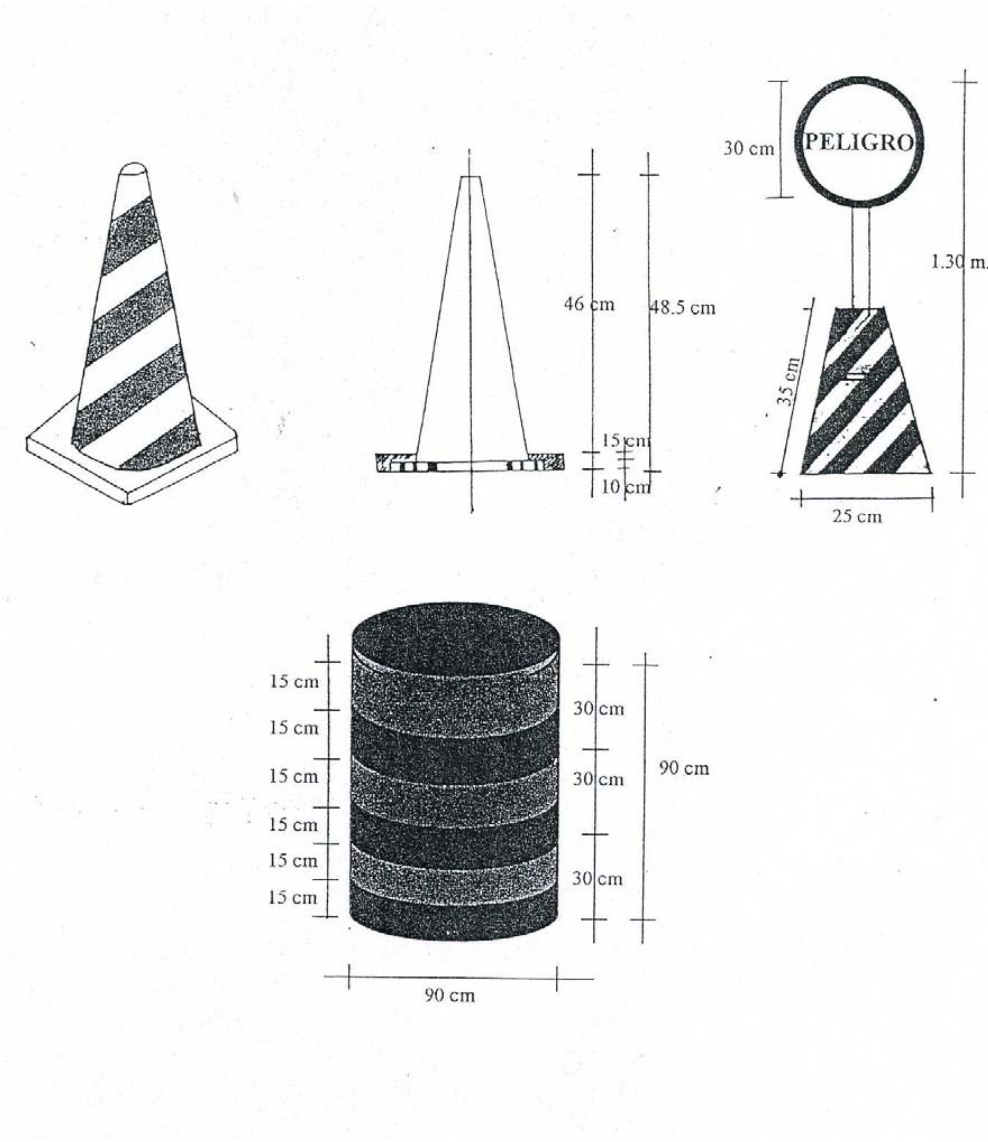
- M: total death. D: temporary defoliation (crop loss in permanent crops)

| **CLAIM FORM FOR ENVIRONMENTAL DAMAGES** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Name and surnames of applicant | | | | | | | | |
| Identification No | | | | | | | | |
| Title: | | | | | | | | |
| Entity | | | | | | | | |
| Name of park affected | | | | | | | | |
| Location of damaged property | Rural district | | Municipality | | | | | |
| | | | Dept | Plane coordinates | N: | | E: | |
| Type of property* | | | | | | | | |
| Other type of property or tenure* | | | | | | | | |
| Present vegetation of site | | | | | | | | |
| Damage caused | Forest 1: | | Area M2 | | # of plants | Quality* | | |
| | Forest 2: | | Area M2 | | # of plants | Quality* | | |
| | Other: | | Area M2 | | # of plants | Quality* | | |
| Spraying date | Day | | MONTH | | YEAR | | TIME | |
| Date of claim | Day | | MONTH | | YEAR | | TIME | |
| Purpose of petition | Repair | | Estimated value | $ | | Other | | |

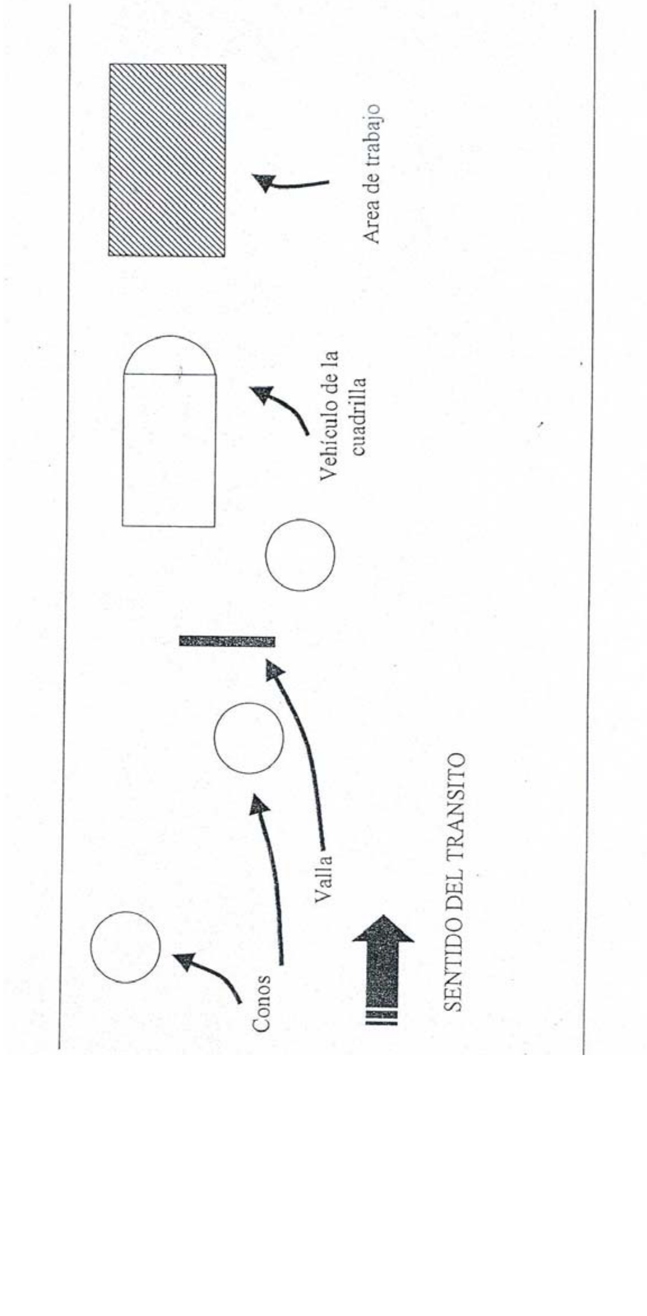
| | | | | |
|---|---|---|---|---|
| | Which? | | | |
| | Paid value damages recovery of water bodies (if applicable) | | | $ |
| Address for correspondence: | | | | |
| Documents and evidence attached | 1) | | | |
| | 2) | | | |
| | 3) | | | |
| | 4) | | | |
| | 5) | | | |
| | 6) | | | |
| Signature of applicant | | | | |
| Receiving officer | Name: | | Title: | |
| | Entity | | | |
| Signature of officer | | | | |

- *Páramos, sabanas, morichales,* low and medium stubble, others in the area


**ALERTSIGNS**



46 cm
48.5 cm
15 cm
10 cm
30 cm
PELIGRO
1.30 m.
35 cm
25 cm
15 cm
15 cm
15 cm
15 cm
15 cm
15 cm
30 cm
30 cm
30 cm
90 cm
90 cm


Area de trabajo
Vehículo de la cuadrilla
Valla
Conos
SENTIDO DEL TRANSITO

| SOCIAL MANAGEMENT PROGRAM | RECORD 9 |
|---|---|

## 1. DESCRIPTION OF ACTIVITY GENERATING IMPACT

The development of a program of the characteristics of eradication of illicit crops by aerial spraying of a herbicide involves a series of interactions with the communities of the affected areas, either to inform them about the characteristics of the spraying or to resolve complaints or conflict that may arise.

Indeed, it is possible that the aerial spraying of glyphosate affects third parties crops located around the area sprayed on their pets, or accidentally, the product falls on people, and as a result, their health may be affected. It is also possible that spraying affects accidentally water bodies used for human consumption, watering troughs, aquaculture and fisheries, so that it may be necessary to engage in immediate decontamination programs.

## 2. OBJECTIVES

The objective of this activity is to achieve a good level of relations with the population living around the areas of illicit crops spraying areas with glyphosate and to support it with complementary actions aimed at improving their living conditions as a mechanism for social viability of the PECIG. The objective also includes training on the Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate –PECIG and on environmental protection measures included in EMP. These actions must be complementary to the information and environmental education provided for in the educational communication Program.

## 3. ACTIVITIES

Indeed, the above objective can only be achieved through the application of socio-environmental management criteria recommended for the various activities of PECIG.

Besides these activities, which are basic for the development of the Program, it is recommended to execute some actions leading to obtain acceptance and cooperation of the local population and to improve their living conditions. These actions include five, in particular: interinstitutional support, alternative development promotion, compensation for damages caused, environmental recovery and improvement and health attention. Information, education, training, **civilian monitoring**, and signage also form part of social management, which by its nature, have been included in a separate program (Record).

### 3.2 Interinstitutional support

The Program for the Eradication of Illicit Crops by Aerial Spraying with Glyphosate –PECIG is a strategy the Government uses to control drug issues. I includes:

- *Alternative Development Plan - PNDA*. El The Alternative Development Plan – PNDA aims to promote socio-economic activities to substitute illicit crops, and which constitute a real alternative for peasants who grow coca, poppy or marijuana.

  DNE will coordinate with PNDA the development of alternative projects in areas covered by the eradication program. It is assumed PNDA will execute its projects autonomously and own coverage areas and subject to regional sceneries where its mission is applied, whose strategic purpose is to reduce the participation of the target population in illicit crops and to articulate it in building legal social and economic alternatives, playing a positive role as a tool for adapting to the conditions to support the peace process.

Likewise, it must be acknowledged that PNDA´s management model is supported on the need to engage in actions leading to offer economic and social development alternatives to the population affected by illicit crops. In this sense, PNDA has opted to strengthen voluntary eradication based on Social Agreements for Alternative Development, whose objective is to set forth agreements with communities affected by the illicit crops who express their will to eradicate them.

Consequently, the PNDA´s work is defined by the implementation of regional development processes aimed to discourage population related to coca and poppy crops.

- *Social Solidarity Network.* The purpose of this network is to support communities in areas affected by illicit crops with programs and projects for health care.

- *Investment Fond for Peace.* Supports communities and organizations in the financing of infrastructure projects and social projects.

- *Illicit Crops Integrated Monitoring System – SIMCI.* The National Narcotics Directorate (DNE) and the Anti-Narcotics Police, with the support of the United Nations International Control Programme (UNDCP), designed and implemented the SIMCI project which developed a methodology aimed to the permanent and exhaustive monitoring of illicit crops, not only quantifying them but locating them in the different regions in the country with the use of satellite images. The monitoring and environmental Record of this EMP and its annexes shows a more detailed description of this project.

- *National and regional coordination.* It is of great importance that DNE should closely coordinate its actions with agencies assigned to the National Narcotics Council and to the Regional Narcotics Council; also, with agricultural technical assistance agencies such as Autonomous Regional Corporation (environmental) (CARs) and Agricultural Technical Assistance Municipal Units (UMATAs), in order to design and to promote joint programs on environmental education and community development.

- The approach process with departments and, simultaneously with municipalities is achieved with the adequacy and implementation by the Regional Council, of the following activities:

- The National Narcotics Directorate will call a meeting of the Regional Narcotics Council, Majors and representatives of entities potentially involved with this entity, where PECIG´s formulation principles, EPM´s Social management Program and its articulation with the Departmental Plan to Fight Drugs, the Departmental Development Plan, development plans and municipal POTs.

- The purpose is to include in these plans, specific actions to mitigate, compensate, prevent and take the corrective measures inherent to displacement and attention to the floating population, incentives to legal crop growers, and to obtain information on settlers, subsistence farmers, coca–leaf harvesters *(raspachines)*, training on the illicit crops issues and the impact on the environmental component, amongst others.

- The responsibility for the above is under the Regional Narcotics Council, which seeks articulation of the Social Management Plan with departments and municipalities, such that, in the context of the Departmental Plan of Fight Against Narcotics, provision is made of departmental and municipal development plans and municipal land regulations (POT) specific actions for the mitigation, compensation, prevention and adopting of corrective measures inherent to the displacement and attention to the floating population, incentives to legal crop growers and strengthening of these activities.

- *Administrative agreements.* DNE will establish integration agreements with State technical agencies to support and provide the required information, according to its competencies for the sound development of measures adopted in the EMP. In general, support from the following entities is required:

  a. Agustín Codazzi Geographic Institute of Colombia (AGUSTIN CODAZZI GEOGRAPHIC INSTITUTE OF COLOMBIA - IGAC) for the generation of basic cartography.
  b. National Health Institute of Colombia (INS), for epidemiologic follow-up in eradication areas.
  c. Statistics Administrative Department (DANE) for production of socio-economic statistics in the program area.

d. Colombian Agriculture and Livestock Institute (Colombian Agriculture and Livestock Institute - ICA) for follow-up of phytosanitary aspects of the program and promotion of agriculture production.
e. Autonomous Regional Corporation (environmental) (CARs) for environmental follow-up aspects.

- At the same time, PECIG must seek involvement with other institutions for the management of social issues, as a support strategy to local communities. The most concerned entities are the following:

a. SENA for support in training processes and technical assistance.
b. Departmental Education Divisions, for development and inclusion in academic programs or institutional education projects of preventive and information strategies against drug issues.
c. Departmental Health Divisions for the establishment of epidemiologic windows and relevant studies on health impact due to spraying.

**3.2 Financial compensation actions**

Compensation is defined as the payment which DNE and the Anti-Narcotics Police will make to the owners of lawful crops accidentally sprayed or due to adverse weather factors. The payment of these compensations will be subject to the provisions of Resolution 0017 of October 4, 2001, as follows:

*Procedure*

| | |
|---|---|
| Accountable entities: | National Narcotics Directorate (DNE) and the Anti-Narcotics Police (DIRAN) |
| Reception of claim: | Claims must be submitted by person affected before the Municipal Ombudsman, in form similar to the attached. |

| | |
|---|---|
| Preliminary verification: | The Municipal Ombudsman will request Colombian Agriculture and Livestock Institute - ICA and/or UMATA a visual inspection of the facts which will be recorded and attached to the claim, in a format designed for that purpose. |
| Remission to DIRAN: | Two days following the Colombian Agriculture and Livestock Institute - ICA and/or UMATA report, the Municipal Ombudsman will send report to DIRAN with copy to the DNE. |
| Background information: | Within 5 days following receipt of the claim, DIRAN will certify whether there was aerial spraying on that date, according to the Satellite Tracking Flight reports (SATLOC) and all other documentation and spraying polygrams. |
| Field visit: | If DIRAN´s certification is positive regarding site spraying and date indicated in the claim, the Complaints Team will make a field visit within the following 10 days in order to verify the basis for the claim, determine damages and their relationship with aerial spraying of glyphosate. |
| Record of Acknowledgement: | If, after the field visit, the Complaints Team concludes that damage was caused and spraying was effected, the Team will estimate the amount of the damage and will sign a record of Acknowledgment. On the contrary, if it concludes that no damage was caused, it will inform this decision to the Municipal Ombudsman within 2 days of the visit, explaining the reasons for non-acknowledgment. |

| | |
|---|---|
| No visit: | No visit will be made when public order conditions so avoid it. |

*Bases for crop replacement*

Crop replacement will apply only in the following cases and in the following manner:

| | |
|---|---|
| Object of replacement: | Licit crops affected by spraying. |
| Opportunity: | Complaint will be processed provided it is filed within 60 days of spraying. |
| Classification: | Permanent and transitory crops, as defined in the Resolution. |
| Permanent crops: | Replacement will include the following: a) investment in installation; b) value of damaged crop at market prices as per CORABASTOS Chart; c) reinstallation value of the crop; d) value of future crops calculated until production of the new plantation. |
| Transitory crops: | Replacement will include value of the damaged crop at per CORABASTOS Chart. |
| Calculation of replacement: | The Complaint Team will calculate replacement value according to the number of damaged plants, calculating on this base the maximum possible production, as per Charts provided by Colombian |

Agriculture and Livestock Institute - ICA.

| | |
|---|---|
| Requirements: | a) DIRAN certification on spraying on site and date denounced: b) copy of SATLOC reports; c) copies of spraying record and spraying polygram; d) copy of detection report of illicit crops and PECI´s monitoring systems of the municipality or area of the complaint; e) copy of the field visit report; and f) all other documents as appropriate. |
| Payment: | A Damage Recognition record will be signed between the coordinator of the Complaint Team and the beneficiary and payment will proceed. If beneficiary is not to be found at the time of these proceedings, the document will be left in the Ombudsman´s Office who will obtain signature of beneficiary and send it to DIRAN. To proceed with payment, this Damage Recognition record must be sent to the DNE. |

### 3.3 Environmental compensation actions

If damages are caused on State-owned forests or on the Nature Parks Compensation system, the procedure will be the following:

| | |
|---|---|
| Accountable entities: | Anti-Narcotics Police (DIRAN) |
| Reception of claim: | Claims must be submitted by the Environmental Authority (CAR) or by the Special Administrative Unit of Nature Parks (UAESPNN) before DIRAN, in a form similar to the attached. |

| | |
|---|---|
| Background information: | Within 5 days following receipt of the claim, DIRAN will certify whether there was aerial spraying on that date, according to the Satellite Tracking Flight reports (SATLOC) and all other documentation and spraying polygrams. If this report concludes that no spraying was made on the date and site indicated, the result will be communicated to the CAR or to the UAESPNN, as applicable. |
| Field visit: | If DIRAN´s certification is positive regarding site spraying and date indicated in the claim, the Complaint Team will make a field visit within the following 10 days in order to verify the basis for the claim, determine damages and their relationship with aerial spraying of glyphosate. |
| Record of Acknowledgement: | If, after the field visit, the Complaints Team concludes that damage was caused and spraying was effected, the Team will estimate the amount of the damage and will sign a record of Acknowledgment. On the contrary, if it concludes that no damage was caused, it will inform this decision to the Municipal Ombudsman within 2 days of the visit, explaining the reasons for non-acknowledgment. |
| No visit: | No visit will be made when public order conditions prevent it. |

*Basis for crop replacement*

Crop replacement will apply only in the following cases and in the following manner:

| | |
|---|---|
| Object of replacement: | Natural forest and water bodies affected by spraying. |
| Opportunity: | Complaint will be processed provided same is filed within 60 days of spraying. |
| Natural forests: | Replacement will include the following: a) area of affected forest, in square meters or hectares; b) reforestation value per hectare with plantation density not less than 1000 plants/ha, at market prices as per the corresponding CAR Charts. |
| Water bodies: | Replacement will include the cost of cleaning work by the corresponding CAR or municipality, as per contracts or minutes. |
| Calculation for Replacement | The Complaint Team will calculate the replacement value according to the number of hectares damaged, multiplied by the value of the plantation per hectare affected times 2 for maintenance and replacement purposes. In the case of water bodies, calculation will be made according to effectively payment or expense caused to the CAR or to the municipality. |
| Classification: | Permanent and transitory crops, as defined in the Resolution. |
| Requirements: | a) DIRAN certification on spraying on site and date denounced: b) copy of SATLOC reports; c) copies of spraying record and poligram; d) copy of detection report of illicit crops and PECI´s monitoring systems of the municipality or area of the complaint; e) copy of |

| | |
|---|---|
| | the field visit report; and f) all other documents as appropriate. |
| Payment: | a) A Damage Recognition minutes will be signed between the coordinator of the Complaint Team and the authorized CAR or UAESPNN officer, or the Municipality and payment will proceed. The minutes will be sent to the DNE to make the corresponding payment; b) DNE will process before the Anti-Narcotics Council payment on the denounce, if any, with Peace Fund resources; c) if no relationship between program´s operation and damage caused is found, no payment will proceed. |

### 3.4 Health Care

Health attention should be given at two levels: occupational health and health of population exposed to aerial spraying with glyphosate.

This Record will only refer to health measures of population exposed to aerial spraying with glyphosate, since occupational health will be processed in the industrial safety sheet. The recommended measures on this respect are the following:

a) **Epidemiologic monitoring**

Surveillance of spraying effects of a chemical agent on the health of persons living in the regions subjected to the treatment should be appropriate as to its planning and methods, in order to obtain a result which at the same time is reliable, cost-benefit, cost effective and far from economic extravagance and generation of unnecessary public panic.

The risk derived from spraying is conditioned by both the intrinsic toxicity of glyphosate and the magnitude and exposure time to its effect, biological efficiency of the exposure route and environmental conditions where this happens.

In the case of the use of glyphosate formulation, the greatest intensity and magnitude of exposure in the development of Program activities will fall on persons exposed to substances used in aerial spraying, that is, to those responsible for formulation handling, preparation and application of mixtures.

Regarding populations of treated areas, it should be considered that they will be exposed to a diluted intrinsic low toxicity agent, of the minimum absorption capacity of exposed living beings, and therefore, of a minimum exposure to its systemic effects, of general and on the spot applications, of populations far from cultivate areas with a very low potential of direct exposure and with a low exposure level exclusively through environment.

Epidemiological monitoring by persons and entities responsible for the health of communities can be done in two optional ways:

- Regular monitoring according to usual assistance practice, or
- Epidemiological monitoring enhanced for possible effects

The first option involves comparing diseases of unknown origin against case definitions of exposure or toxic effects of glyphosate, and testing of suspected diagnosis through laboratory tests.

Given that the margins of human exposure through environment are not sufficient to produce detectable concentrations or amounts of the agent (glyphosate) in samples of biological fluids, direct measurements of glyphosate in these concentrations are discarded. This also applies to personnel exposed to concentrated preparations of glyphosate.

As for the population of treated areas, it is more appropriate to establish a communication system between those responsible for public health and a central level on possible effects, on what does and what does not constitute glyphosate exposure effects, and an immediate reaction system for the field research as required.

According to current legislation, the monitoring of potential effects on the population living in areas of illicit crops, the territorial entities, through the Health Promotion Agencies (EPS) or to the Subsidized Regime Health entities (ARS, SISBEN) contracted by the regional directorates for the purpose (Acts 9/1979, 100/1993, regulatory decrees 1891/1994 and Accord 29 of the National Council for Health Security).

In compliance with the functions established by law, above entities must select the monitoring option of their election, and report uncertain or highly suspect cases associated with Program´s activities, through their information systems and channels established at central level of the National Health Security System.

Notwithstanding the foregoing, for DNE to be able to make a closer follow-up of the possible effects on health of population exposed in spraying areas, the following are some measures recommended by the DNE:

- To establish direct contact with regional health authorities in the departments with illicit crops, to inform the Program and its potential effects, and to propose the joint execution of an epidemiological monitoring plan on such effects.

- To design a format on epidemiological monitoring, jointly with the Ministry of Health, and to promote its use in hospitals in the municipalities of influence of the eradication program.

- To promote and conduct seminars at national level on the matter designed to train local hospital officers in the physiological and sanitary aspects linked to possible affectations by glyphosate, and train them on epidemiological monitoring, jointly with the Ministry of Health, and to show the how to complete the form previously agreed with the Ministry.

- To establish mechanisms such that the form be completed by local hospitals and sent to the Ministry of Health, every month.

- Based on the monitoring results in the first six months, the Environmental Sub-Directorate and Social management of DNE will design and propose CNE an immediate notification system of suspicious events caused by spraying activities, and of acknowledgement for treatment expenses due to health affections of the exposed populations, in cases previously proven, in similar form to the design provided for the acknowledgment of damages on lawful crops (Resolution 017/2001). Toxicology sheets of the Ministry of Health will be taken into account for this purpose.

- Establishment of a training program for health assistance and administrative staff, as provided for in the educational communication program.

## 4. SCHEDULE

The monitoring activity is to be performed throughout the life of the eradication program of illicit crops by aerial spraying with glyphosate.

## 5. FOLLOW-UP AND MONITORING

This will consist of:

- Monthly verification of compliance with activities of interinstitutional support.
- Monthly verification of activities in coordination with PNDA

- Monthly verification of coordination activities by regional entities and on execution of proposed events.
- Monthly verification of financial compensation processes for crop damages.
- Monthly verification of compensation processes to Environmental Authorities and the Nature Parks Unit UAESPNN for environmental damage.
- Monthly verification of epidemiological monitoring activities as provided for in this program.

## 6. ACCOUNTABILITY

The DNE and DIRAN, through the Environmental Sub-Directorate and Social Management of PECIG.

## 7. COSTS

The total cost is estimated in $1,118.000 per year, broken down as follows:

| | |
|---|---|
| • Interinstitutional support | $ 16,000.000 |
| • Liason with PNDA | $ 16,000.000 |
| • Coordination with regional entities | $ 16,000.000 |
| • Financial compensation for crop damage | $ 350,000.000* |
| • Financial compensation for environmental damage | $ 700,000.00** |
| • Health care (Preparatory phase, 1st year) | $ 20,000.000 |
| TOTAL | $1,118,000.00 |

**END OF SOCIAL MANAGEMENT PROGRAM**

| EDUCATIONAL COMMUNICATION PROGRAM | RECORD 10 |
|---|---|

## 1. DESCRIPTION OF THE ACTIVITY GENERATING IMPACT

In the course of the illicit crops eradication program by aerial spraying with glyphosate herbicide (PECIG), the social and economic nature and connotations of the process require permanent communication with the community, at national, regional and local levels, for the program to be understood and accepted by society as a whole.

## 2. OBJECTIVES

The objective of this program is to develop a set of activities designed to inform the public, at national, regional and local levels, of the nature and scope of PECIG, its results and its problems. In parallel, it seeks to train all personnel who take some part in the glyphosate spraying, so that there will be permanent improvement in their skills in handling the products under their care, and avoid potential accidents which would endanger the health of persons and the environment. Similarly, there will be mass educational communication campaigns in ecological matters, in the PECIG target areas.

This program should be developed in coordination with the Social Management program of PECIG (see Record 9).

## 3. ACTIVITIES

The Educational Communications Program has four basic components: information, training, environmental education and signposting, through which the intention is to win the acceptance and collaboration of the local population, and improve their conditions of life. Five of these actions are particularly important: information, education, training, signposting and health care.

### 3.1. Information

The public should be constantly informed at national, regional and local levels, particularly among the communities located in the areas of influence of the centres of glyphosate spraying, on matters such as:

- Objectives of PECIG
- Importance of the program
- Characteristics of PECIG
- Social and environmental measures applied
- Results of the Technical Environmental Audit
- System of attention to complaints.

This information should be channelled through the following media:

- Operation of an Internet webpage, placing permanent information on the results of the environmental management plan and PECIG, with summary reports of the Environmental Audit, results of environmental monitoring conducted under the EMP, monthly summary charts of spraying by municipality, department and nucleus, number of plots and hectares sprayed, and other matters which DNE and DIRAN consider should be the object of public knowledge.

- Monthly PECIG information bulletin, in the context of other activities of the programs of the fight against drugs

- Regular press communiqués, with PECIG results and results of the environmental management plan

- Holding of an annual national seminar, attended by experts and researchers, NGOs, government agencies and the police, to disseminate environmental and social aspects, and results obtained.

- Information campaigns through the media.

### 3.2. Training

Training should be addressed to a range of actors, including technical and operational personnel in PECIG, health authorities, and others involved in the implementation of the program.

#### 3.2.1. Training operational personnel

In accordance with Decree 1843/1991, operating personnel should have access to training courses or processes and instruction, offering theoretical and practical nature, with a minimum intensity of 60 hours accumulated over a year, the content being in accordance with the type of activities which in which they engage, and it is anticipated that the training will include the following issues:

*Base personnel*

a) Information on pesticides, types formulation, precautions in handling and general matters of toxicology and environmental pollution;
b) Different forms of intoxication;
c) Instructions on the proper care, handling and safety of equipment in each activity;
d) Measures and processes to avoid contamination of products for human or animal consumption;
e) Instructions on waste disposal;
f) Initial signs of intoxication and general measures in the first aid;
g) General information on the scope of legislation on pesticides and their management;
h) Basics of registration control, with an emphasis on the handling of herbicides and environmental impact;
i) Environmental Management Plan, with an emphasis on programs managed at the base, that is, measures for the handling of glyphosate (storage, mixing), transport of the herbicide; handling of solid waste and wastewater, social management, and integral safety;
j) Attention to and referral of complaints about damage to crops and other; and
k) Contingency planning, with drills for accidents.

*Pilots and spraying crew*

a) Information on pesticides, types of formulation, precautions and handling, and general matters of toxicology and environmental pollution;
b) Different forms of intoxication;
c) Instructions for the proper and safe handling of spraying equipment;
d) Instructions for the calibration of spraying equipment;
e) Initial signs of intoxication and general first aid measures;
f) General information on the scope of the law on pesticides and handling;
g) Base phytosanitary control, with an emphasis on the handling of herbicides and environmental impact;
h) Environmental Management Plan, with emphasis on the program of interest, that is, handling and management of spraying operations, social management and integral security; and
i) Contingency plan, with drills for response to attacks on a loaded aircraft.

*3.2.2. Regional and local personnel in medical and central services*

a) Effects of glyphosate on human health;
b) Mechanisms of the transfer of glyphosate in trophic chains;
c) Methods of epidemiological research;
d) Training for research in symptomatology, and effects potentially linked to glyphosate;
e) First aid measures to be taken in the event of intoxication, skin exposure, or inhalation of glyphosate;
f) Completion of forms to record attention given in cases of potential glyphosate effects;
g) Procedure for the dispatch of forms to departmental and national health authorities, DNE and DIRAN;
h) Procedure in the system of attention to complaints of persons affected by damage allegedly attributable to PECIG.

**3.3. Environmental education**

**3.2.1. Education for local communities**

During spraying operations, a campaign of ecological education will be conducted, and it will be designed to create awareness among the population on the natural values of their region, and ways of protecting them. This education will play at particular attention to the following issues:

a) Introduction on the environment, and its relationships with human activities,
b) Local flora and fauna, and the economic importance,
c) Obligations of PECIG with regard to the environment,
d) Detailed explanation of the environmental management plan,
e) Forms of community participation in the program, and
f) Preventive measures to combat exposure to glyphosate.

The campaign will be conducted through workshops in each of the municipalities affected object of the PECIG, and will be addressed to local communities. The workshops will be held on the issues proposed above, and those issues will be condensed into leaflets.

Invitations to the workshops will be made through mayors, the regional development authority CAR, and the agricultural advisory offices UMATA, amongst others. They will preferably be held on a Saturday or Sunday, following detailed programming to be set up by DIRAN, and implemented by a consultant specializing in environmental matters.

**3.2.2. Environmental training for technical and operational personnel in the program**

Workshops will also be held in each base for program personnel, organized into groups of 30 (4 per base), giving emphasis to environmental management, depending on the speciality or activity (mixers, workshop personnel, equipment operations, police, etc).

Given the volume of personnel (about 120 per base), about four workshops per base will have to be held, for a total of 36 workshops nationwide (30 per workshop).

These workshops will be held in the first two months of each year, with the content proposed in Record 9, Social Management Program. This training will be in the hands of experts. Leaflets will be prepared on environmental management in the project, and distributed to all those attending.

The Program Records to be used are those for the Environmental Management Plan. Further, two leaflets need to be prepared as basic material for the workshops, one for the training of local communities, in which there is information on the project and management plan, as basic element, and another for workers, with an emphasis on environmental management measures to be applied by workers in the course of their work.

### 3.4. Signposting

The purpose of signposting is to make the local population (those living in the neighbourhood, and those passing through each base), aware of security and safety measures to be taken into account in order to prevent risks associated with the program inside the bases. Among the measures to be applied, the following are recommended (see Figures 1 and 2 as an example).

- *Preventive signs*, warning the user or the existence of a hazard and its nature, and providing safe passage for vehicles, equipment and program personnel (applies only inside the base).

  Preventive signs should be placed at sites where glyphosate is stored in a mixed, where fuel

  is stored, and at other places where there are special risks.

- *Regulatory signs* indicate limitations, prohibitions and restrictions on use, and will be placed at points where an order must be obeyed.

- *Informative signs* indicate temporary directions to take to reach a certain place, or in the form of the presence of obstacles at a given point.

Therefore, portable notices and hoardings must be made up out of sheet steel, with metal braces, with giving signs visible to pedestrians and drivers, and directly related to safety measures, including:

- Identification of entry and exit points to the base
- “No Litter” signs
- “No parking” signs 100 m before and after the main gate of the base (if the base is on a public highway)
- Recovery and recycling: plastics, glass, cardboard, etc (inside the base).

Other signs should be installed at barricades, with metal hoardings or reflective tape, with appropriate support, light cones, bins, light paths and luminous lines, to provide temporary isolation to the perimeters.

**4. SCHEDULE**

This activity will take place while the aerial spraying activities are in progress, with annual programs to be established by DIRAN.

**5. FOLLOW-UP AND MONITORING**

This will consist of the following:

- Monthly check of compliance with information campaigns and the preparation and distribution of leaflets
- Weekly inspections of the condition and presence of notices and holdings
- Monthly check on the arrangements for training workshops and environmental education
- Daily check on the environmental comportment of base personnel

**6. ACCOUNTABILITY**

DIRAN and DNE

## 7. COST

The annual cost per base is estimated as COP 31,000,000, is distributed as follows

| | |
|---|---|
| Workshops | COP20,000,000 |
| Meetings with agencies | COP1,000,000 |
| Signposting | COP10,000,000 |
| Total | COP31,000,000 |

The following global costs must also be taken into account for the whole program:

| | |
|---|---|
| Webpage | COP 30,000,000 |
| Monthly bulletin | COP 5,000,000 |
| Leaflets | COP 5,000,000 |
| Mass communication campaigns | COP 60,000,000 |
| Total | COP 100,000,000 |

**END OF THE EDUCATIONAL COMMUNICATION PROGRAM**

| PROGRAM FOR INTEGRAL SAFETY AND SECURITY AND OPERATIONS BASES | RECORD 11 |
|---|---|

## 1. DESCRIPTION OF THE ACTIVITY

During glyphosate aerial spraying operations a set of activities take place at the operations base and in the air, which, if executed inappropriately, could lead to accidents or and damage to the health of persons, loss of assets and other events.

An appropriate working procedure and efficient use of the various types of tools and machinery during operations at the base will reduce the risk of accidents and impacts on employee health.

This management program is based on the concept that accidents be significantly affect the normal functioning and activities of the program in any of its phrases, generating income disadvantages such as increased production costs, supplementary cost (in damage, repairs, materials, etc), and this will also be associated with a poor image of the program, and a consequent negative impact on the social component.

Difficult atmospheric conditions, together with the stress caused by the risks involved in these operations, makes it necessary to create and develop activities which will encourage the entire human group, and create a harmonious, health and healthy environment, for employee welfare.

Among the risks which may arise in the various antinarcotics bases due to operations with herbicides (handling and use), fuels and other chemicals, there might be the following:

*Contamination of the atmosphere.* This is originates from gases generated from in vehicle transport, and vapours which may be emitted from operations in storage, transport, mixing, spillage of the herbicide, and most especially due to the evaporation from badly-closed containers. In one way or another, this will contaminate the environment, and produce irritation and produce unpleasant effects on personnel remain in permanent contact with chemical substances

*Contamination of water.* This is linked to a spillage of herbicide, and its possible discharge into local water sources.

*Contamination of the soil.* Spillage may also take place inside the base, and of the physical, chemical and biological conditions of soil.

*Intoxication of mixing personnel*. The herbicide may enter the human organism through the mouth, or may be inhaled, or enter through the skin or eyes, during activities such as eating or drinking while in contact with the herbicide. Entry through the respiratory system occurs when mixing takes place in conditions of wind, or by inhaling of smoke or vapours from fires, and, at storage sites, coming from badly-closed, broken or leaky receptacles, or when spillage is not promptly cleaned up, or the wrong kind of respirator is used, or filters are contaminated.

*Spills.* These basically may occur during the storage and transport of the herbicide, and involve the risk of intoxication to the mixer, or damage to vegetation and soil.

*Fire.* The causes of fire are many. Smoke and gas is generated, some of which are toxic (in particular, those in the burning of fossil fuels) are an immediate risk to employee health, and offer the danger of burns, by their nature.

There are also other activities and phenomena derived from them, that cause impact during spraying operations, and that must be handled from the point of view of industrial safety, in particular the following:

- Handling of land machinery and equipment, including fumigation aircraft and support
- Handling of fuels and lubricants used in general equipment and machinery

- Noise of aircraft and helicopters of the program, creating sound contamination

This program is based on the integral security and safety plan at operations bases, drawn up by the Antinarcotics Police, and established by the National Police.

## 2. OBJECTIVES

The program aims to avoid risks to personnel taking part in spraying or in environmental hazards which may be derived from the operation and mixing of the herbicide, the process of loading aircraft, and inappropriate use of dosers, spraying equipment, pumps, hoses, and equipment in general, and the handling of fuel, machinery and equipment in routine base work.

Continuous supervision by supervisory personnel will be a primary objective in guaranteeing that operations are conducted correctly.

This program will be an instrument for ordering responses from personnel in the event of an accident.

## 3. ACTIVITIES

### 3.1. Safety measures to be adopted

#### 3.1.1. Risk control measures

Poor storage of glyphosate and its collections, and of fuels and lubricants, spillages of liquids, badly-closed receptacles and other events may produce odours and other environmental problems.

The control to avoid this risk is based on constant supervision. In order to prevent these effects, there must be additional work areas separated from the site of accommodation, dormitory areas and places where food is prepared under cover, with good ventilation, away from water sources and plastic containers, for appropriate storage; further, there must also always be sawdust, earth, clay or some other absorbent material to hand, for immediate application in the event of a spillage

Should a nearby water source be contaminated, this must be immediately corrected, improving the drainage system to avoid contamination of groundwater, by constructing the ditch with earth around it, sending the mixture to a water treatment plant.

Herbicide spillages and hard areas can be countered by covering them with earth, and subsequently cleaning the spillage area with abundant water, in order to prevent it from spreading and contaminating soil.

In some cases, where the spill is abundant, it should be retained and absorbed. The material used in this activity should be eliminated at strategic places, such as the sanitary infill in the nearest human settlement, where it can be used as coverage material, given the relatively rapid degradation of glyphosate in the soil

**3.1.2. Measures for handling**

The following precautions and should be followed when using the product:.

- There should be no contact with eyes or clothing;
- Avoid breathing vapour or mist from spraying;
- Wash your hands before eating, drinking, chewing gum, using tobacco, going to the toilet;
- Remove clothing at once if it comes into contact with herbicide. Then clean thoroughly, and change into fresh clothing;
- Do not contaminate water when eliminating wastewater from washing equipment.

### 3.1.3. First aid measures

If glyphosate enters the eye, keep the eye open, and wash with abundant water. If ingested, this may cause irritation to the gastrointestinal tract, and it necessary to dilute it by ingesting water or milk. If inhaled, take the person out into the fresh air. If he is not breathing, apply artificial respiration, preferably mouth-to-mouth. At all events, the best course is to obtain medical help.

If there is intoxication due to the action of glyphosate, the following measures should be taken:

- Keep the patient breathing
- Wash his eyes with abundant water
- If contamination is through the skin, personal intoxication should be removed from the working area, and his clothes and shoes, and clothing should be thoroughly washed before reuse. The patient should be promptly washed all over with water and soap, and his scalp and should be washed, and wash underneath his nails. In this process, avoid rubbing or washing the skin violently. Finally, he should be dried and dressed in clean clothes.
- If there is contamination through the eyes, and I should be washed with water 10-15 min, with the patient lying on his side so the water does not fall into his mouth or into the other eye. After washing has been completed, the eye should be covered with gauze and a clean handkerchief.
- If contamination is through inhalation, the person intoxicated should be taken away from the working area and placed out in with fresh air, and his clothes should be loosened to ease breathing.

### 3.1.4. Measures to combat spills

Spills generally occur during storage and transport, and should be attended to at once, in order to avoid the risk of intoxication, contamination of the environment, and fire.

A person who is going to be exposed to this risk must wear full protective equipment, including boots, gloves, respirator, etc. and have personal knowledge of the degree of toxicity and flammability of the product.

Water should not be thrown onto spilled herbicide. Rather, the spilled liquid should be covered with absorbent material such as earth, or, failing that, apply lime to prevent odour that would irritate workers. It should be expected that the matter will completely absorbed the spill.

Any product which can be recovered should be should have absorbent material scattered over it, which should be turned several times in different directions with a broom, until completely clean.

Next, use a broom and a spade to pick up this material, place it in a plastic bag, and then give it some appropriate final disposal preferably in a sanitary infill. Subsequently, a solution containing caustic soda, water and detergent should be applied to the floor, to decontaminate it.

To prepare the solution for one square metre, use quantities of water, 250g of caustic soda and 300g of detergent. Places the quantity required in a container, then add the caustic soda in spoonfuls, and stir with a stick; finally, add the detergent. Use gloves and goggles for this.

Warning. Do not throw water on to caustic soda, it may explode.

To apply a decontaminating solution, do the following:

- Surround the stained area with absorbent material (atapulgite, bentonite or other absorbent clays);
- Apply the solution to the centre of stain;
- Cover the entire area with absorbent material and leave for several hours, preferably until the next day;
- Effect final disposal, placing the material in a metal drum and eliminating it in a sanitary infill. If there is no such facility nearby, an area should be

constructed manually at the base.

When cleaning is completed, wash protective items used, applying the solution of sodium fluoride in water at 5% (50 cc per litre of solution), for decontamination.

**3 1.5. Firefighting measures**

The flamepoint of glyphosate is over 200°C, but the temperature at which self-ignition would take place has not been determined. In the event of a fire involving herbicide, this would be a cause of smoke, gases or even toxic vapours, which may create environmental health problems.

In order to avoid this kind of accident, it is essential to keep the installations completely clean and tidy, not smoke at work sites, store items correctly, and keep electrical installations in perfect order.

If a Class B fire break out, that is, when the fuel is liquid or gas, proceed as follows:

- Give the alert immediately
- Use extinguishers to see whether the fire can be put out
- Apply foam, dry chemicals, $CO_2$
- Evacuate personal not taking part in the extinguishing exercise
- If the fire cannot be controlled, leave the area upwind, since smoke may be toxic
- The water used for extinguishing should be used in moderation, to avoid spreading, and generate less waste
- Where possible, build a sand barrier to prevent the dispersion of water used in extinguishing, or cleaning liquids

Once the fire is put out, take the following precautions:

- Cordon off the area and place sounds, to prevent unauthorized entry
- Personnel taking part in cleaning work must wear protective equipment
- No smoking, eating or drinking in the contaminated area
- Carefully decontaminate protective items and tools used in the cleaning exercise when the exercise is completed
- In very special cases, and if available nearby, it would be advisable to adopt

measures of prevention and control, taking water samples for analysis, and determining whether it is or is not suitable for consumption or any other activity in contemplation

**3.1.6. Rules for location extinguishers**

Extinguishers should be conveniently signposted, depending on the classification of fires, in the following manner.

Class A. The combustible item is solid (paper, cardboard, wood, cloth, etc

Class B. Whether combustible substances liquid or gas

Class C. Combustible items are electrical installations or equipment

Class D. Where metals present which react to air, and further generate their own oxygen,

such as aluminium and titanium.

Extinguishers should be located in visible and accessible places, and be inspected monthly and be charged every six months if not used. Personnel should be instructed on proper operation of the extinguisher. There must be extinguishers at different points of each base, where there is the possibility of a high (offices, restaurants, kitchens, cafeterias, stores and fuel pump, herbicide store, handles, parking aircraft in areas, and helicopters, camping sites for herbicide, etc.

**3.1.7. Personal protection equipment**

Personal protection is of vital importance to the proper execution of work, without restriction, and with regard to personal safety, and further, to avoid accidents which will bring serious consequences to the institution. All employees must use elements required for personal protection, including:

- 2 overalls, which can be easily washed and dried, to secure a change of clothing every day or more, where circumstances required

- 1 pr trousers, with rubber sheeting
- 1 pr nitryl gloves
- 1 pr leather gloves (depending on risk of handling)
- 1 pr safety boots
- 1 Helmet or head covering
- Protective equipment for respiration, ears or skin, where the risk requires
- Each employee must have double-door, independent and individual locker at the entrance to the operations side, to keep his street clothing and work clothing
- Keep towels and soap for each worker.

The glyphosate storage warehouse must have visible signposting and areas marked out, with hazard warnings and emergency exits, and sufficient space for personal to move around and transport containers with this liquid. Once the chemical substances have been used, the empty containers must be plugged and kept away from perishable products and water sources, since these will retain vapours and residues of the product

**3.1.8. Measures to be taken in the event of an attack, involving glyphosate**

Bases are constantly exposed to attack, and the material used for spraying and eradication of illicit crops is the principal target, that is, glyphosate.

In order to prevent attacks against glyphosate, the storage system is to be constructed in a concrete store some 50-100 cm high, with a mechanism for the evacuation of residues if necessary (see Record 2, Program for the handling of glyphosate and its coadjuvants at operations bases). During combat, a container or bin will be placed on the discharge pipe, to collect up any liquid spill. The bypass Valve will be kept open for this activity

A given number of empty drums must be kept on site, with lids, so that they can be replaced, and continue with the process until the liquid is entirely drained.

If there is a spill due to inappropriate location of plastic containers that contain glyphosate, action should be taken after combat is finished, implementing the measures described above, consisting of the application and absorbent material available nearby, and taking the right precautions.

### 3.1.9. Washing of aircraft

The washing of aircraft after spraying operations will be effected taking account of recommendations such as the following:

- Work away from the water sources.
- Set up a single place for this activity.
- Design and implement a special and appropriate system for the discharge of wastewater.
- Give regular maintenance to the system, adopted for the proper functioning and operation of the same.
- Make a complete check of the inside of aircraft prior to washing, to ensure that there is no liquid, in order to avoid greater contamination of the receiving body of water.

### 3.1.10. Maintenance of mixing equipment

The doser, the mixing tank, the couplings, the hoses and the nozzle used in the mixing process to supply aircraft with herbicide must always be in good condition, avoiding any leaks of pure and mixed substances.

### 3.1.11. Storage

The chemicals must be stored under cover, in place with good ventilation away from water sources, food, forage or seeds. Storage must be effected in containers or tanks made of stainless steel, aluminium and glass, plastic, or plastic-lined containers, since some materials such as steel, galvanized metal or unlined containers react with glyphosate, forming hydrogen gas, which because a highly flammable gas mixture (see Storage and handling of glyphosate at the base).

### 3.1.12. Other safety measures

*General*

Follow appropriate techniques and use of all kinds of equipment and materials

- Do no more than four hours operation in spraying activities, and relieve spraying personnel every week.
- Do not allow unauthorized personnel to remain in working areas, particularly in areas used to store herbicides and coadjuvants.
- Do not allow access to aircraft and helicopters or to maintenance workshops or parking areas by unauthorized personnel.
- All electrical installations must be explosion-proof.
- Restrict smoking in working areas.
- Restrict the use of drugs etc in working areas.
- Firearms will not be allowed in working areas by civilian workers.
- Traffic regulations must be respected in the Program vehicles platform.
- No horseplay or fighting in working areas.
- No business may be done with the materials or assets of the Program.
- Regulations described in industrial health and safety manuals of the Police.

*Preventive measures*

- All personal participating in the Program should be aware of the principles and content of this Program Record, with instructions regarding the elementary procedures to be used in project activities, and possible danger situations. This measure must be implemented by each worker who comes into the program, and also through the education program.

- There must be at least one person engaged as responsible for supervising compliance with industrial safety regulations during program activities, appointed by the Commanding Officer of the base.

- Vehicles, aircraft, equipment and materials must all be frequently checked, and processes and systems in general, and a complete check made of installations.

- Defects in materials and equipment, and damage caused by accidents, must be repaired.

- A safe place must be found in advance to store fuels, handling them in safe containers.

- Careful evaluation (efficacy, safety and protection), of technologies and procedures used in each, on the ground or in the air, following the aviation authorities regulations.

- Elimination and substitution of unsafe products.

- Protection systems for machinery and employees.

- Selection of the most suitable personnel to work in program, and personnel must made aware of areas with the risk of explosion, fire, or attack, and equipment allowed to be used in the various areas of work.

- Written instructions and application of procedures for working in welding, electrical work, work at height, excavations, load lifting, and materials storage

- Supervision and control of employees; work to be performed with discipline and authority

- All areas such as access roads and working areas within the base, must be signposted and marked out, particularly areas for workshops, fuel supplies, herbicide stores and coadjuvants stores, mixing areas and areas for the circulation of personnel and machinery. There must also be warning signs or prohibitions, such as the mandatory use of helmets, no smoking, and restricted transit.

- Emergency procedures must be clearly and visibly posted, with rules for the handling of hazardous substances and materials. Exits designed for personnel evacuation should be clearly marked.

Figures 1 and 2 show some of the safety items to be used by workers, and some of the preventive signposting

**3.2. Execution**

**3.2.1. Specific functions**

*Anti-narcotics Division*

- DIRAN will be responsible for the overall security of the safety of all personal taking part in the illicit crop spraying activities, by implementing effective actions to prevent and investigate operations, as required to reduce accidents at spraying bases to zero.

- All regulations indicated in Decree 1843/1991 for the use and handling of pesticides must be followed in the training of personnel working in operational phases to avoid accidents in manouevres.

- Complete forms for the control of measures established.

*Eradication of illicit crops area*.:

- Develop control and prevention programs against risks to personnel working as mixers or loading aircraft for spraying illicit crops for their safety and welfare

- Transmit orders and check and these regulations are understood and observed by Base Commanding Officers

- Coordinate personnel medical examinations for those permanently engaged in mixing or discharging or other platform operations, with the health function.-

- Supervise visits to bases in the source of spraying-related activities-

- Provide support for the achievement of objectives.

*Base Commanding Officers*

- Provide herbicide mixers with knowledge of regulations and orders, and check compliance.

- Disseminate orders, regulations and manuals for the use and handling of chemicals used in the mix and in spraying operations, training technical personnel-

- Ensure that technical and environmental guidelines suggested by the Environmental Authority are observed in eradication spraying, given the specific conditions of spraying of coca-leaf and opium-poppy, within set operating parameters (see Program for Glyphosate Spraying Operations).

- Supervise mixing activities and the calibration of equipment used in spraying to ensure that the comprehensive safety and environment regulations are observed.

- Check spraying equipment calibration and ensure that dosage and volume of discharge per hectare as in accordance with the Program (Record 1).

- Coordinate the sending of spraying polygrams with the Antinarcotics Division, reporting developments (return of aircraft with No. of gallons in Hooper)

*Herbicide mixing technician*

- Use personal protection equipment during mixing operations and loading of aircraft.

- Dose for coca-leaf as provided in Sheep 1 and handling of glyphosate at operations bases Record 2 .

- Report any deficiencies in the workings, maintenance or leaks arising during work will be reported.

- Keep accounts of mixing operations, with the safety regulations and precautions indicated for the handling of the herbicides

- Be responsible for the herbicide remaining in good storage conditions, within established parameters

- Adapt the storage area, with the necessary signposting, with informative notices and communication of areas

**3.3. Administration**

*Funds*

Funds required to transport and maintain installations, and for personnel welfare and other expenses caused by the illicit crop eradication operations will be managed by the service areas and with service and support areas of directly in with the competent authorities and agencies

*Uniforms*

Uniforms as required by the special nature of activities, with additional sets of for personal protection in the event in the individual contact with chemical substances

*Physical plant safety*

Adaptation of installations, preventive and informative notices as necessary for safety, to be supplied by the Head of the zone or Base Commander.

**3.4. Command and communication**

*Command*

- Antinarcotics Division
- Antinarcotics Department
- Aviation area
- Interdiction area
- Service and support area.

*Communications*

DIRAN media

**4. SCHEDULE**

The industrial safety program must be applied permanently inside the base and during aerial operations.

**5. FOLLOW-UP AND MONITORING**

Follow-up is the responsibility of DIRAN, in coordination with the safety and security supervisor, and they will make regular inspections of the installations and operations, in accordance with regulations for protection, safety, security and hygiene of the program area

## 6. ACCOUNTABILITY

The Base Commander of the operations base, accountable to DIRAN, responsible for the appropriate management of industrial and environmental security and safety in the program.

## 7. COSTS

Costs refer to the implementation of the industrial safety and security regulations of the program. The application of these measures forms part of the execution of each program activity. Signposting has been provided for in the Educational Communications program. The costs of the fuel storage systems, and of herbicide and other storage, and security and safety systems are included within the normal costs of construction and operation of each base, and may not be charged environmental costs.

| Activity | Unit | Quantity | Unit cost | Item cost |
|---|---|---|---|---|
| Industrial safety regulation | | | | |
| Personal costs* | hours/month | 2 | COP3.5,000,000 | COP 7,000,000 |
| Equipment of security personnel | Global | 15 | COP 50,000 | COP 750,000 |
| Direct costs (stationary, publications, reports)* | Global | | COP1,250,000 | COP1,250,000 |
| Total | | | | COP9,000,000 |

**END OF THE INTEGRAL SECURITY AND SAFETY RECORD.**

| PROGRAM FOR ENVIRONMENTAL MANAGEMENT AND INTER- INSTITUTIONAL COORDINATION | RECORD 12 |
|---|---|

## 1. DESCRIPTION OF THE PROGRAM

The implementation of environmental management measures in the various stages of the illicit crops eradication program by glyphosate by aerial spraying glyphosate (PECIG) requires administrative responsibilities for planning, execution, follow-up and control.

Therefore, it is necessary at this point to make a redefinition of strategies established to achieve the purposes of the PECIG is part of the national policy for the fight against drugs, and this is THE framework established by the government in which State agencies must perform the actions to confront the problem of drugs in Colombia.

The program in itself brings together certain social, political, economic, legal, environmental and health priorities and, amongst other things, but in turn, is also conditioned by the presence and action of a number of administrative agencies and organizations for promotion and control and national and regional levels, in whose jurisdiction of the PECIG must be implemented.

Therefore, it is essential to the successful implementation of the EMP, that plans be made for the actions of the various agencies in PECIG exclusion areas, and to coordinate execution particularly with reference to environmental and social management. It is the work of the Narcotics Council CNE, in the current institutional framework, to bring together all activities and adapt them to the achievement of a common objective, that is, the struggle against illicit drugs.

This Environmental Management and Interinstitutional Coordination program is designed for the entities involved to be able to bring together the best efforts in pursuit of environmental performance which, according to their policies, corresponds to them, and is of interest to them.

**2. OBJECTIVES**

In order to secure compliance with environmental specifications of the various stages of PECIG, and the execution of activities in prevention, correction, mitigation and environmental compensation established in this EMP, through direct action by the entities responsible for the program, and in coordination with the various agencies and sectors involved in the struggle against drugs, and specifically, in eradication through aerial spraying of illicit crops by the herbicide glyphosate.

**3. ACTIVITIES**

**3.1. The institutional context**

PECIG is part of the institutional structure principal components for the CNE, created by the Government in 1973 as the senior authority in national drugs policy; the narcotics directorate DNE, as national coordinating agency, and the Antinarcotics Division of the National Police (DIRAN), responsible for eradication operations.

As instruments of coordination which can be set up in the course of the program, there is provision for the making of agreements, collaboration agreements, and other tools of bilateral negotiations between agencies. However, it is essential that there be reflection on the part of all the interested organizations all the organizations interested in correct execution of PECIG, and implementation of the EMP, in relation to all types of coordination to the type of coordination which can be most effective.

Only synergistic action between all entities will secure the efficacy of EMP and the efficiency of PECIG, performing functions given for each of them.

*CNE*

This organization was created by Decree 1206 of June 26, 1973, and is an organ that provides advisory services to the Government, to formulate policies, plans and programs for adoption, which public and private entities should pursue in the struggle against the production, trade and use of drugs or substances producing physical or psychic dependence. It would also act in the area of control of the legal use of such drugs or substances.

The composition of CNE under Article 90 of Law 30/96, amended by Article 35 of Decree 2159/1993, is as follows:

- Minister of Justice or his delegate, as Chair
- Minister of Defence or his delegate
- Minister of Education or his delegates
- Minister of Health or his delegate
- Minister of Finance or his delegate
- Minister of Environment or his delegate
- Director of CNE, who may speak but not vote
- Public Service Procurator or his delegate
- Director of the Security Police DAS or his delegate
- Director of the Police or his delegates
- Attorney General or his delegate
- The Presidential Program

The principal functions of CNE, under Article 91 of Law 30/1986 are following

- To formulate, for adoption by the Government, policies plans and programs which public and private entities should pursue in the struggle against the production, trade and use of addictive drugs. Likewise, the Council proposed measures for the control of the legal use of those drugs.

- To indicate the specific campaigns and actions to be taken by each official organization.

- To order the destruction of illicit crops be such means as it considers appropriate, subject to the favourable opinion of agencies responsible for public health, and for the preservation of the country´s ecosystems

- To issue regulations as necessary for the performance of its functions, and to propose the issue of those which are within the government´s competency.

- To guide and coordinate the activity of State and private agencies engaged in prevention, scientific research and judicial police, control and rehabilitation in the area of addictive drugs and substances

- To maintain contact with foreign governments and international organizations in matters of its competency, and to pursue action with them in order to coordinate the action of the Colombian government with that of other States.

- To have available, in accordance with any serious indications obtained from intelligence organizations, information on activities of persons, aircraft, docks or ocean, river or land terminals, engaged in drug-trafficking, the suspension of licences for aviation, river and land transport personnel, and permits or certificates for operations. It will give instructions to the appropriate authorities to this effect.

*DNE*

DNE was created to coordinate the development and execution of policy in the area of control and prevention and repression of drugs. Article 93 of Law 30/96 states that the narcotics office of the Ministry of Justice will act as the Executive Secretariat of the CNE. Its functions include:

- To execute CNE decisions.
- To conduct studies assigned by CNE.
- To oversee compliance with CNE decisions, and reports as appropriate.

- To update the inventory of assets occupied or seized due to their direct links with drug trafficking. and related crimes, and oversight of correct use.
- To form part of processes which attempt to indemnify damages due to the seizure of property.
- To coordinate the functioning of the Technical Advisory Committee and of the Regional Narcotics Councils, and similarly to oversee the activities of State and private agencies responsible for prevention and scientific investigation and judicial police activities in control and rehabilitation, and maintain contact with foreign governments and international organizations.
- To implement and coordinate actions provided for in National Drugs Plans, ensuring that public entities in the decentralized sector and organizations which have some responsibility in execution, should design programs within the context of policies provided, and ensure that the use of funds set aside for such actions, whether from the national budget or international cooperation, are efficiently and rationally allocated;
- To present plans and projects considered necessary to comply with its responsibilities for the consideration of the Council.
- To evaluate the execution of policies, plans and programs pursuant under Article 93, suggesting amendments or adjustments as necessary.

DNE, as the coordinating agency in the planning and development of PECIG policies, is responsible for coordinating the execution of the various actions provided for in this EMP.

In complement to the competences of the institutional structure, in relation to the PECIG all the divisions which dealers coordinate in the EMP, subject to verification of activities, are the following:

- To develop the elements of administration for stages of the PECIG.
- To coordinate the implementation of the stages of PECIG.
- To set criteria and proposed solutions for the handling of emergencies.
- To organize the implementation and execution of the EMP in PECIG.
- To pursue actions as necessary to contract studies, lines of research and other matters in relation to environmental management.
- To propose strategies and mechanisms of control
- To set up communications about the program with internal and external parties interested in its environmental management..
- To supervise and evaluate compliance with the EMP in its various components
- To check compliance with current environmental regulations (Figure 1)

*DIRAN*

Decree 43/97, Article 2 states that "The Antinarcotics Division of the National Police will be responsible for the planning and direction of Police operations designed to prevent, and repress major or minor criminal conduct within Colombia, related to the production, manufacture, exports, imports, the distribution, sale, use and possession of narcotics, and the growing of plants which are used to make them", in accordance with the terms of Law 30/96 and further provisions of law which supplement or amend it. This Article was adopted as permanent legislation by Legislative Decree 2253/1991, Article 1.

Since DIRAN is directly responsible for the execution of eradication operations, it is therefore responsible for the application of a range of measures and actions designed to prevent, correct, mitigate and compensate for environmental impact generated by those operations, both at antinarcotics bases, and in application zones.

**3.2. The scheme of administration**

It is a fact that the environment must be managed, to the extent that man transforms it to meet his needs and requirements, because environmental matters are sustained by a complex interrelationship between biotic and abiotic components, and by the extent to which one of these components can be manipulated volumes, others will be affected to a greater or lesser extent.

In this context, in the course of the eradication activities by aerial spraying with glyphosate, the agencies involved must maintain a high level of performance in standards of cognition and environmental management. Executing and follow-up agencies and support elements must firmly believe that this high level of performance in inter-institution action and environmental management is a synonym of quality and effectiveness in the PECIG operations and the EMP.

The mechanisms of development of the scheme will be established on the basis of the concept of evaluation of environmental management and of compliance with current legal regulations and standards (Figure 2).

### 3.2.1. Scheme of coordination

The following will be the scheme of coordination and inter-institutional relations established for this program (Chart 1):

a) Institutions responsible for the EMP

1. CNE, as the organ of decision for the formulation of drugs policy. In particular, for the execution of the aerial spraying strategy, Law 30, Article 91 projects of the functions of "ordering the destruction of crops of marihuana, coca-leaf and other plantations from which substances producing dependence can be extracted, using the most appropriate methods, and subject to the favourable opinion of agencies responsible for public health and preservation and equilibrium of ecosystems in Colombia". Further, Article 92 makes the exercise of the functions of Article 90 mandatory.

1. DNE. DNE is the Executive Secretariat of CNE, and is responsible for coordinating the preparation and execution of the EMP (under Article 93 of 30/96)

3. The Antinarcotics Police, under Legislative Decree 423/97, is responsible for the planning and operational execution of PECIG.

b Agencies involved in EMP follow-up

1. Technical Environmental Audit, responsible for following and monitoring measures adopted in the EMP

2. Ministry of Environment

The Ministry is responsible for follow-up to the coordination and implementation of the EMP and its effects on the environment, as the body responsible for environmental management and for renewable natural resources in Colombia. It is mandated to secure the recovery, conservation and protection of renewable resources and the environment, and to regulate general conditions for a healthy environment, amongst other things, in order to prevent, eliminate or mitigate the impact of activities which contaminate, deteriorate or destroy the environment or natural heritage.

3. Ministry of Health. Responsible for the design and implementation of an epidemiological monitoring system of the impacts on human health which appreciated much cause.

4. INSTITUTE OF HYDROLOGY, METEOROLOGY AND ENVIRONMENTAL STUDIES - IDEAM.. Responsible for follow-up and supervision of the environment and possible contamination and degradation caused by PECIG and ecosystems, as the Institute responsible for surveying and handling scientific and technical information and ecosystems, and setting the technical basis for classifying concerning the use of land for purposes of planning and regulating territory, under Article 17 of Law 99/1993.

5. Autonomous Regional Corporations (CAR), responsible for the development of projects and programs defined in the Compensation Plan for decontamination and recovery of environment and renewable natural resources, and impacts which might have been caused by PECIG, as the regional environmental authority, and in accordance with the terms of article 31.20 of Law 99/1993. Resources for the implementation product, financed with funds from the FIS, and the struggle against organized crime, subject to CNE approval.

c) Support institutions

1. National Alternative Development Plan (PNDA). Uses coordinates to demarcate zones for alternative development projects will be located and voluntary eradication agreements, so that they will not be affected by PECIG.

2. Social solidarity network (RSS). Uses coordinates to demarcate zones where productive development projects will be dictated, in order to avoid them being affected by PECIG.

3. The Colombian Agriculture and Livestock Institute – ICA - approves technical and operational parameters for aerial spraying of illicit crops with glyphosate, as in Resolution five, Article 7 CNE.

4. AGUSTIN CODAZZI GEOGRAPHIC INSTITUTE OF COLOMBIA - IGAC, supplies basic and thematic maps showing soils and agroecological capacity.

5. The Interinstitutional Technical Committee. Advises DNE on the development of PECIG.

6. Departmental and municipal authorities.

7. The national office for attention to and prevention of disasters.

8. Local committees for attention to and prevention of disasters.

3.2.2. Interinstitutional relations

*a) Between executing agencies*

1. The CNE approves areas to be sprayed, following a plan drawn up jointly by DNE and the Antinarcotics Police, based on measurements made by the SIMCI monitoring Project

2. DNE, coordinating the with the Antinarcotics Police DIRAN, for environmental, social and economic information required for spraying operations to be conducted within safe parameters

3. DIRAN, based on guidelines provided by CNE and information supplied by DNE, proceeds to effect spraying operations

*b) Between executing agencies and evaluation agencies*

1. The Technical Environmental Audit, based on plans made by DIRAN prior to each operation, and after spraying in each zone, proceeds to monitor and evaluate impact on the environment, human health, and agricultural activities, following the approved methodology. It has one month to presents its report to DNE, but if it detects negative impact, the report must be made immediately.

DNE immediately reports to DIRAN on the results of the audit process. If there is negative impact, the Social Management and Compensation plan of the EMP is activated, to include and there is coordination with the entities defined in it.

3. The Ministry of Health. Once the monitoring system is set up, the Ministry will make a monthly report to DNE on health cases identified through it. The Environment and Social Management office of DNE, after each spraying operation, will contact the references in the zones centre of this system, to review information reported in it.

4. The environmental authority INSTITUTE OF HYDROLOGY, METEOROLOGY AND ENVIRONMENTAL STUDIES - IDEAM will implement a mechanism for follow-up of biophysical resources in operations zones, particularly, it with regard to

possible contamination or degradation caused by PECIG, and make a quarterly report to DNE of results obtained

5. DNE will follow-up programs of inspection, verification and control, mitigation programs, and where appropriate, social management and compensation. In each case, there will be a process of coordination with the entities defined in the plans.

*c) Between entities of coordination, execution and support*

1. The alternative development plan PNDA and the social solidarity network will report every three months and before each spraying operation to the DNE and the Antinarcotics Police, giving the location of productive projects, in order to take these into the these locations into account when planning fumigation operations.

2. The Antinarcotics Police will inform RSS of spraying operations to be initiated, in order to activate the Humanitarian Attention Program for those affected by the eradication program

3. Colombian Agriculture and Livestock Institute - ICA, at the request of DNE and the Antinarcotics Police, will approve technical and operational parameters of PECIG

4. AGUSTIN CODAZZI GEOGRAPHIC INSTITUTE OF COLOMBIA - IGAC supplies DNE with basic and thematic maps with regard to soils and agroecological capacity

5. The Inter-institutional Technical Committee is an instance of support for DNE in the PECIG

### 3.3. Operational organization for implementation of the EMP.

- DNE, as the national coordinator of PECIG, will secure the implementation of the EMP through the various participating agencies. For this purpose, it is proposed to create an Environmental and Social Management office within DNE, with the following functions:

- Coordination and follow-up of the execution of the PECIG

- Environmental and socio-economic characterization, in coordination with the Antinarcotics Police, of nuclear areas of the illicit crops, to guarantee protection for the environment and social context.

- Measurements of census and statistics to identify and locate the extension of illicit crops in various PECIG zones.

- Follow-up the monitoring of input of implementation of the EMP.

- Development and enforcement of measures of mitigation, compensation and environmental control with the operating agencies of PECIG.

- Implementation of the Educational Communication Program addressed the communities.

- Design and operation of information system for the public on PECIG results.

- Coordination and harmonization of planning PECIG actions with social and environmental management programs and projects developed by other agencies in the context of the policy to combat drugs

- Chairmanship of the Interinstitutional Technical Committee, an advisory body of the DNE for PECIG, and follow-up of compliance with functions and responsibilities arising within it.

- Supervision of the audit and technical inspection contract for PECIG.

- Attention to and processing, in coordination with the Antinarcotics Division, of complaints made by individuals allegedly affected by PECIG, observing the principles of celerity, effectiveness, transparency, good faith and promptness, and all others required by current law.

- The establishment of inter-administrative agreements with State institutions contributing to PECIG.

- Contracting and follow-up of studies and research as a function of minimization of risks to human health and the environment.

- Definition and implementation, in coordination with national-level organs or their bodies and entities (CNE, PNDA, RSS and FIP), and local organizations (CSE, CARs, governors and mayors), for alternative measures to eradicate illicit crops (manual eradication agreements, alternative development projects, etc).

- Research proposals to input and projects for CNE approval and financing through the rehabilitation and social investment fund FIS, designed to strengthen social, economic and environmental rehabilitation in PECIG zones.

- Preparation of documents, position papers and other requirements of international, national and local industries requested from the DNE.

- Other functions delegated to it in accordance with the competencies of the Division.

Given the nature of PECIG activities, the Division proposed must have a minimum staff of professionals can take including in agronomist, forestry engineer, environmental engineer and a sociologist or anthropologist, amongst others, with the logistical media required to operate in the office and in the field.

One alternative to the Division proposed is the allocation of the above functions to an existing office of DNE.

*Cycle of environmental management*

Environmental management within PECIG must be seen as the process of continuous improvement, whose principal elements and the relationships between them are shown in Figures 1 and 2.

a) The process starts from preliminary studies, and is integrated into the system in the following manner:

- The EMP will be checked and adjusted following additional requirements made by the environmental authorities and operating conditions at the time that that operations start.
- The plan requires resources (technical, staffing, economic, logistics, communications), contributed by the agencies committed to the program.
- The plans must be disseminated, and participants must receive training in it. Dissemination is technical, and includes the definition of responsibilities.
- Results of actions must be communicated to all interested parties.
- Control mechanisms must be set up to ensure that the program proceed as planned, as a means of achieving the strategic objectives and targets proposed.
- A system of measurement must be set up to evaluate the results of actions taken, in terms of efficiency and effectiveness of the application of EMP measures (see program of inspection, verification and control, Record 6).
- Actions will be aided by agile mechanisms for taking corrective or preventive action in accordance with the results of the evaluation.

- An information system must be made available to administer the information generated by the process in because of the program.

- The process must allow regular revision review and feedback, as required to improve to secure continuous improvement of the program and of EMP.

- The planning system brings together environmental planning functions of the program, in particular the conceptualization and organization of the operating development of the EMP. The product of the system is a detailed operating program, with schedules, definitions of responsibility, quantification and appropriation of resources required for execution.

b) The integral communications system contains the following general functions:

- Management of the information generated by the management system.

- Production of useful information for interested parties, the generation of performance reports and feeding of the webpage.

- Dissemination of the EMP. Programs included in it, procedures, and other management tools.

- Development of the training program, see Record 10.

- Generation of interim and final reports of the EMP for the environmental authorities.

c) The function of environmental control will be secured through an appropriate environmental inspection service, formed by a multidisciplinary team whose functions and results will be interdisciplinary. This inspection function must have measurement tools to generate the information required.

d) The evaluation of activities will be affected with indicators supported by the results of the systems mentioned above

**4. SCHEDULE**

This will be a permanent activity from the time that glyphosate spraying begins.

**5. FOLLOW-UP AND MONITORING**

The follow-up and monitoring of the program will be based on its performance indicators, in particular:

- Creation and operation of the environmental and social management office of DNE
- Compliance with all programs in the EMP
- Permanent and agile coordination with DIRAN, and social support organizations (PNDA, RSS, Ministry of Health), and the organizations in the Interinstitutional Technical Committee and regional agencies.
- Prompt compliance with functions environmental and social management established in the EMP.

**6. ACCOUNTABILITY**

In the current institutional framework, the agents responsible for this program are: new

- CNE
- DNE
- Antinarcotics Police

**7. COST**

The cost is estimated to be COP364 million per year. The cost of inspection work should be coordinated with the cost of the program of inspection, verification and control in this EMP

END OF THE PROGRAM FOR ENVIRONMENTAL MANAGEMENT AND INTER INSTITUTIONAL COORDINATION.

| CONTINGENCY PLAN | RECORD 13 |
|---|---|

INTRODUCTION

Since the illicit crops eradication program is being conducted with glyphosate spraying, and glyphosate is a broad-spectrum herbicide, and although the evaluation of environmental risk reported a high degree of degradation of glyphosate in different environmental scenarios, the program's operation as such is subject to several risk factors (guerrilla action, mechanical failure of aircraft, environmental considerations, etc.), which compromise human life and the natural environment, when by the action of these factors, and amongst other risks, there would be the need to dump the product totally and immediately.

The Contingency Plan is a document which sets out strategies of response to attend to emergencies which may arise during the various stages of manipulation of the site for the eradication of illicit crops (transport, storage, manipulation and spraying). Among the possible events are dumping (total and immediate discharge of glyphosate), which in the oil industry would be equivalent to a spill. For all events analyzed, in the contingency plan establishes persons responsible, and mechanisms for the supply of basic information on possible areas affected. Likewise, procedures are established to be implemented in each situation, with actors involved for support as requested , and equipment and materials required for each action.

With the formulation of the Contingency Plan, the Antinarcotics Police aims not only to respond promptly to emergencies derived from operations, but also to act within the integral national policy full attention to emergencies, and therefore, to engage with inter-institutional committees with existing inter-institutional committees at local, departmental and national levels, given that the program is an integral part of the national anti-drug policy, requires the support and concurrence of the number of institutions and industries in government, each with its own mission and objectives.

**GLOSSARY OF TERMS**

DISASTER. Serious damage or alteration to normal conditions of life in a given geographical area, caused by natural phenomena or by catastrophic effects of the action man, accidentally, exceeding the capacity for response of the community affected, and requiring special attention from state organizations and other instances of a humanitarian or social service nature.

EMERGENCY. Situation generated by the occurrence of the disaster, which severely modifies the normal conditions of life of a community, and makes immediate intervention necessary for its control

THREAT. This is the probable magnitude or extent of unexpected natural phenomenon, natural, technological human phenomenon, which by its destructive potential, is hazardous to the population, the economy, or the environment. In a simplified form, the threat (A) may be expressed as the product of:

The potential energy (EP) of the matters involved if the phenomenon takes place

The susceptibility of that mass (SM), to activate the phenomenon

The magnitude (M) of the detonating effect, able to cause the hazardous phenomenon to take place

The threat can be quantified through the use of the following expression:

$$A = EP*SM*M$$

THREAT ZONE. The area of coverage of occurrence of a possible threat, regardless of the presence or absence of goods or persons.

VULNERABILITY. The susceptibility of an element or set of elements in a system to suffer damage or failure in the presence of a phenomenon, which is potentially destructive or destabilizing, due to its magnitude.

Vulnerability (V) is a relationship existing between exposure (E) and resistance (R):

Exposure can thus be defined as the degree to which the system or its component elements are subject to the action of a potentially hazardous phenomenon

Resistance is the capacity of the elements exposed to avoid or soften the effect of the action of the hazardous phenomenon.

In general, vulnerability studies should take account of four fundamental considerations

Human vulnerability,

Vulnerability of vital element and strategic elements,

General physical vulnerability, and

Social, economic and environmental vulnerability

RISK EVALUATION. Risk evaluation is intended to establish the most probable consequences or effects, based as a basis for proposing selective, reasonable and effective solutions to mitigate a given risk. These activities comprise:

The identification of risk factors and conditioning factors

The location of persons and it structures exposed, and the specific location within the process

An evaluation of the most probable consequences or effects

RISK ZONE: This is the zone where there is the greatest degree of threat, and the greatest presence of persons or assets, which might be affected.

RISK. Probable expected magnitude of damage or failure of one or more elements in a system, within a given territory and time, caused by the materialization of the hazardous phenomenon.

Risk (R) is therefore a function of the project potential danger or threat (A), of vulnerability (V) of the elements exposed to the threat.

Risks can be classified as follows:

AVOIDABLE. These are risks whose origins can be avoided, and consequences can be cancelled out with technically, economically or socially feasible measures.

CONTROLLABLE. The threatening phenomenon can be predicted, along with its consequences and consequences can only be attenuated or mitigated, because it cannot be technically, economically or socially manageable.

UNCONTROLLABLE. Risks in which the capacity for prediction and evaluation is incomplete, or and science and technology are not capable of providing a viable technical, economic or social solution.

ACCEPTED. Risks arising as a consequence of the preceding scale, and defined as the difference between the greatest level of risk which can be controlled (controllable), and the maximum permissible risk (uncontrollable).

## 1. GENERAL CONSIDERATIONS

The Contingency Plan is a set of activities and operations to be planned and undertaken in order to anticipate, prevent or correct some potential outcome, and which can be present in the arise from operational, natural or exogenous failure, and cause a negative impact on persons, assets or the environment.

The program also seeks to do the following:

- ✓ Minimize environmental impact in the face of occurrence of a disaster
- ✓ Minimize the injuries which emergencies may cause to personnel acting in the program or
- ✓ communities located in the area of influence
- ✓ Minimize economic loss
- ✓ Reduce claims and costs derived from civil liability for possible for possible damage
- ✓ Reduce the area of influence of glyphosate spraying outside the limits of the illicit crops

The program is designed to prevent emergencies and to occupy a high priority position in the general framework of crop eradication activities, and the following premises should be taken into account

- ✓ The analysis of risks is considered to be the baseline to establish the scope and directions of the Plan.
- ✓ The organizational, logistical and operational responsibilities of the Plan are clearly defined and studied by personnel engaged in activities
- ✓ A cooperation link is established between related operations areas
- ✓ There will be coordination between the authorities and local, regional and national authorities and communities, in order to optimize the response capacity to emergencies

## 2. CONTINGENCY PLAN STRUCTURE

The contingency plan basically consists of a strategic plan, and operating plan and a database, with the following basic components

CONTINGENCY PLAN STRUCTURE

STRATEGIC PLAN OPERATING PLAN DATABASE OR INFORMATION SYSTEMS

Responsibilities and Procedures and protocols Permanent and prompt information

functions for response to losses for prevention and response

The diagram illustrates the following:

The STRATEGIC PLAN seeks to ensure that each person or entity responsible is clearly aware of their functions and responsibilities in the Plan, and performs the functions assigned to him, and uses available resources efficiently to attend to emergencies.

The OPERATING PLAN is part of the Contingency Plan which establishes emergency procedures, and allows for rapid mobilization of human and technical resources to implement immediate actions in response, as foreseen.

The INFORMATION SYSTEM OR DATABASE is an instrument which provides rapid and timely communication with personnel forming brigades and agencies engaged in external support.

## 2.1. Strategic plan

The coverage of the Contingency Plan is limited to spraying program operations areas. The antinarcotics bases will have equipment, mechanisms and trained personnel to attend to eventual incidents related to the aerial spraying processes

Within the specific PECIG implementation areas, the following have been defined as priority for actions within the contingency plan;

- ✓ Antinarcotics bases, and nearby areas
- ✓ Areas of transit of spray aircraft, flight lines between bases and application areas
- ✓ Areas close to illicit crops

These areas were determined in accordance with the characteristics of spraying operations, threats and risks present in the course of the same.

The structure of the Contingency Plan is fundamentally based on the formation of a standing emergency committee (CPE) for each base, responsible for the following activities:

- ✓ Planning of action to be taken in any event
- ✓ Establishment and ordering of hierarchy of reaction
- ✓ Allocation of relevant functions
- ✓ Direction and coordination of actions to be taken
- ✓ Evaluation of results of applying the contingency plan

| BASE STANDING EMERGENCY COMMITTEE (CPE) |
|---|

| | | |
|---|---|---|
| Emergency group brigades | Internal support brigades | External support |

| | | |
|---|---|---|
| Chairman CPE or coordinator, | Communications Brigade | Fire service |
| Head of Emergencies | Stores Brigade | Red Cross |
| | Security and Supervision Brigade | Civil defence |
| | Evacuation and Assistance Brigade | Army |
| | Fire, explosion and Spillage | Ecopetrol |
| | Control Brigade | Local Disaster Prevention Committee |
| | Spraying Emergency Brigade | Local authorities |

## 2.2. OPERATING PLAN

The coordination centres for the activation of the Contingency Plan will be the Antinarcotics Police bases, which will have the necessary communications equipment, as part of the disaster attention equipment, and operations centre, and the local committee or regional committees for disaster prevention and attention.

The purpose of the plan is to establish basic operating procedures of the Contingency Plan. It defines the basis and mechanisms for notification, organization and operations

**OPERATING PLAN**

- ✓ Preventive and control measures
- ✓ Internal support brigades communications
- ✓ External support brigades communications
- ✓ Activation of alarms
- ✓ Contingency plan activation
- ✓ Evacuation in emergency
- ✓ Measures after evacuation
- ✓ Overturning of tanks
- ✓ Fire control in the storage area
- ✓ Explosion control in the storage area
- ✓ Spillage control in the storage area
- ✓ Fire control in the spraying area

- ✓ Explosion control in the spraying area
- ✓ Spillage control in the spraying area
- ✓ Evaluation of the contingency plan
- ✓ Training programs

The following are the procedures or protocols to be executed in each component of the operating plan:

### 2.2.1. Prevention and control measures

In the operations base

- ✓ The Standing Emergency Committee Chairman will make arrangements to acquire materials and equipment needed to implement the contingency plan, such as communications equipment, extinguishers and first aid, and will order the appropriate brigades to install them in the appropriate places, fire extinguishers to go to the areas most vulnerable to fire.
- ✓ The Communications Brigade will install alarms and fire and explosion alert equipment, and make regular checks on the same, with signposting in all areas of the base: no smoking, restricted area, no unauthorized entry, use safety equipment, emergency exit, evacuation route, high tension, though extinguishers, etc, and will maintain coming occasions equipment
- ✓ The Fire Brigade will be responsible for maintaining the extinguishers in all risk areas
- ✓ The Evacuation Brigade will be responsible for checking and maintaining the first aid equipment
- ✓ The Head of Emergencies at the base will arrange drills to check on procedures to attend to spills, fire and explosion generated by fuels and glyphosate, in the appropriate areas
- ✓ The Committee Chairman will develop cooperation agreements with local emergency committees to establish mechanisms of mutual cooperation.

### 2.2.2. Communications with Internal Support Brigades

The existing communications system should be used to advise all base personnel and all brigades about emergencies for them to come into service immediately and give relevant recommendations, and if the circumstances so merit, to advise the Standing Emergency Committee

**2.2.3. Communication with external support brigades**

If the contingency cannot be attended to by internal brigades, the Head of Emergencies will contact it existing external groups specializing in attention to emergencies, to inform them of the emergency arising, and request their immediate presence and support.

The Head of Emergencies will coordinate action with internal and external support groups to respond to the emergency.

The local emergency prevention and attention committee will be used to inform local authorities and the community in general with regard to responsibilities in attending to any dumping of material, and to prevent possible adverse effects. These responsibilities will generate specific actions, such as evacuation of certain areas where there is exposure to the greatest damage to public health, prohibitions on fishing in certain areas, prohibitions on the sale or consumption of certain hydrobiological products, community cooperation, etc.

Information supplied will be objective, accurate and concise, and refer to proven facts

In case of a spillage produced in flight, the DIRAN will act through the Chairman of the Emergency Committee, as operator of the product dumped, will make an initial report to the competent authorities, which will act in accordance with their mission (preservation and protection of the environment and health), to supply personnel or technology to attend to this type of event, where security conditions allow, these entities will include amongst others the Ministry of Environment, the regional environmental authorities CAR, Ministry of Health, Colombian Agriculture and Livestock Institute - ICA, and the Public Procurator (Attorney General) for Environmental and Agricultural Affairs.

The Chairman of the Emergency Committee will make an initial report of the dumping, which will contain basic information on specific circumstances (time place and manner), in order to make a preliminary estimate of the magnitude and severity of the event.

The initial report will be made on Form I - "Initial Report" (see attachment), taken from the National Contingency Plan and adapted to the Program´s operating conditions.

### 2.2.4. Activation of alarms

In the event of emergency, the shift officer acting as Head of Emergencies at the base will activate the emergency alarm.

If any other person is in the emergency area, he will immediately advise the Head of Emergencies, for him to activate the alarm.

The Head of Emergencies will advise the Standing Emergency Committee, which will define actions to be taken to attend to it.

Once corrective action has started, the Head of Emergencies may order the alarm to be deactivated.

The levels adopted by the National Contingency Plan will be used to activate the contingency plan.

### 2.2.5. Activation of the Contingency Plan

Once the emergency has been reported, the members of the Standing Emergency Committee will proceed as follows:

- ✓ Make an immediate plan for corrective measures for safety, and local emergency plans
- ✓ Immediately communicate with the internal support brigades, ordering the immediate presence with their identification badges, and coordinate activities

- ✓ Combat the emergency following procedures established below
- ✓ If required, request the presence of external support brigades
- ✓ Order the suspension of activities which interfere with appropriate attention to the emergency
- ✓ Supervise the rescue work for personnel exposed to the emergency or who are victims of it

Activation of the contingency plan may take place at different levels, depending on the characteristics of the emergency:

*Level I. Partial activation, Plan alert*

In this type of event, the Program will take actions designed to control the situation, activating response at its highest level. Military and civilian personnel participating in the event within a maximum of three hours after activation.

*Level II. Activation of the plan requesting support from Operating Committees*

This occurs in remote areas within the coverage of the Program operations, and there is coordination with local and regional emergency prevention and attention committees. This level is developed within 24 hours following the event.

CHART 1. ACTIVATION LEVELS FOR THE CONTINGENCY PLAN TAKEN AND EDITED FROM THE NATIONAL CONTINGENCY PLAN

| LEVEL | | | |
|---|---|---|---|
| **HIGH LEVEL**<br>Occurs over areas of human settlements, nature park areas, and sources of water supplies | | | **N3** |
| **MIDDLE LEVEL**<br>In areas of forest, and high density of drainage. | | **N2** | |
| **LOW LEVEL**<br>Developed on with total and immediate dumping on meadows or lawful crops in areas distant from sensitive ecosystems | **N1** | | |
| | **SPECIFIC** | **LOCAL** | **REGIONAL** |

**Level 3. Total instant activation.** Disaster-major volume and severity, within zones covered by the local contingency plan

The event is totally beyond the control of the program operations, and exceeds the capacity of local or regional systems to provide assistance requested. National-order agencies must be involved, to provide guidance in actions. This level will be developed if the event exceeds the capacities of Level 2 operation within 48 hours of occurrence, for which national-order agencies will provide support.

**2.2.6. Criteria of priority in response operations**

The highest priority is addressed to the protection and preservation of human life threatened by the incidents.

Where there are limitations of resources or time, and the choice must be made to protect resources of the greatest value and importance for the safety and welfare of the human population of the area. Subsequently, protection will be given to high-ecological value resources which are most sensitive, such as primary and secondary forest with native vegetation, guaranteeing the sustainability of ecosystems, and in the last resort, threatened socio-economic resources (lawful crops such as plantain and yucca), and ecological elements catalogued as medium or low risk, such as scrub.

If the choice has to be made between the protection of two threatened resources, each with a different risk index, priority will be given to the most sensitive one. If there are two resources in the same conditions of risk value, the choice will be to protect the resource which is affected, would cause the most serious adverse socio-economic impact on the human population in the short or medium term.

**2.2.7. Operating procedures and responses**

**2.2.7.1. Evacuation and assistance in the event of fire or explosion at the base, due to faults of an operational nature**

Once the alarm has been activated by the Head of Emergencies, in the event of a fire or explosion due to operational failures, or the base personnel will follow these recommendations:

- ✓ *The Head of Emergencies will order Brigade personnel to suspend activities, and prepare to deploy the procedure for emergency response*

- ✓ *The Evacuation Brigade will direct the evacuation from the area quickly, and in an organized and calm manner, separating out persons who have lost control of themselves, giving guidance to so that they will avoid inhaling smoke, making people walk as close to the ground as possible, preventing people returning to the evacuation areas, ensuring that evacuated personnel that personnel have been completely evacuated, and if not, make a rapid inspection of the area*

- ✓ *The Brigade will provide first aid to personal suffering injury or who have collapsed.*

After evacuation

- ✓ *The Evacuation Brigade will check to ensure that all personnel are unhurt, report if any person seems to have disappeared, and prevent people from returning to the danger area except for members of the support brigades*

- ✓ *The Brigade will guarantee that people will only be able to go back to their place of work once the risk has been eliminated*

**2.2.7.2. Spills of fuels and glyphosate**

**a. Spills due to the overturning of a tanker- truck during transport**

- ✓ Check the condition of the driver and other accompanying personnel, to protect human life, providing first aid where required, and then withdrawing from the vehicle to avoid possible fire or explosion.
- ✓ Isolate the area, by constructing ditches said that the liquid does not reach water sources or water intakes or wildlife areas.
- ✓ Advise local authorities to report the emergency.
- ✓ Quantify the amount of the product spilled.

- ✓ Isolate the area with security cordons
- ✓ Proceed to clean up if security conditions allow.
- ✓ Isolate existing drains or sewers, in order to prevent the area affected from expanding.
- ✓ If the spill takes place over a body of water, the Head of Emergencies will advise personnel who operate intakes downstream as soon as possible. The brigade will install observation barriers around the intake downstream, once the emergency has been declared. A reconnaissance should be made of the banks of the water source to identify places of impact, and proceed to isolate and clean up, advising the local authorities and external groups with experience, if the spillage exceeds the capacity of internal brigades or groups.
- ✓ If the spill occurs on land, the brigade will isolate the area with safety cordons, and proceed to clean up and isolate existing sewers or drains, to avoid the affected area from spreading

B. Spills of glyphosate and fuel at the base

- ✓ The Head of Emergencies will order members of the appropriate brigades to suspend activities and to deploy the procedures required for response to emergencies.
- ✓ Check the state of the mixer and other personnel contaminated by the spill, in order to protect human rights life, providing first aid when necessary.
- ✓ Isolate the area by building a ditch so that the liquid will not reach water sources or wildlife areas.
- ✓ Quantify the amount of product spilled.
- ✓ Isolate the area with security cordons.
- ✓ Proceed to clean up if safety conditions permit.
- ✓ Isolate existing drains or sealers, to avoid the area affected from expanding.
- ✓ If the spill takes place on dry ground, the brigade will isolate it with security cordons, clean up, and isolate existing drains or sealers, to avoid an expansion of the affected area.

**2.2.7.4. Control of fire and explosions at a base due to operating failures**

- ✓ The Head of Emergencies will order the immediate presence of the Fire Brigade and the Evacuation Brigade.
- ✓ The Evacuation brigade will proceed to evacuate the base, following procedures.
- ✓ The Fire Brigade will isolate the site of the fire, evaluate the type of fire, and select the most appropriate extinguishing equipment. Small fires can be put out with nearby extinguishers. Once the fire has been controlled, equipment should be recharged or replaced

- ✓ The Head of Emergencies will communicate with the Fire Service if the fire cannot be easily controlled by internal brigades, and if explosions caused by caused by operating activities occur.

**2.2.7.5. Attacks on the base**

- ✓ The Head of Emergencies will immediately advise all police personnel forming the supervision and security brigade.
- ✓ Civilian personnel present the base will be ordered to take up positions of safety, and if safety and security conditions permit, they should be evacuated at once.
- ✓ The Chairman of the Emergency Committee will request help from the Army if necessary
- ✓ Base personnel will be ready to defend the most vulnerable areas of the base, where an explosion or fire might affect with greater risks, such as storage systems

**2.2.7.6. Procedure for response to attend to disasters during spraying**

**a. Primary incident report.** The pilot´s report will reflect the circumstances of the incident.

It is possible that the pilot does not report the incident immediately after it occurs, because aircraft communications systems have been damaged, or the pilot has not detected the incident promptly, or the incident may have injured in pilot (aircraft shot down). This last eventuality is particularly likely to occur with aircraft operating coca-leaf spraying, since they operate without accompanying helicopters

**INCIDENT REPORT**

(diagram)

If the incident is detected and communication systems have not been affected, the pilot should immediately report it to the base, specifically to the Emergencies Committee Chairman, who will check that the pilot is unharmed, and make a primary or initial evaluation of the damage.

If the aircraft has suffered any adverse effects from an incident, regardless of whether it is of slight, medium or high importance, the decision will be taken to return to base. Before returning to base, the pilot and the Head of Operations, after evaluating the incident, will decide whether it is necessary to dump the product. If it is decided that the project should be dumped (medium and high level incidents), the pilot and Head of Operations will analyze the area, and will define the point at which the least adverse effects would be caused, in accordance with environmental parameters established in the characterization process.

The hierarchical order for dumping will be:

- ✓ Illicit crop areas
- ✓ Grazing land
- ✓ Scrub or secondary forest
- ✓ Primary forest areas

Incidents if the process of crop eradication will be classified in accordance with the following criteria:

*Slight incident.* Incident in which there is no serious threat to the safety of the aircraft, and therefore of the pilot. In this kind of incident, it is not considered necessary to dump the product. In this case, the aircraft ceases operations and returns immediately to base.

*Medium incident*. The pilot has the operating capacity and airworthiness to evaluate the zone for dumping the product. Priority is given to the zones established in advance for the process in the characterization of spraying areas. The pilot will return to base immediately after dumping product

*High incident*. This is a highly hazardous event, in which the pilot no longer has airworthiness sufficient to choose the place where he will dump the product, and therefore must do so immediately and return to base

*Fatal incident*. These are incidents in which the outcome is fatal, because generally ending with a crash.

The follow-up to the particular operations undertaken in the Contingency Plan is established depending on the specifications in the plan for supervision, inspection and control

b. **Activation of response team.** This level of operations relates to all activities undertaken to put the spraying emergency attention brigade into operation. It includes a reconfirmation of the exact spot of the incident, the security study for the area in which the incident occurred, transits to the area, evaluation of the need to take corrective measures, and dumping if necessary.

c. **Spraying emergency attention brigade**. This brigade will take action to apply corrective measures that in the Contingency Plan for events related to a total of specific dumping product.

The coordination of response team is the responsibility of the Base Commanding Officer (Head of Emergencies each base), who becomes the brigade coordinator as of the moment that the incident is reported.

d. **Check on security conditions**. If an aircraft is forced to dump all or part of the product, this activity is generally related to criminal actions (hit by gunfire, obstacles on plots, etc), technical failures in aircraft, environmental conditions or human failures.

Since the contingency action must be undertaken in same area where the incident takes place, it is a priority to check the security conditions in place where the product is to be dumped, in order to avoid a transit and operations by the response team, which might repeat the incident. The security study is obtained from intelligence reports promptly supplied by the forces of law and order in the area, and information from technical personnel making a technical study of the incident.

If intelligence information reports that security conditions are not suitable for the spraying emergency attention brigade to move out, await new orders, to be given when security conditions become optimal. Meanwhile, spraying operations will continue in other areas.

**ACTIVATION OF RESPONSE TEAM**

(diagram)

e. **Geographical reconfirmation of the area**. SATLOC will be used by the Head of Emergencies to provide a geographical location of place where the aircraft was forced to dump the product, in order to dispatch the response team to that place.

f. **Transfer of the spraying emergency attention brigade to the site**. If security conditions reported by the regional intelligence office of the National Police are optimal, the brigade will be dispatched in accordance with parameters established in the operating procedures for crop eradication by aerial spraying.

g. **Evaluation of the area affected by dumping product**. The spraying emergency brigade will evaluate whether there is justification for dumping water in the area affected. This procedure taken into account if the dumping is effected on lawful crops, illicit crops, bodies of water, population centres, etc.

h. **Application of corrective measures**. Depending on the geographical characteristics of the place, time and weather, and security, aircraft will dump 200-300 gallons of water on the place affected.

2-4 dumping activities will be effected. This corrective action should be taken during three hours following the incident. Dumping will be effected during this time provided that the security evaluation allow it.

i. **Information report.** This level of operation is activated by the Head of Emergencies, from the moment the pilot or security team accompanying him reports the incident. The purpose is to establish an information flow between authorities and entities which support or accompany them or are affected by the incident.

j. **Technical report on the incident**. This is a careful review of the aircraft by technical personnel of the Antinarcotics Police Aviation Area attached to the base involved in the area where incident occurs, and the eradication program advisers. The purpose of evaluation is to check on possible damage caused to the aircraft, and to certify results obtained. In the event of a contingency related to human failure, the technical report will make the initial evaluation, for use in a preliminary disciplinary investigation.

k. **Completion of the initial report form.** The Head of Emergencies, who becomes the coordinator of the Spraying Emergency Brigade, will make an initial report of the dumping, taking account of the technical report of the incident, which will contain basic information of the specific circumstances of time, place and manner, and to make a preliminary estimate of the magnitude and severity of the event.

**FLOW OF REPORTS**

Diagram

l. **Final technical report**. The Head of Emergencies, with the support of the Spraying Emergency Brigade, will present final technical report in writing to the Antinarcotics Division, for forwarding to DNE, within 20 days of the occurrence of the dumping, in order to provide detailed knowledge of the circumstances of the event, attention, and control.

The final report of the event will contain the following

- ✓ Date and time of the incident, date and time of initial notification to the Government agency
- ✓ Date and time of the end of the emergency
- ✓ Location of dumping. The map used by the Program, with the exact location of the dumping given by the SATLOC system
- ✓ Cause of dumping
- ✓ Volume dumped
- ✓ Determination of affected areas. (Land, natural resources, installations)
- ✓ Determination of communities possibly affected
- ✓ Operating plan developed, and response times used in control
- ✓ Description of measures for prevention, mitigation, correction and monitoring
- ✓ Support required (requested/obtained).

In addition to the above information, an evaluation and will be made of the dumping, using technical criteria to evaluate the capacity for attention to the event, and to identify immediate risks in the forthcoming spraying operations. The aspects to be considered in the evaluation of the dumping are:

- ✓ Origins of dumping
- ✓ Characteristics of the herbicide and principal physical-chemical characteristics
- ✓ Determination of possible risks to personnel engaged in the emergency, in community and in operations.
- ✓ Estimated potential approximate maximum volume of dumping
- ✓ Evaluation of prevailing environmental and weather conditions
- ✓ Expected trajectory of the discharge of the dumping
- ✓ Identification of resources threatened
- ✓ Available equipment. Evaluation of availability of equipment to control the dumping
- ✓ Maximum transit time to the place of occurrence. Establish and evaluate maximum response times by the Contingency Plan response team.

j. **Criminal denunciations**. The Chairman of the Emergency Committee, and the pilot involved in the emergency will lodge a criminal denunciations with the appropriate authorities, for them to discover the persons responsible for the damage caused to the aircraft as a result of the incident.

**2.2.8. Evaluation of the contingency plans**

Once the emergency is over, the Chairman of Emergency Committee, the

Commanding Officer of the Antinarcotics Base will act to determine definitive closing down of operations, and evaluate consequences derived from the dumping with regard to the efficiency of actions taken, and effects on the environment.

#### 2.2.8.1. Final emergency report

For all events involving the activation of the Contingency Plan, there will be a final written report addressed Emergency Committee, giving an account of the events which took place at the base and during spraying, the report also be addressed to the various government agencies responsible for environmental matters (CAR, Ministry of Environment), and members of the National Technical Committee of the National Contingency Plan, within eight days of the date of the dumping, in order to provide detailed information on circumstances of the dumping, and attention and control deployed.

#### Evaluation of response to emergencies

In order to control and undertake evaluations of actions, contingency plan will keep a log, which contains the daily report of control activities and attention to dumping, and actions undertaken. The basis for the preparation of reports, and attention to possible claims

After the event has ended, and based on report on action taken, particularly in the effectiveness of the Plan, with reference to attention to the disaster. This evaluation will allow determination of the most important aspects to be taken into account in the reformulation and redesign of the Contingency Plan, based on experience obtained from the emergency.

The evaluation will involve the following analysis:

- ✓ Origin of the emergency
- ✓ Speed of activation of the alarms
- ✓ Mechanisms and times of evacuation
- ✓ Procedures to combat the emergency
- ✓ Sufficiency of available equipment
- ✓ Levels of knowledge at the time of emergency

- ✓ Response levels
- ✓ Analysis of operational and natural risk
- ✓ Relationships with local or regional committees for emergency prevention and detection. Channels of information to the community
- ✓ Communication systems
- ✓ Structuring of the IT plan. Existence of plates, maps, plans. Information on critical areas, inventories of control equipment, list of authorities, etc.

**2.2.9. Training programs**

It is a fact that a Contingency Plan, to be effective, not only requires the organization and equipment to attend an emergency but also, as a basic element, efficiency on the part of personnel, and this can only be obtained by training.

For training purposes, following environments and materials required and supplied by DIRAN

- ✓ Decision making
- ✓ Crisis management
- ✓ Personnel organization. Command, control and supervision of response operations

For training purposes specific to operating matters, recommended training directives must be prepared in accordance with recommendations in the National Contingency Plan.

The specific training programs should include the following:

- ✓ Contingency Plan. All personnel in nuclei must receive a course on operating schemes and the organization of the Contingency Plan, and conduct regular drills on events which may cause threats, gradual, evacuation, firefighting, and first aid.

- ✓ Other specific issues are:

**Technical**. Storage and handling in areas of operations of spraying equipment, and materials, and organization of working teams.

**Environmental.** Reconnaissance operating areas and a range of ecosystems with different degrees of sensitivity.

**Operational**. Information on physical and chemical properties, and methods of deactivating them.

The frequency of training should be as follows:

- ✓ 3 training sessions a year with practical work for all personnel
- ✓ 12 practical sessions a year for Emergency Response Brigades
- ✓ 1 course a year for Commanding Officers, in methods of prevention and control of contingencies, and the development of basic knowledge on the effects of dumping

### 2.2.10. Emergency equipment

**DESCRIPTION**

| |
|---|
| Safety boots |
| First aid kit |
| Folding stretcher |
| Rigid stretcher |
| Safety helmet |
| Resuscitation Kit |

| |
|---|
| Air supply kit (mask, hose, blower) |
| PQS 50-LB satellite extinguisher |
| PQS CO2 20-lb extinguisher |
| First aid: portable material |
| 2 ½” 15-m hose |
| 1 1/2” 15m hose |
| ½” rope |
| Pump for firefighting |
| Overalls |
| Fixed hose reel |
| Electric siren |
| Axes |
| Product recovery pump |
| Water tank |
| Aircraft |

## 2.3. INFORMATION SYSTEM OR DATABASE

The contingency plan database will supply information required to ensure that the strategic and operational plans are efficient. All the information required by the Contingency Plan will be compiled and updated permanently by DIRAN, through the Chairman of the Emergency Committee.

The Contingency Plan requires information to be presented as geographical information, general listings, attachments, and consolidation into the following types of information: legislation, referencing, logistics, statistics, local and industrial contingency plans and environmental considerations, amongst others.

For the purposes of handling the Contingency Plan database, DIRAN, acting through the Chairman of the Emergency Committee, will request relevant information from municipal, departmental or national agencies.

When information is requested from an agency, the agency will inform the administrator of the information that part of the information is confidential or restricted, and state the provisions of law covering that restriction. At the same time, it will establish the conditions in which that information may be used.

DIRAN will have a specific project for software, hardware, staff and logistical support, to administer and process existing information.

**3. SCHEDULE OF ACTIVITIES**

The programming and organization of the Contingency Plan is intended to foresee and provide against any event which might become a disaster, and the following activities need to be undertaken:

**PROGRAMMING**

This component includes the formation of emergency groups and the allocation of functions and responsibilities.

- ✓ Standing Emergency Committee
- ✓ Emergency group
- ✓ Internal support groups
- ✓ External support groups

**ADAPTATION OF AREAS AND INSTALLATIONS IN EACH NUCLEUS**

Certain areas may be needed for response to any eventuality, to attend to an emergency, such as green areas, sporting facilities, first aid areas, etc.

**ACQUISITION OF EQUIPMENT TO ATTEND TO EMERGENCIES**

- ✓ Control equipment
- ✓ Safety equipment
- ✓ Prevention and protection equipment
- ✓ GIS and database.

**FORMATION OF INTERNAL AND EXTERNAL SUPPORT BRIGADES**

**EXECUTION OF THE TRAINING PROGRAM**

- ✓ Workshops, talks, lectures, drills.

## 4. ESTIMATED COST

Personal protection equipment

| Description | Unit | Quantity | Total cost |
|---|---|---|---|
| Personal protection | nucleus | 12 | COP 30,000,000 |
| Emergency control equipment (extinguishers, detectors, barriers, pumps) | nucleus | 12 | COP 60,000,000 |
| First aid kits | | 12 | COP 30,000,000 |
| Training program | nucleus | 12 | COP 30,000,000 |
| Total | | | COP 150,000,000 |
| END OF CONTINGENCY PLAN RECORD. | | | |

## GLOSSARY

Definitions of the main specific and most frequent times are given below, to enhance understanding of this study

*Absorption*: a process by which plants take nutritive elements from the substrate and incorporate them into their issues.

*Aquifer.* A geological layer, whose constitution favours the accumulation of groundwater

*Aerobic:* organisms that cannot live without air, and which consume oxygen during development and metabolic activity

*Anaerobic*. Organisms that live and develop in the absence of air, and for which oxygen is often toxic.

*Biomass.* Mass per unit of surface or volume of a set of organisms or certain living organisms living in an ecosystem (biozenosis)

*Seedlings*: Trees 0.30-1.30 m high

*Trophic chain*. The chain of molecular transfer between different organisms composing an ecosystem (producers, consumers, decomposers).

*Biogeochemical cycle*. The circuits or lines from which elements required for life circulate in plants and animals and return to the soil, water or atmosphere, from which they are again taken in by living beings.

*Environmental component.* This component is used to indicate physical, biotic, socio-economic all cultural factors which form the environment (physical, biotic component, etc),. As such, each environmental component is an element of the environment (see below, definition of element).

*Conservation*. Maintenance of the productive capacity of a resource, through sustainable systems of use, exploitation and management. This is different from preservation, in the sense that preservation does not accept uses which imply any alteration of natural vegetation cover or of natural evolution processes.

*Contamination*. Alteration of the conditions of an ecosystem is caused by discharges and emissions of liquid and gas use waste, noise, or the disposal of solid waste on the soil.

*Hydrographic basin*. An area whose waters follow a given course

*Decomposition*. Process by which certain organisms (worms, bacteria and insects) decompose organic matter in simple organic compounds (humus).

*Dissolution*. Process by which salts present in the soil are dissolved in water which filters into it

*Ecology.* The study of the structure and functioning of the biosphere, or more generally, its components known as ecosystems.

*Ecosystem*. A functional system which is more or less stable over time, with a sufficient area to be characterized, and constituted by a set of living organisms present in it, and the physical medium for the interchange of energy and matter (Biotope).

*Environmental element.* According to Legislative Decree 2811/1974, these are all elements of factors which form the environment or influence it, including waste, refuse, residues, and leavings, noise, the conditions of life resulting from urban or rural human settlements, and goods produced by man, whose production is induced by man, in which environmental deterioration may have an influence

*Emissions.* A discharge of gases, particles or smoke into the atmosphere from fixed from sources such as a factory chimney or mobile sources such as vehicle exhaust. This may also be natural.

*Run-off.* Flow of water in the liquid state, may be surface or underground

*Evaporation*. Emission of water by a surface free of liquid water, at a temperature lower than boiling point.

*Evotranspiration*. The process by which water coming from the evaporation of liquid and the transpiration of plants is transported from the ground into the atmosphere

*Photosynthesis*. A physiological mechanism by which organisms containing chlorophyll are able to assimilate carbon gas and transform it into living matter, using light radiation as energy.

*Fragility*. Vulnerability or degree of susceptibility of medium or its components to a given action

*Small trees*: Tees with  a DBH of more than 10 cm

*Habitat*. A homogeneous environment on a surface or in a given volume of an ecosystem. A place where a man lives or inhabits, including housing and infrastructure

*Homeostasis*. The faculty of self-regulation in a an ecosystem which tends to reconstruct the initial relations between components of communities, and to maintain the functional structure of the ecosystem constant

*Saplings*: Trees with a DBH of 10 cm or less, and a height of more than 1.30 m.

*Environment.* A set of energy, physical, chemical and chemical, biological and social conditions dominant in the area where living organisms live. Synonym: Biotope.

*Mineralization*. Process through which humus is transformed into mineral substances under the action of bacteria and fungi.

*Percolation*. Rainwater or surface run-off which filters and passes through surface formations of the earth

*Persistence.* Permanent over time, opposite to temporary, or short-term events

*Population.* A set of individuals belonging to the same species which lives in a given ecosystem

*Rainfall*. Water which falls from the atmosphere and a solid or liquid form, from a cloud or set of clouds. It may be liquid or solid.

*Preservation.* The maintenance of a state of affairs of an area or ecosystem in conditions of natural evolution. In order to achieve this, in general the regulations applicable to nature reserves and nature parks are applied.

*Resilience or recoverability*. The capacity of an ecosystem to absorb environmental tension without changing to appreciably different ecological conditions. In other words, it indicates the capacity of ecosystem to reorganize itself by itself when under pressure.

*Hydraulic bed*. This is the bed in which a watercourse or deposit, designed to provide protection and environmental management of the body of water. In watercourses, this bed corresponds to the alluvial valley. In lakes, pools, creeks, dams and the like, this corresponds to the flood zone.

*Sensitivity* (of an ecosystem). Ecological susceptibility to alteration, evaluated as a function of the regional and global importance of the ecosystem and its resilience.

*Succession.* Certain populations (or micro populations), that succeed in a given environment

*Symbiosis*. A mandatory synergic association between two organisms.

*Synergism.* Association between two organisms which is beneficial to one or both of them. Symbiosis, mutualism and commensalisms are forms of synergy. By extension, the word is used to indicate processes in which the combined action of two elements of phenomenon generates more drastic conditions than the separate action of them of each of them.

*Soil solution.* Solution in which plants take on nutritive substances

*Alluvial valley*. A strip or bed along a watercourse, over which the watercourse spreads during flooding and deposit sediment. It is therefore a risk zone for urban development

*Discharge.* The discharge of a liquid effluent into a body of natural water or a sewerage system. This may be domestic wastewater or industrial wastewater, or mining or industrial wastewater.

**CONTINGENCY PLAN**

*Accident*. Any incident whose origin is considered to be fortuitous.

*Unsafe action*. Activity counter to parameters of safety already and already stipulated or taken for granted. The human contribution to the development of an accident.

*Risk management.* A set of strategies designed to minimize risks associated with the functioning of the system, in order to minimize loss and guarantee continuity.

*Adversely affected person*. The individual or legal entity is suffering damage to assets or operations as a consequence of a loss.

*Threat or hazard.* The possibility of a loss will occur, analyzed considering only the type of event and the place.

*Environmental threats*. The condition able to generate damage in the environment.

*Logistical support.* The function of response to emergencies during the phases of control and mitigation, consisting of a coordination of internal resources to support and facilitate the operation of emergency action groups.

*Sensitive area.* A geographical area exposed to losses, whose characteristics have a high degree of vulnerability.

*Assumption of Risk.* The strategy of risk management consisting in not performing actions designed to control risks, acceptance of risk.

*Attack.* A loss caused intentionally. All attacks entail loss.

*Characterization*. The degree of sensitivity of a system to a risk, measured with regard to the level of adverse effects possible to its stability.

*Circumstances*. Risk factors external to the system, which do not depend on it or are not controlled by it.

*Conditions*. Internal risk factors, depending on the system and controlled by it.

*Disaster*. The result of an emergency with serious consequences.

*Emergency.* Situation which implies a state of partial or total disturbance of a system, due to the imminent probability of occurrence or actual occurrence of a loss, and whose magnitude may endanger the stability of the same, or require a response greater than that established (basic response), implying a temporary modification of the organization of the system.

*Evacuation.* A planned action, in which each person threatened by collective risks follows pre-set procedures designed to bring him to safety by his own means, or by other existing means, through movement, and to places of lower risk

*Risk profile*. Location related to a risk with regard to risk levels defined as acceptable, as a functional combination of frequency and severity of the same (Vulnerability).

*Contingency plan.* Preset response to events associated with operations, which may affect them, without representing a threat or harm or injury.

# ENVIRONMENTAL MANAGEMENT PLAN OF THE PROGRAM FOR THE ERADICATION OF ILLICIT CROPS BY AERIAL SPRAYING WITH GLYPHOSATE (PECIG)

VOLUME OF ANNEXES

Bogotá, November 2001

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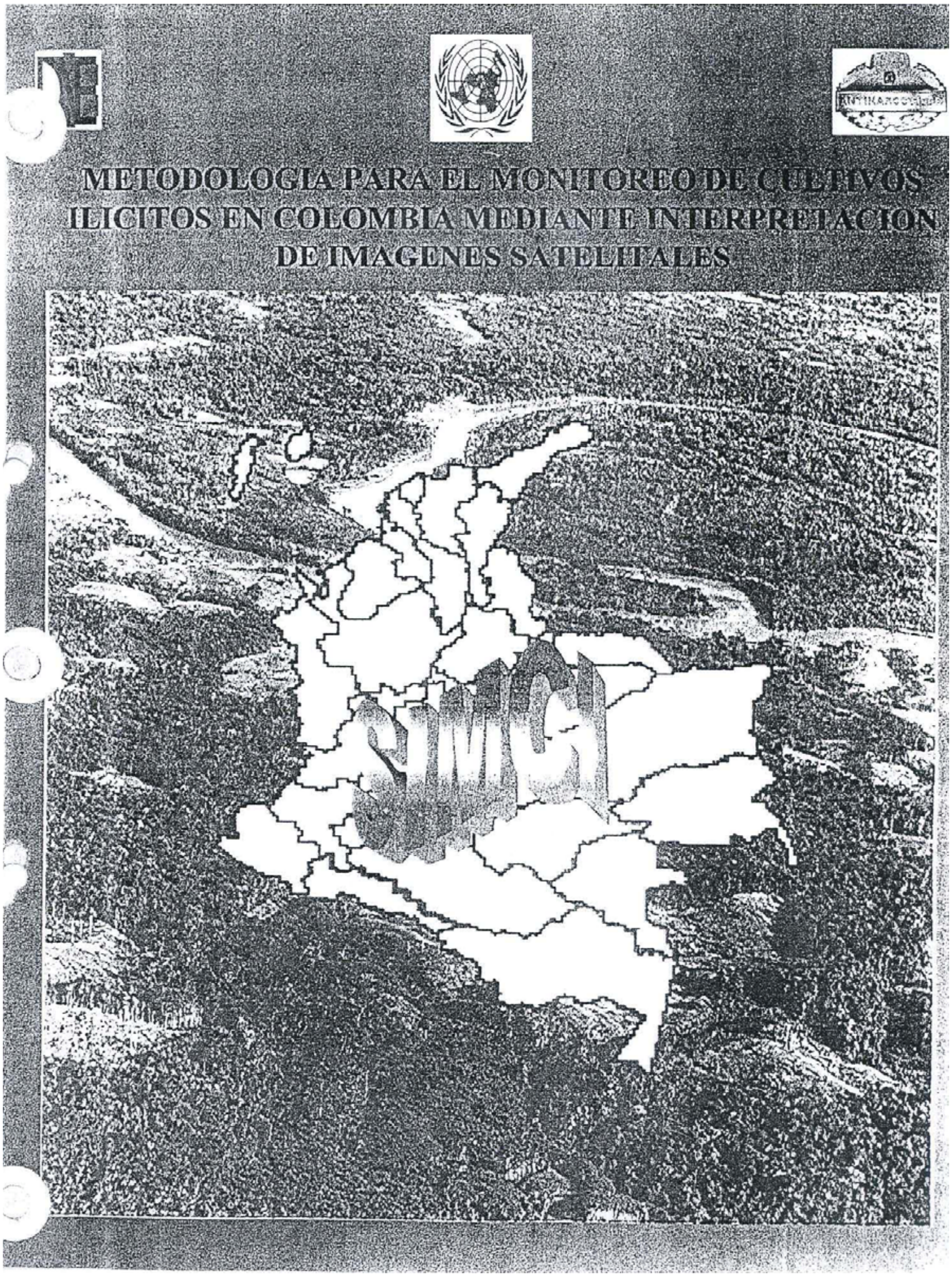
METHODOLOGY OF THE ILLICIT CROPS MONITORING IN COLOMBIA USING SATELLITE IMAGE INTERPRETATION



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**INTRODUCTION**

> Remote sensing and computer-based digital imaging have changed the study of land surface and the evaluation of the natural resources.

One of man's major concerns throughout history has been the exploration of the planet Earth. His attention has been driven by a powerful need to know what lies beyond his domain.

In all his proceedings, man has used a number of elements that distinguish him not only as a creature seeking keenly to investigate his surroundings, but also as an individual out to dominate the environment.

In consequence, his curiosity and desire to learn about the land he dwelled first led him to climb a tree, and later conquer a mountain to take in the sweeping view of the landscape.

Even in this summary of man's early exploratory activities, the basic elements of today's modern science of remote sensing come into view: *The light source*, formed in this case by the sun emitting light or solar radiation; *the landscape*, made up of all objects in the territory explored by man, such as rivers, mountains, vegetation and man-made elements; *the scene*, that is, that section or area of the landscape on which man centers his interest; *the remote sensor*, with which light emanating from the scene is captured and which, in this case, allows a visual representation of that area of the landscape that has been focused by the iris and the eye lens; *the platform*, which is where the remote sensor is placed or mounted for an overview of the entire scene; *the processing system* comprising the device to process, qualitatively and quantitatively, data provided by the remote sensor regarding the scene, which, analyzed and interpreted by man's brain, provide valuable information in relation to the landscape that is useful in making any decisions about the environment; and *the field support*, which consists of direct inspection at various selected points of the scene, of the different attributes of the objects found in the field in order to evaluate the data obtained previously from a distance.

This remote observation of the Earth's surface is the framework for the study of spatial remote sensing that is conceived as the technique which allows the attainment of scenes or images of the

Earth's surface from sensors installed on space platforms, assuming that between the Earth and the sensor there is an energy interaction, either by reflection of solar energy or an artificial energy beam, or by its own emission which is transmitted to the land surface, where the detected signal can be stored and interpreted for a particular application.

In December 1997, the Government of Colombia initiated in the provinces of Guaviare, Vaupés and Vichada a pilot phase (ILICO) for the identification of illicit crops with such technology. The current project (SIMCI) has continued and extended this work by creating a methodology for ongoing and comprehensive monitoring of illicit crops, not only quantifying but also specializing them in different regions of the country using satellite imagery.

Part of this project is the design and implementation of a Geographic Information System for the analysis of information generated by satellite images. This will provide data to the UNDCP international monitoring system in tune with the resolutions of the Space Meeting of the UN General Assembly dedicated to the world drug problem (UNGASS, June 1998) and Resolution 42/3 of the Commission on Narcotic Drugs (CND) on "Monitoring and verification of illicit crops."

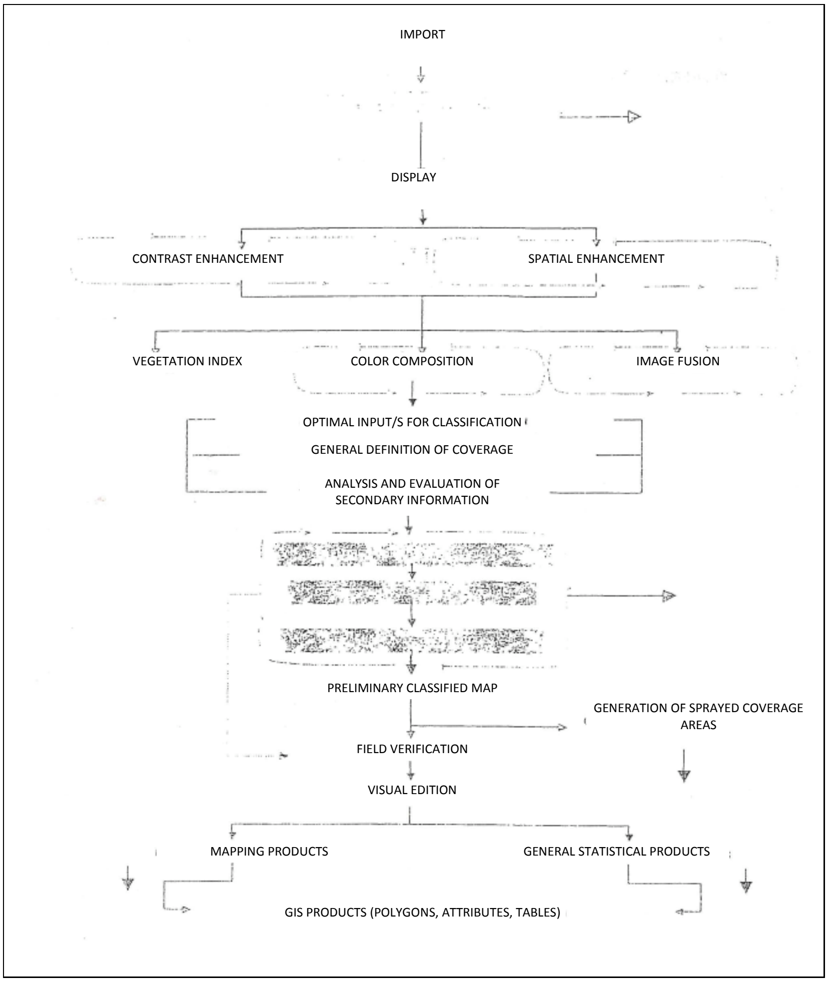
# 1. METHODOLOGY OF THE ILLICIT CROPS MONITORING IN COLOMBIA USING SATELLITE IMAGE INTERPRETATION

The purpose of this paper is to distinctly illustrate the complete methodology that has been designed and implemented throughout the project.

To this end we submit the methodological framework that shows all the different processes used to obtain a theme map, which identifies and spatializes illicit crops in Colombia.

In many cases, the production of a map is the final phase of the work, its ultimate outcome. In others, such as in the SIMCI project, it is merely another document that provides, along with other land variables, an integrated understanding of the space under consideration. With this approach, the project, supported on a Geographic Information System as a tool, aims to generate new information based on the treatment of stored data to solve more complex situations. These require handling different information sources and layers using spatial analysis and statistical techniques to guide the project to management and decision-making at the different levels required. (see Figure 1)

**FIGURE 1 METHODOLOGY SCHEME OF THE ILLICIT CROPS MONITORING IN COLOMBIA**



## 1.1 IMAGES EMPLOYED

The project has used SPOT, LANDSAT IKONOS and RADAR satellite images. For the purposes of the project, the spatial resolution is secondary to the spectral and temporal, because the phenomenon studied is very dynamic in time and the spectral dimension is the definer, therefore it is critical to use sensors that provide information on certain bands where the phenomenon of interest is more evident.

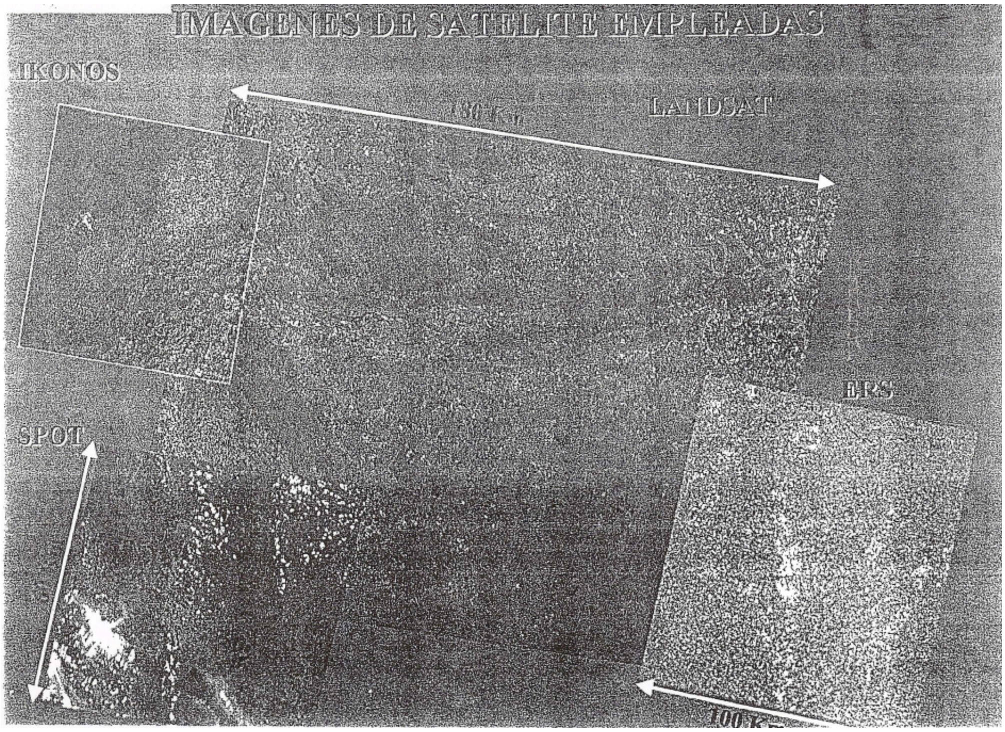
The SPOT (Systeme Probatoire d'Observation de la Terre) satellite developed by the French CNES in cooperation with Belgium and Sweden, has two sets of push scans called HRV (Haute Resolution Visible). These two sensors allow imaging in two modalities: panchromatic and multispectral (green, red and near infrared) with a spatial resolution of 10 and 20 meters respectively; the area covered in each scene is 60 km per side which means a coverage of 360,000 hectares, with a spectral resolution of 3 bands for Spot 3 and 4 bands for Spot 4.

Landsat is a U.S. satellite with coverage of 180 km per side, equivalent to coverage of 3.24 million hectares, with a spatial resolution of 28 m for the spectral mode and 15 m for the panchromatic and a spectral resolution of 7 bands. The decision to use SPOT or LANDSAT lies in the nearness of the image for the target date of the figure and the presence of a lower percentage of clouds since either of these two types of images allows us to discriminate at an optimum level of quality the coverage of interest for the project. (See Figure 2)

The French satellite ERS can be used in the case where LANDSAT or SPOT do not allow gathering information due to the effects of the clouds, since the radar wave penetrates the clouds to capture information of the land surface.

The use of IKONOS in the project is geared toward the identification of poppy crops given its 4-meter spatial resolution at the multispectral level or one meter for the panchromatic band. It is also used for quality control processes, that is, the interpretation using IKONOS images can be compared to that obtained with both SPOT and LANDSAT, as appropriate. Another application is to locate and plan for alternative development programs led by PLANTE.

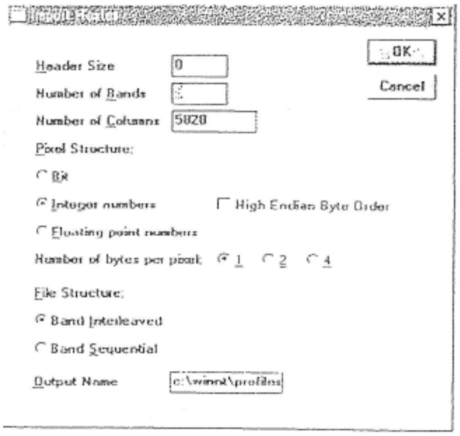
**FIGURE 2 SATELLITE IMAGES USED**



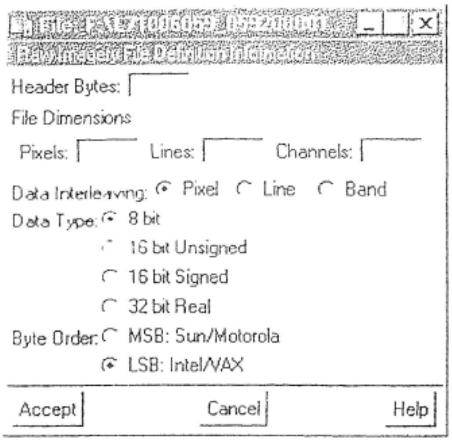
**1.2 IMPORT**

The first part of the scheme shows the item relating to image import.

In ILWIS software version 2.2, the option to import “General raster data” is selected, since this software does not read the original image files directly and the information requested in the import dialog box must be provided.




With the PCI software, the import process is direct, with images that are supplied in BIL and DAT format. For those images that are provided in BSQ format, the software requests additional information similar to that requested by the ILWIS.



**1.3 GEOREFERENCING**

For the georeferencing of an image, it is important to have a series of common observations between the image to be georeferenced and the support (georeferenced image, analog or digital maps, lists of control points with coordinates, GPS, etc.)

That functions that enable the transfer of map coordinates to the image require locating a series of control points between image and map. From the coordinates of these points, a function can be estimated to relate the two documents, because the functions are estimated from the sample coordinates. The quality of the adjustment depends on the precision with which these points are located; otherwise, the estimate will be biased.

The experience gained during the project has indicated that the selection of points is a complex task. In case of an image-to-image registration, the process is simplified, since it is easier to identify commonalities (eg river crossings, roads) between the two images than between image and map.

Figure 3 shows an original band 2 image corresponding to the province of Putumayo exhibiting the municipalities of Puerto Asis and La Hormiga, and which has not undergone geometric correction or georeferencing. (See Figure 3)

Geometric correction seeks to change the positioning of the pixels of the image in order to have them coincide with true north, or for the geographic elements to coincide as regards the position with the same elements represented in a map. This operation can be used both to cartographically correct an image, and to overlay two or more images together, with the aim of conducting multi-temporal studies of the dynamics of illicit crops in Colombia. When georeferencing, we can obtain the exact location of a point with geographical and flat coordinates, take longitudinal or polygon measures on the image in order to understand the area of each and feed the GIS database (see Figures 4 and 5)

Once the image has been georeferenced and geometrically corrected, the next step of the process is to display each of the bands of images and the contrast and spatial improvements where appropriate.

The aim in this process is to display better the data for their visual analysis, in order that the features of interest appear more distinctly in the image. This includes processes of contrast enhancement, spatial enhancement, color composition, vegetation indices and image fusion.

### 1.4 VISUALIZATION

The visualization of a band consists of the digital-analog conversion of the digital levels stored on an image for their representation in the graphical monitor.

#### 1.4.1 CONTRAST ENHANCEMENT

Figure 6 compares an original image against one on which techniques have been applied to improve the visual quality, by enhancing contrast. The data should be better displayed for their visual analysis, so that features appearing in the image are more noticeable.

#### 1.4.2 SPATIAL ENHANCEMENT

Figure 7 shows the difference between an original band and one to which a spatial enhancement was applied, through the use of filters (high pass or low pass) in order to soften or enhance the spatial contrasts present in the DN that comprise it. In other words, the original DN should transformed, so that they resemble or differ from those in most neighboring pixels. This results in that the objects being observed, such as the urban areas, roads and rivers, among others, are more easily distinguished, improving their geometry compared to the original image.

So far, the required unispectral treatments have been performed to obtain a clear image and to allow distinguishing and identifying the different coverage areas of interest as a pre-step to the multispectral treatment. This treatment will enable the interaction of the original bands through the specific combination between them, facilitating the process of interpretation and discrimination of the elements contained in it.

**FIGURE 3 BAND 2 ORIGINAL – SPOT IMAGE 643349**

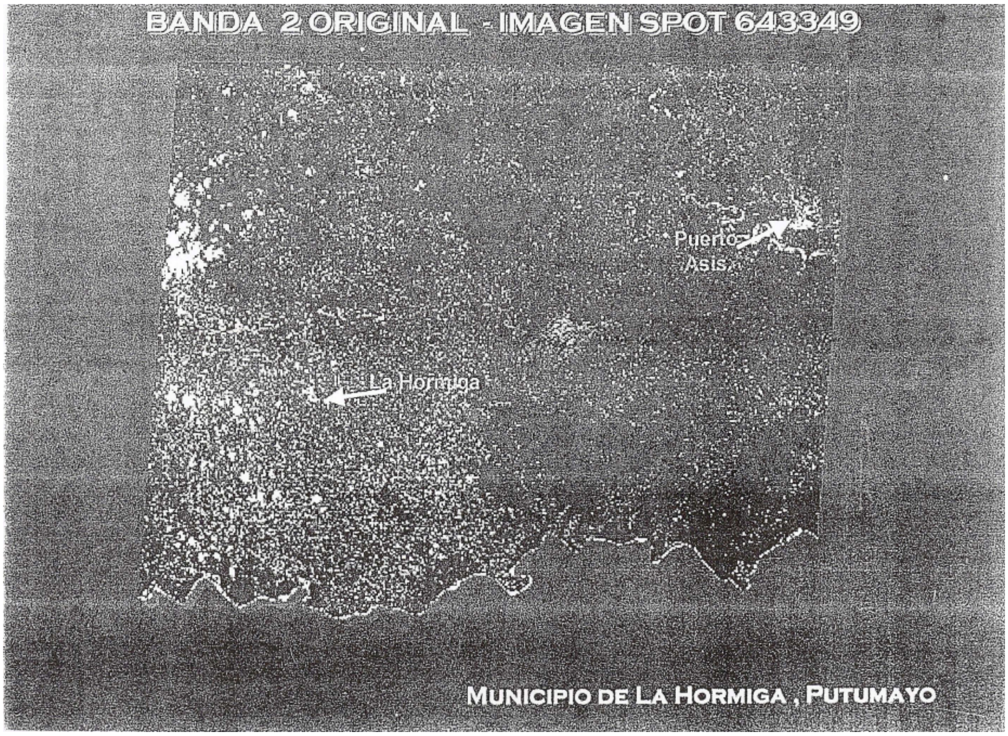


**FIGURE 4 BAND 3 GEOREFERENCED AND GEOMETRICALLY CORRECTED**

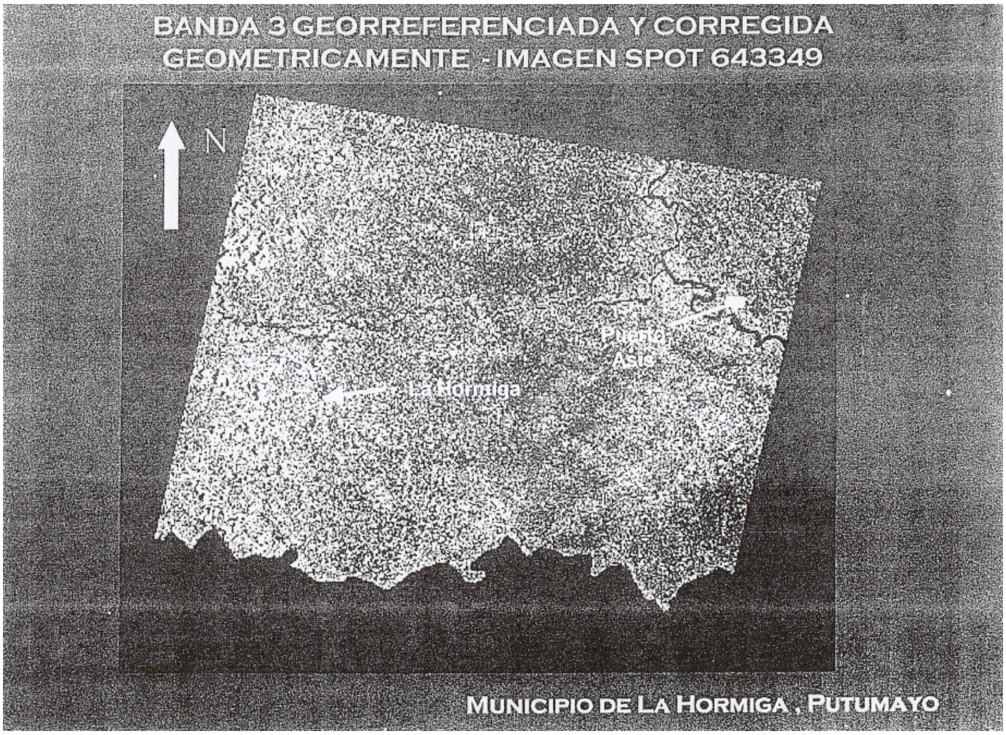


**FIGURE 5 WINDOW GEOREFERENCED IMAGE**

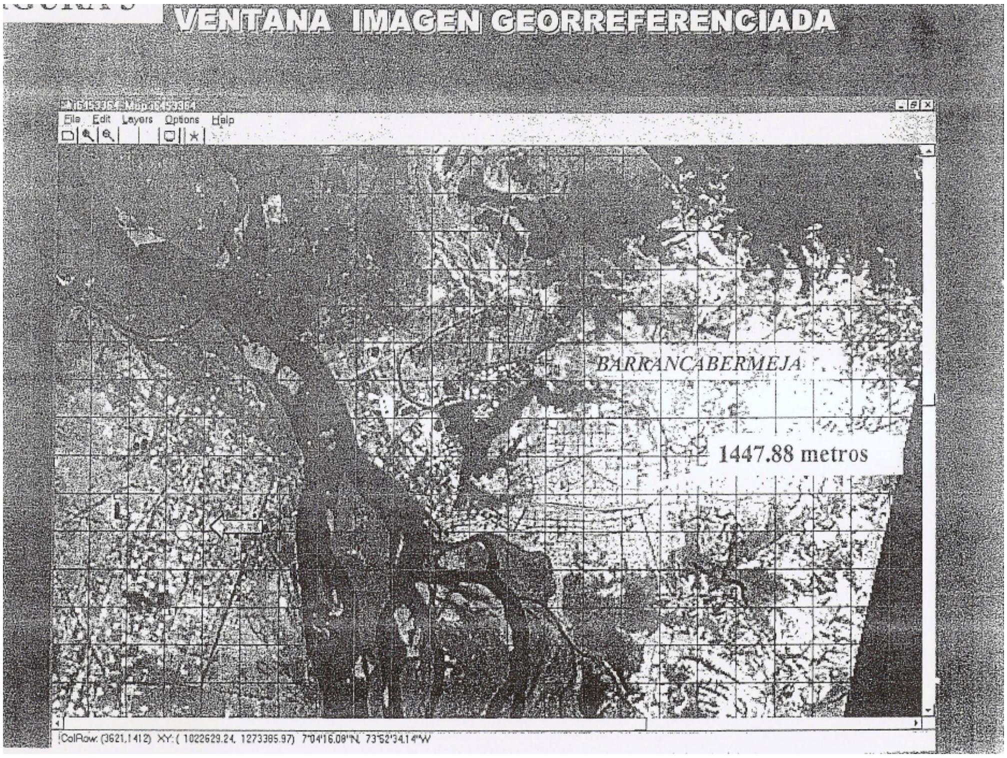
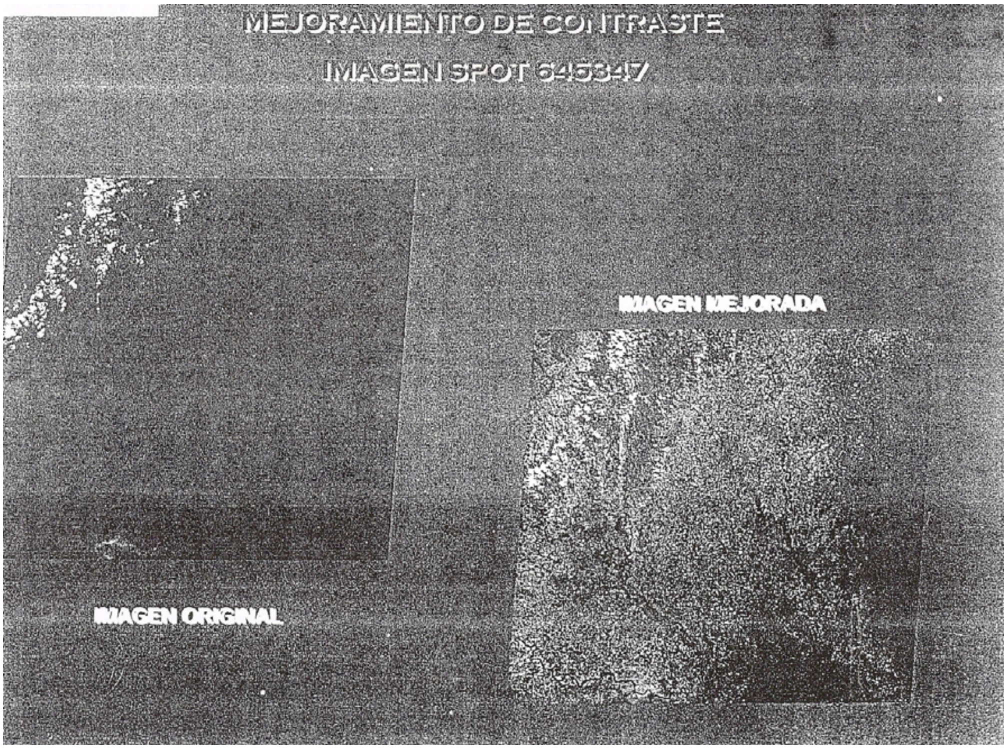


**FIGURE 6 CONTRAST ENHANCEMENT – SPOT IMAGE 645347**



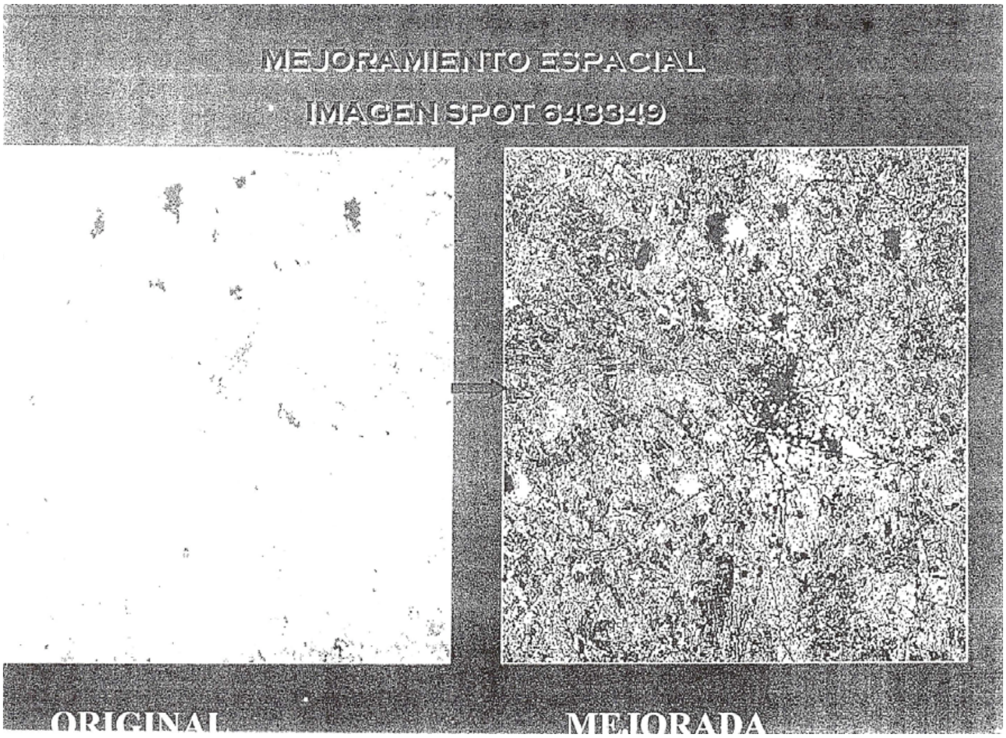

Original Image Enhanced Image

### 1.4.3 MULTISPECTRAL ENHANCEMENT

The color compositions are created and displayed on screen, combining the spectral values of the three bands selected individually. It suffices to apply each of the primary colors (red, green and blue) to a different band of the image, selected with the criteria and in the order deemed most appropriate. This process allows for a simultaneous display of images from different regions of the spectrum, which facilitates visual delineation of some coverage areas. (See Figure 8)

The choice of bands for the composition and the order of the colors for each depend on the sensor which will be worked and the specific application of the project. The most common color composition is the so-called false color, which occurs from applying the red, green and blue colors on the bands corresponding to near infrared, red and green respectively. This composition facilitates the mapping of plant masses, sheets of water, cities, etc., and it has therefore been used extensively in visual analysis studies.

**FIGURE 7 SPATIAL ENHANCEMENT – SPOT IMAGE 643349**




ORIGINAL ENHANCED

**FIGURE 8 MULTI CHANNEL VISUALIZATION**

# VISUALIZACIÓN MULTICANAL

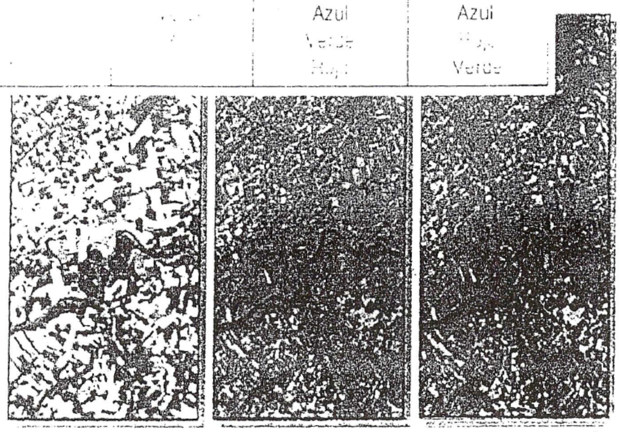
Multi channel products

## PRODUCTOS MULTI-CANALES

Color composition (additive synthesis)

### Composición coloreada (síntesis aditiva)

| Landsat TM | [illegible] | [illegible] | [illegible] |
|---|---|---|---|
| [illegible] | Azul | | |
| [illegible] | [illegible] | Azul | Azul |
| [illegible] | [illegible] | [illegible] | [illegible] |
| [illegible] | | [illegible] | Verde |



Figures 9, 10 and 11 show three different close-up color compositions, showing illicit coca crops, pastures, rivers, swamps and forests in different colors. The selection of a suitable color composition depends on the selection criterion and a combination of bands to differentiate or isolate the coverage areas to be mapped. This is different in each image, according to the inherent characteristics of each.

Another alternative for visual discrimination of coverage is the use of vegetation indices and quotients which, as its name suggests, implies a pixel-by-pixel division between the DN stored in two or more bands of the same image.

Its use is justified in two situations: i) to improve discrimination between soils and vegetation, and ii) to reduce the effect of the relief (slope and orientation) in the spectral characterization of different coverage areas.

When achieving an optimal color composition is not possible, the process is pursued with an alternative way to represent color, which serves not its components, but its properties. This occurs with the hue, saturation and intensity transformation recently employed in remote sensing. (See Figure 12)

The hue originates in the wavelength, where the maximum reflectivity of the object is produced, equivalent to the color taken in by our eyes. Saturation refers to the purity of said color, and intensity can be identified with glow in the percentage of reflectivity received. Figure 13 displays three different images where this technique was applied and clearly shows the discrimination of illicit crops on the environment.

**1.5 LEGEND**

Once optimal input has been obtained for classification, it is necessary to define the legend with the information that the project believes that it can obtain from the satellite images and of course based on a working scale of the maps. (See Figure 14)

It is crucial to note that spatial remote sensing has limitations, and that it is valid to solve a number of problems. False expectations can lead to false conclusions therefore achieving the opposite.

**FIGURE 9 APPROACH TO COLOR COMPOSITION 321 – SPOT IMAGE 643349**

Primary forest

Coca crops

Secondary forest

Pastures

Urban area

River

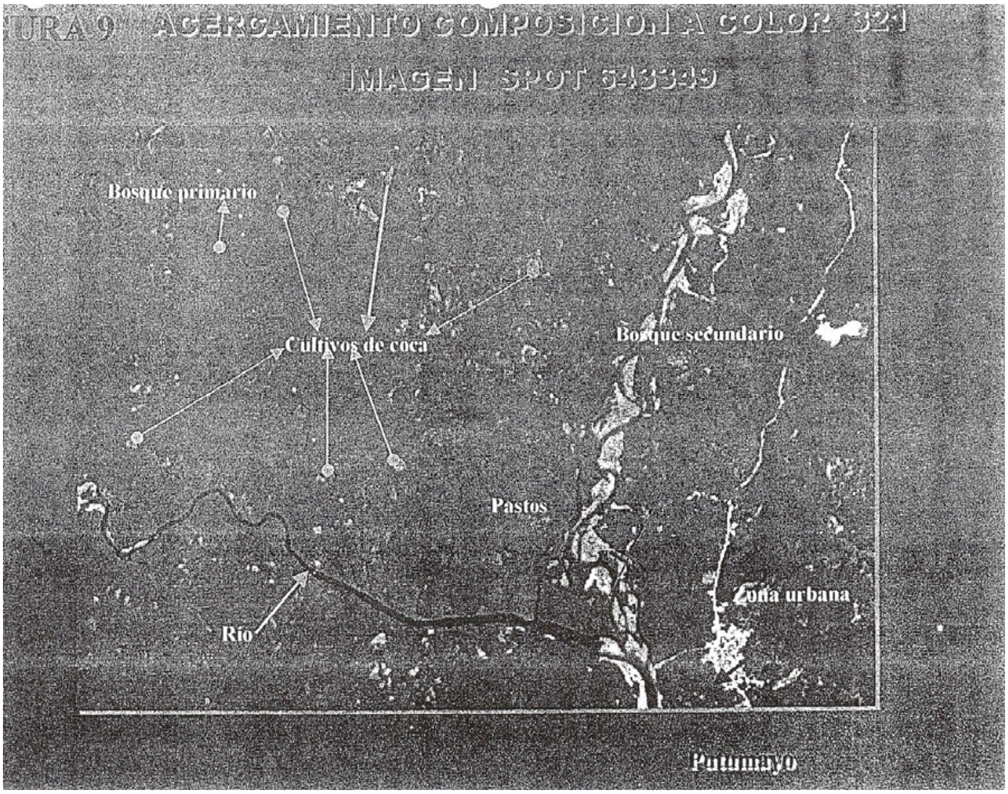


**FIGURE 10 APPROACH TO COLOR COMPOSITION RGB 432 – SPOT IMAGE 645336**

Pastures

Coca crops

Forests

**FIGURE 11 APPROACH TO COLOR COMPOSITION RGB 437 – LANDSAT IMAGE 9_60**

Flooding areas

Pastures

Coca

Water bodies

Forests

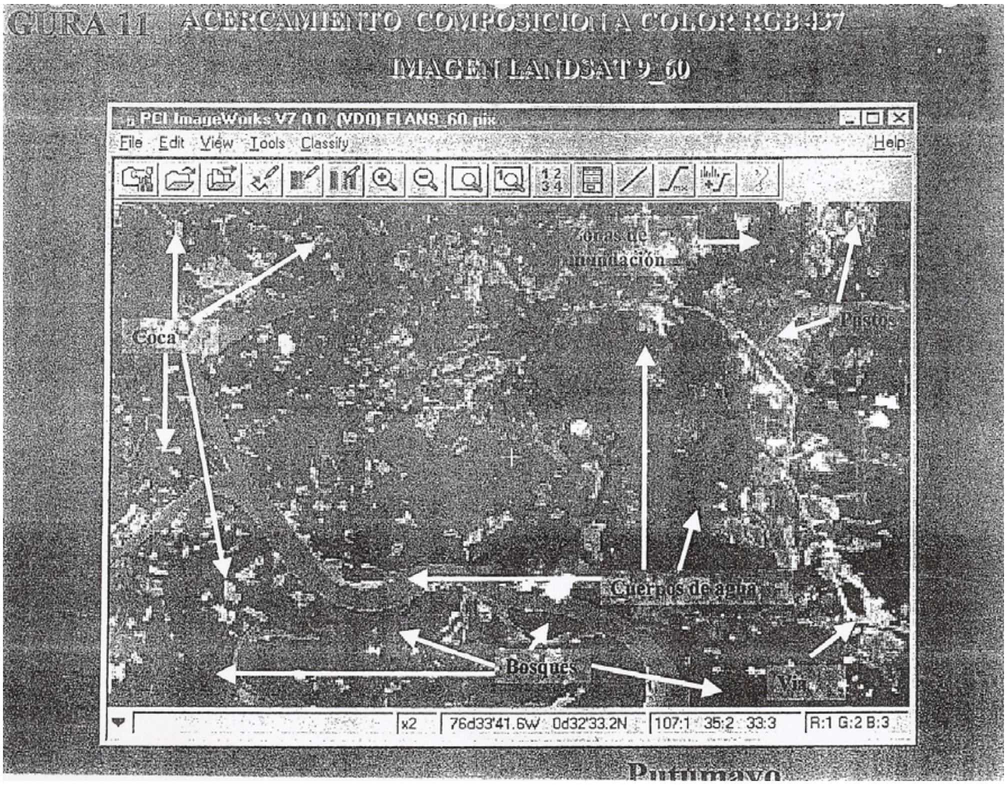


**FIGURE 12 MULTI CHANNEL VISUALIZATION – IHS TRANSFORMATION**

Notion of color

IHS Transformation (Intensity, Hue, Saturation)

Color composition

Intensity
Saturation
Hue

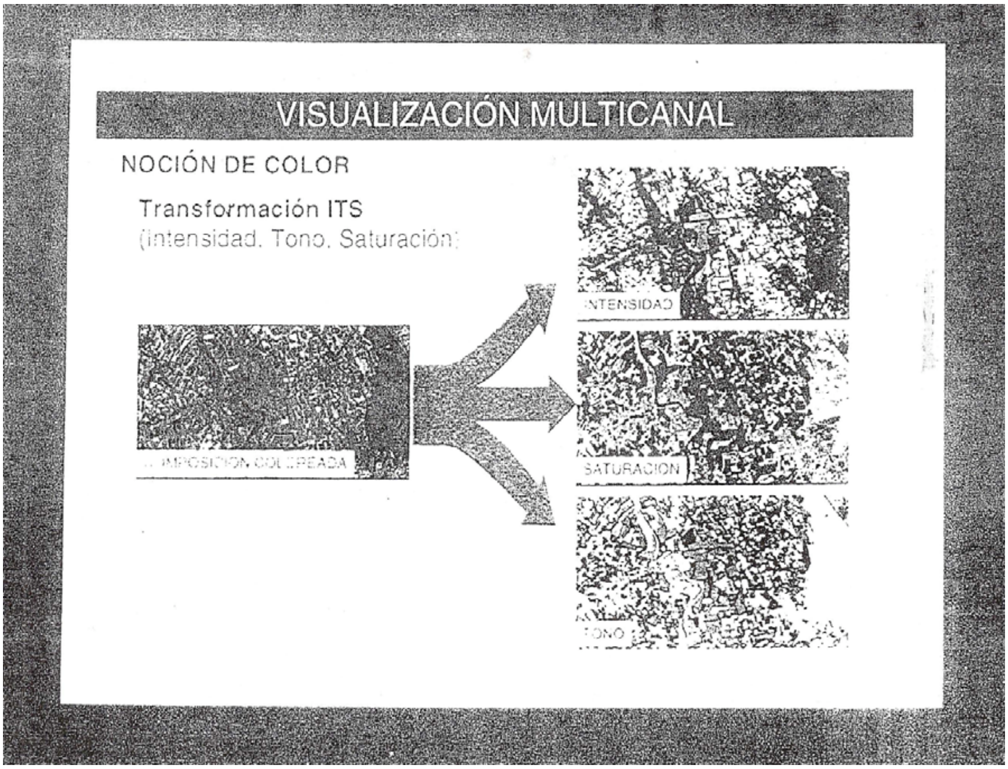


**FIGURE 13 IHS TRANSFORMATION SPOT IMAGES 650345, 652345, 651347**

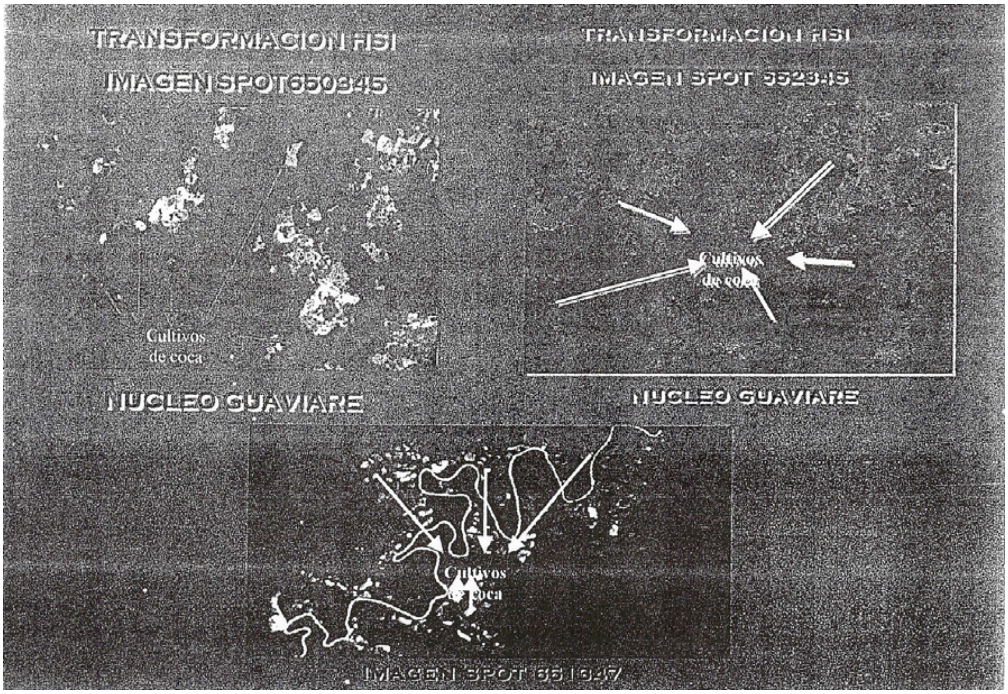
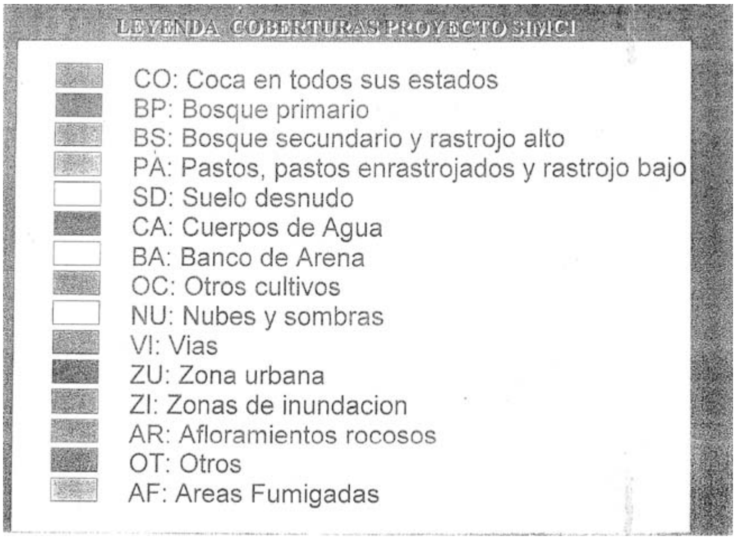


**FIGURE 14 LEGEND SIMCI COVERAGE AREAS**

CO: Coca in all its states
BP: Primary forest
BS: Secondary forest and high stubble
PA: Pastures, stubble pastures and low stubble
SD: Bare soil
CA: Bodies of water
BA: Sand bank
OC: Other crops
NU: Clouds and shades
VI: Roads
ZU: City area
ZI: Flooding areas
AR: Rocky terrain
OT: Other
AF: Sprayed areas



This process should display the data better for visual analysis, so that the features of interest present in the image are more evident; this includes the processes of contrast enhancement, spatial improvement, color compositions, vegetation index and image fusion.

The work legend is necessary not only in terms of scale but also of complexity of the territory, which makes it common in mapping land use to employ a particular legend for each study area, well adapted to local needs.

## 1.6 ANALYSIS OF SECONDARY INFORMATION

Before starting the process of image classification, it is good to clarify that the classification method used in the project is supervised classification, which starts from a knowledge of the study area in its geographical-landscape, cultural and social environment supported on the secondary information and naturally, the fieldwork. This greater familiarity with the area of study allows the interpreter to delineate on the image some pilot areas, which are considered sufficiently representative of the categories that make up the legend. These areas are called, in Anglo-Saxon literature, training fields. The term indicates that such areas are used to train the computer to recognize the different categories. In other words, from them, the computer calculates the DN that defines each class, to then assign the rest of the pixels in the image to one of these categories. This greater familiarity with the area of study, allows the interpreter to define some pilot areas on the image, which are considered sufficiently representative of the categories that make up the legend according to their DN. It is advisable to select several fields by category, in order to adequately reflect the variability in the study area.

Figure 15 shows the framework where the different types of secondary information are recorded, such as fumigation lines supplied by the DIRAN before and after the date of the image.

The fumigation spraying after the date of the image is used for the identification of coca fields by matching image coordinates and spraying lines, for their overlapping on the image. (See Figure 16)

**FIGURE 15 EVALUATION PHASE OF SECONDARY INFORMATION**

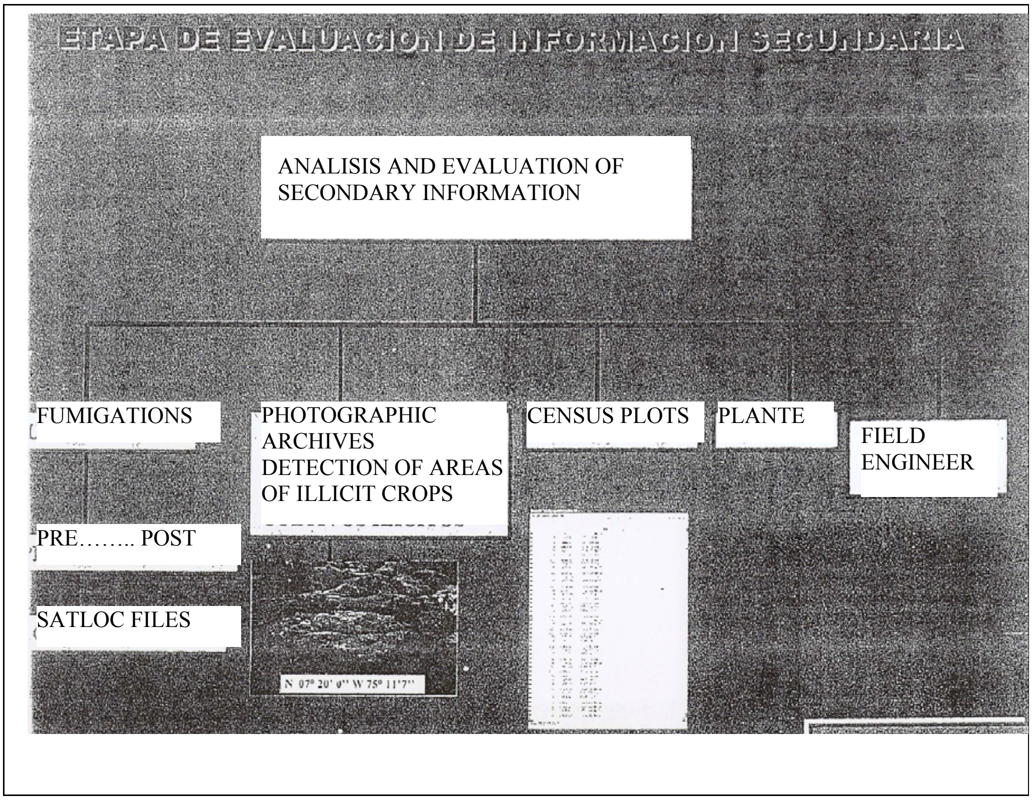
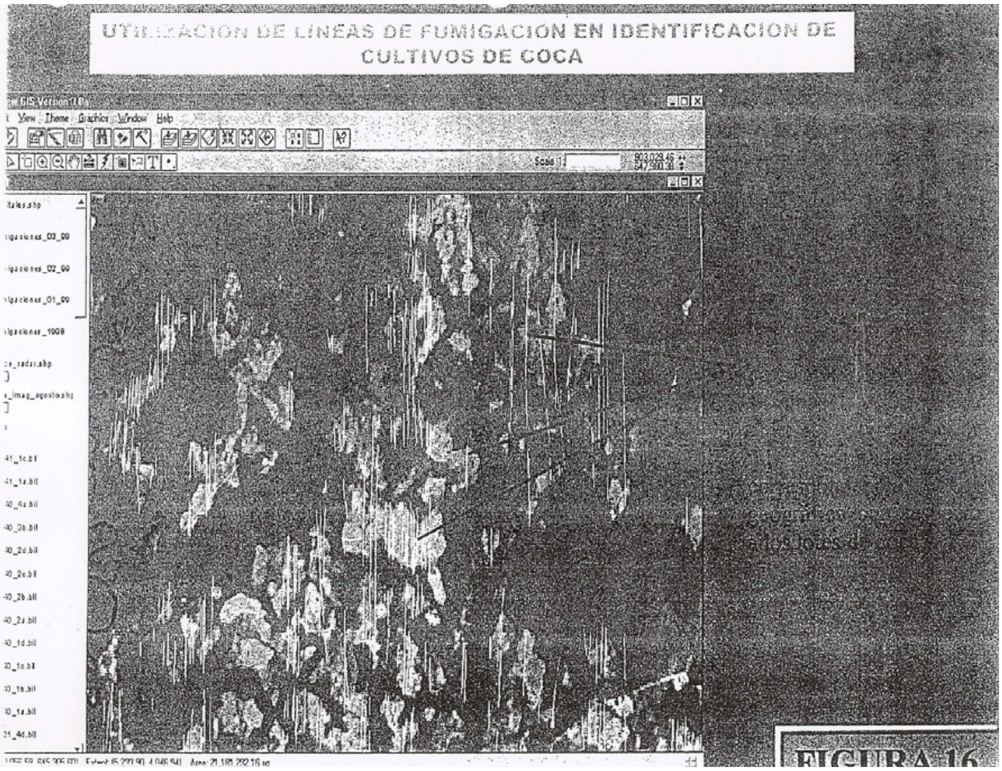


**FIGURE 16 FUMIGATION LINES – IDENTIFICATION OF COCA CROPS**



Another important secondary information comes from the DIRAN photographic archives regarding the areas for detection of illicit crops in the different nuclei or established zones; these photographic archives comprise images of coca crops previously identified and located with their geographic coordinates (latitude and longitude) and which are located on the image to identify the spectral response of the coca crop. (See Figure 17)

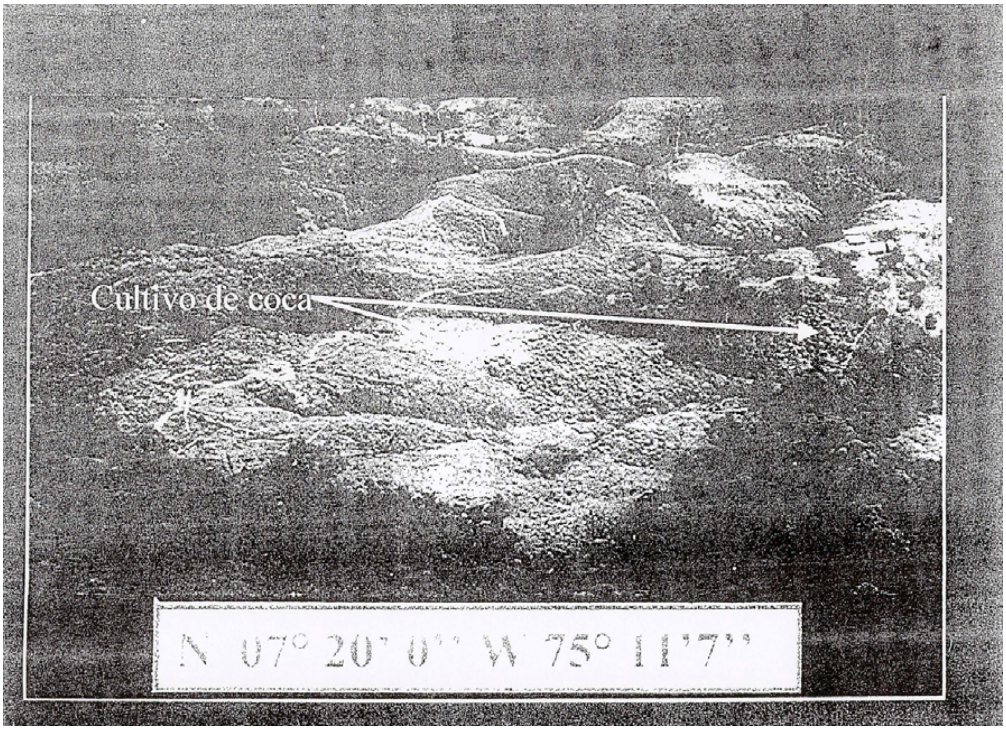
Other supporting information at hand refers to the plots of the visual aerial censuses conducted during 1999 and 2000, which are supplied by the DIRAN with their geographic coordinates related to each of them; in addition to these information sources, there is also available the experience and knowledge of the areas where the illicit crops are developed, of a field engineer engaged for over 5 years with reconnaissance of illicit crops.

## 1.7 INTERPRETATION OF IMAGES

The next stage, following the evaluation of the secondary information, corresponds to the interpretation of the coverage by two methods: the first is a visual supervised classification oriented toward the interpretation of coverage areas such as forests, pastures, clouds, bare soil and the second is visual interpretation of the coverage of coca, and the digitization of water bodies, roads and urban areas. Both methods are based on the proper relationship between the elements of land cover and the reflectance values measured or shown in the picture. Within the supervised classification, there are two stages as follows: the first of these stages is the training and assignment phase (see Figure 18 and 19), in which a number of pixels is assigned to each of the classes to be considered, after the interpreter learns about the coverage areas shown and the values indicated in the image of each of them. These pixels are defined visually in each of the categories or classes to be evaluated, performing a significant and consistent sampling and in line with all the values presented in each of the coverage areas.

Upon completion of the selection and study of the categories involved in the classification, the second stage begins; it is called allocation since it aims to ascribe each of the pixels in the image to one of the previously selected classes.

**FIGURE 17 PHOTOGRAPH OF A COCA CROP**




Coca crop

**FIGURE 18 TRAINING AND ASSIGNMENT PHASE – ILWIS SOFTWARE**

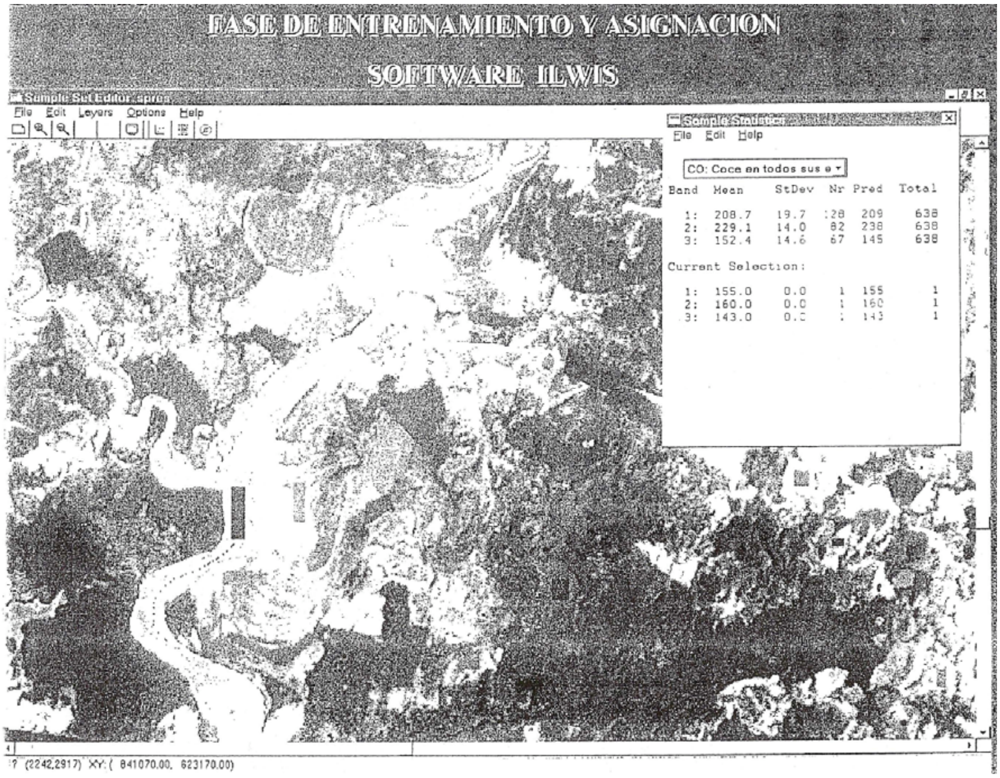
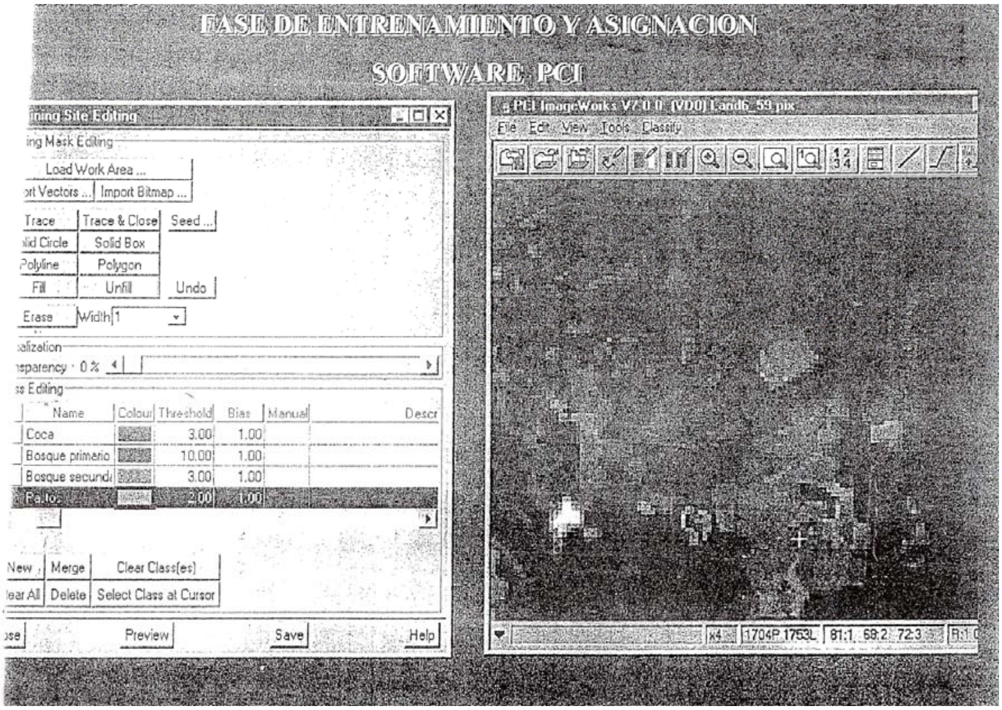


**FIGURE 19 TRAINING AND ASSIGNMENT PHASE – PCI SOFTWARE**



This assignment is performed according to the DN for each of the bands involved in the process. The result of this phase will be a new image; its DN will express the category assigned to each of the pixels in the original image.

The third stage is the evaluation of results, so called because it involves the criteria, knowledge and experience of the interpreter to evaluate the results shown by the computer, after the training and assignment phase. Thus the interpreter evaluates whether the results are correct or incorrect as shown in the image and it performs the necessary corrections to obtain a higher quality product. Within these corrections made at this stage is mainly the resampling of the areas, intensified in the areas where discrepancies with those in the image are manifested. This process is performed continuously and as often as necessary to achieve the highest quality product possible according to the condition of the image. This product is known as the initial classified Map.

The product obtained above undergoes visual editing in order to eliminate confusion or erroneous coverage therein due to similar spectral response conditions. Given different causes such as atmospheric conditions, climate and quality of the image, these responses are not subject to discrimination in the training and allocation phase, which makes visual editing necessary, using the techniques of on-screen digitizing and pixel by pixel editing. (See Figures 20 and 21)

Once all the corrections necessary are concluded, we obtain the product known as the preliminary map classified with its respective legend. (See Figure 22)

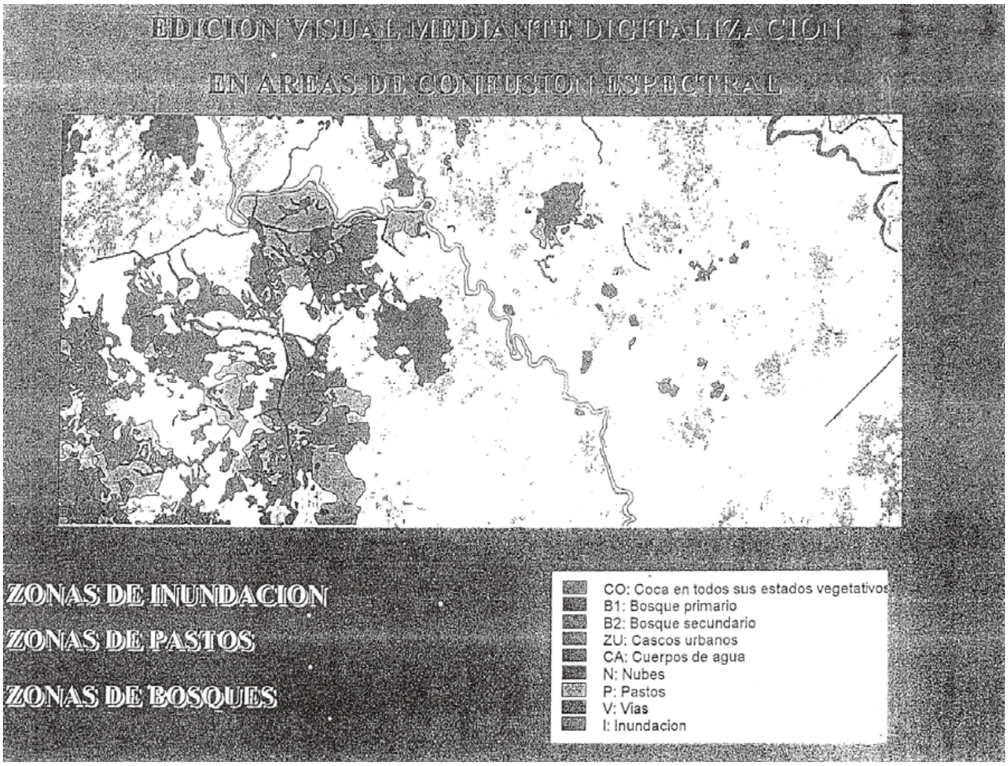
## 1.8 BUILDING COVERAGE IN FUMIGATED AREAS

According to the layout in Figure 1, the next step concerns the generation of coverage for the sprayed areas, which consists of the setting up of fumigation lines prior to the date of the image, with the aim to qualify the coverage in the fumigated areas according to the vegetative or natural regeneration state in which they may be. In these cases we find the coverage of bare soils, pastures, coca and natural secondary forest, to which are assigned the label of fumigated, if one or more fumigation lines pass over them.

**FIGURE 20 VISUAL INTERPRETATION OF COCA CROPS**


Digitized coca plots

**FIGURE 21 VISUAL EDITION BY DIGITIZATION IN AREAS OF SPECTRAL CONFUSION**




FLOODING AREAS

PASTURE AREAS

FOREST AREAS

CO: Coca in all its vegetation states
B1: Primary forest
B2: Secondary forest and high stubble
ZU: City area
CA: Bodies of water
N: Clouds
P: Pastures
V: Roads
I: Flooding

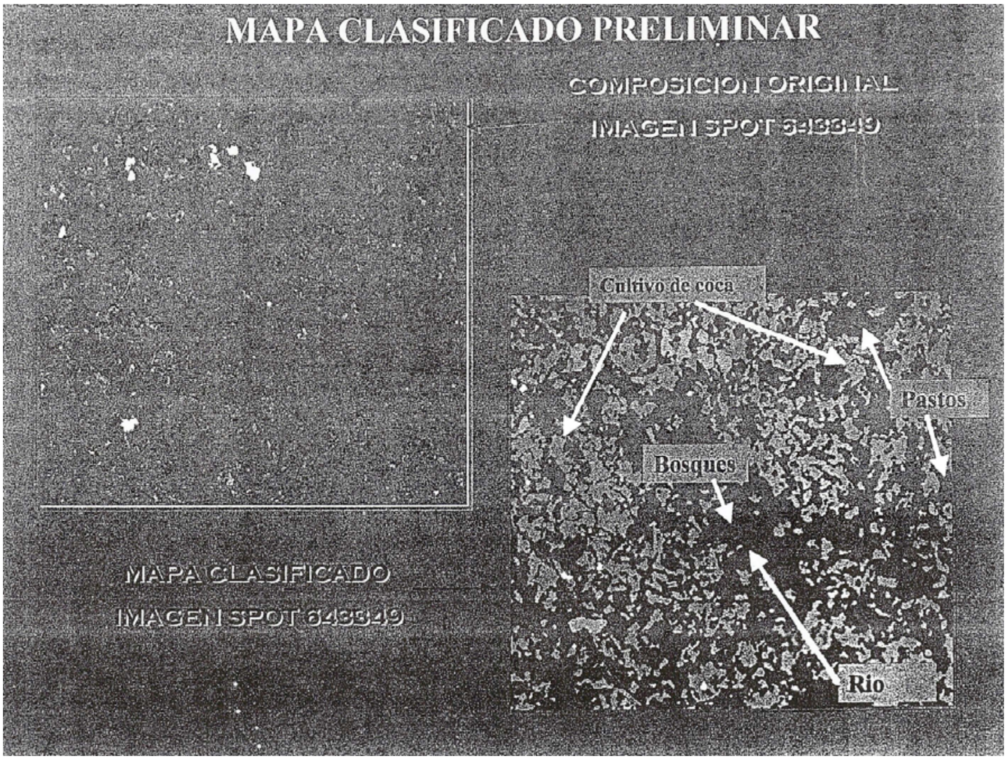
**FIGURE 22 PRELIMINARY CLASSIFIED MAP – SPOT IMAGE 643349**

Coca crop

Pastures

Forest

River



For example, if they were sprayed 8 days before the date of taking the image, there will still be the spectral response of coca and it will be assigned as fumigated; if it was sprayed 6 months before the date of the image, there will possibly be spectral response of pastures, stubble pastures or low stubble and even coca if there was replanting according to what occurred later. In this case the assigned coverage corresponds to fumigated pastures. If sprayed 12 or 18 months, we will find high bush vegetation that will be considered fumigated secondary forest if there was no replanting.

This way a discriminatory coverage is obtained from the fumigated and non- fumigated areas, as well as the vegetative state in which they are. (See Figure 23)

**1.9 FIELD TESTING**

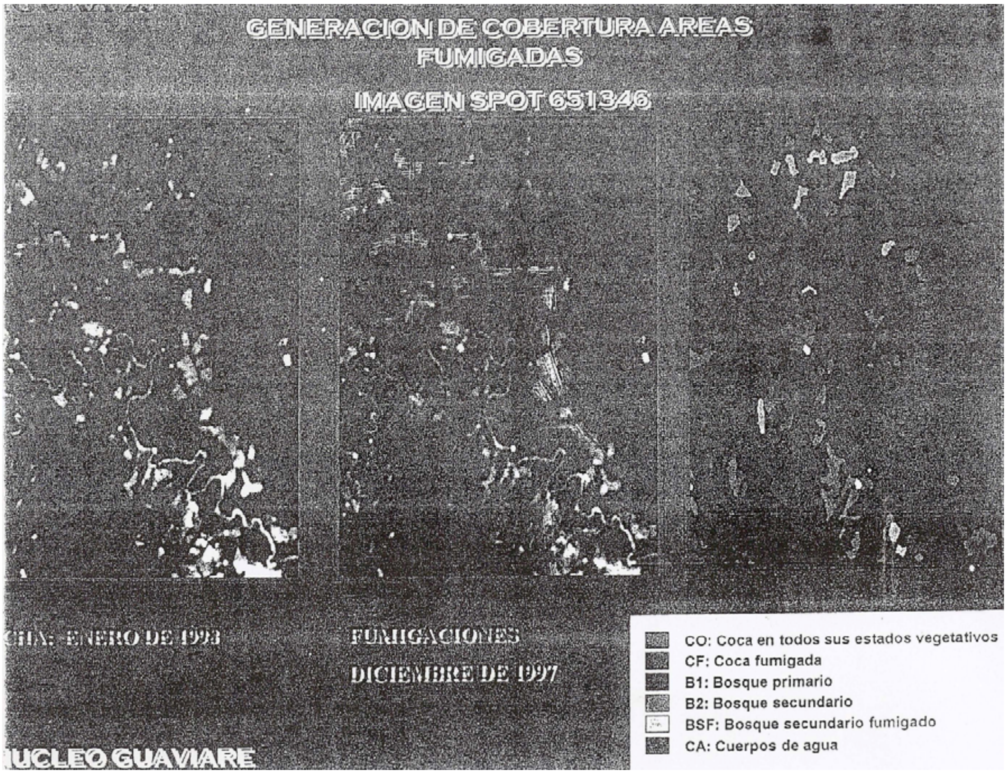
Once the preliminary classified map is obtained with its corresponding coverage areas sprayed, the product is ready for the Verification of the results by visual aerial inspection of the consistency of the legend with the spatial units in the field, which is prepared with three options:

- The random selection of points or coverage to be verified (specific areas)
- The manual selection of areas of confusion or conflict (specific Areas)
- A general sweep by meridians or the parallel

For the first two, points or plots are selected which are equipped with coordinates and identified on the image to transfer them to an analog format (verification sheets on paper). The flight paths are set out on them according to the closeness of the points. The tables with the points and their respective coordinates are given to the DIRAN pilots conducting the field verification by helicopters or Caravan airplanes. (See Figures 24, 25 and 26)

For the third step, the flight route is planned on an analog or digital format, which is aimed at verifying the largest amount of land and coverage areas, following the lines according to the parallel or meridians (see Figure 27)

**FIGURE 23 IDENTIFICATION OF SPRAYED COVERAGE AREAS**



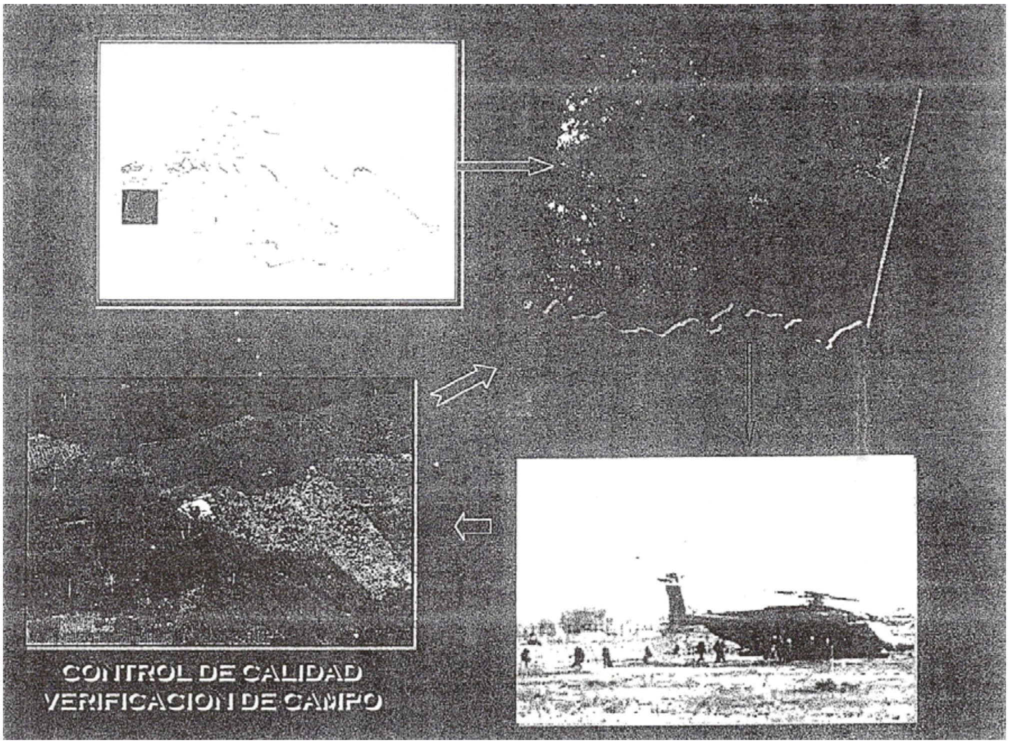

DATE: JANUARY 1993

FUMIGATIONS
DECEMBER 1997

GUAVIARE NUECLUES

CO: Coca in all its vegetation states
CF: Sprayed coca
B1: Primary forest
B2: Secondary forest
BSF: Secondary sprayed forest
CA: Bodies of water

**FIGURE 24 FIELD VERIFICATION SCHEME**




Quality Control

Field verification

**FIGURE 25 FIELD VERIFICATION POINTS – SPECIFIC AREAS**

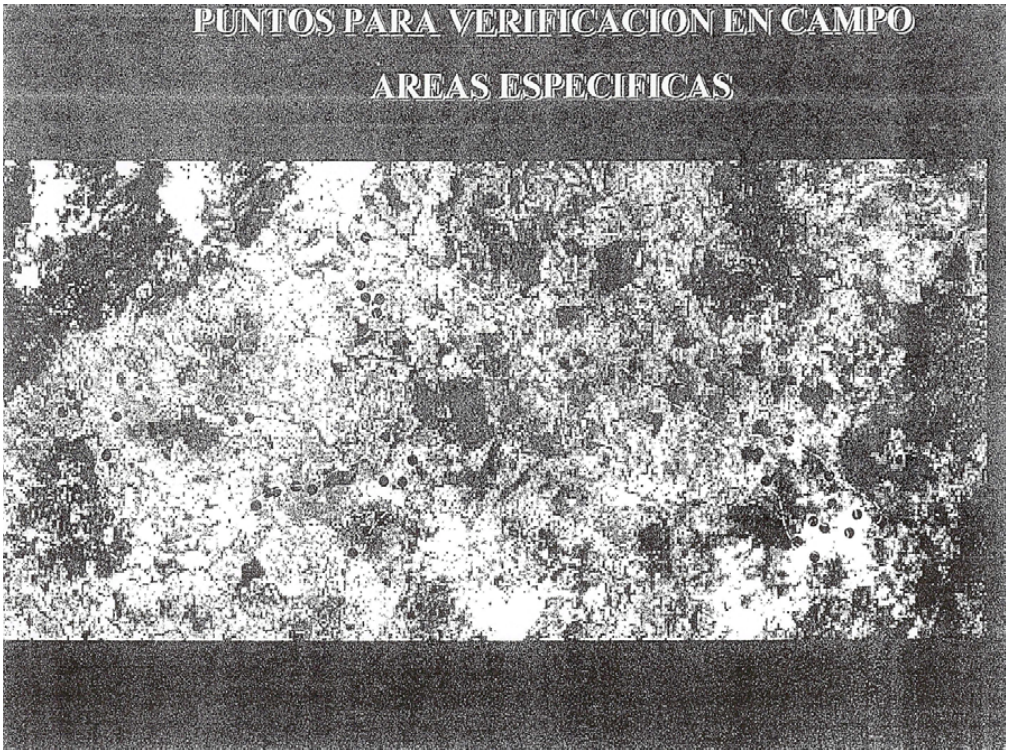
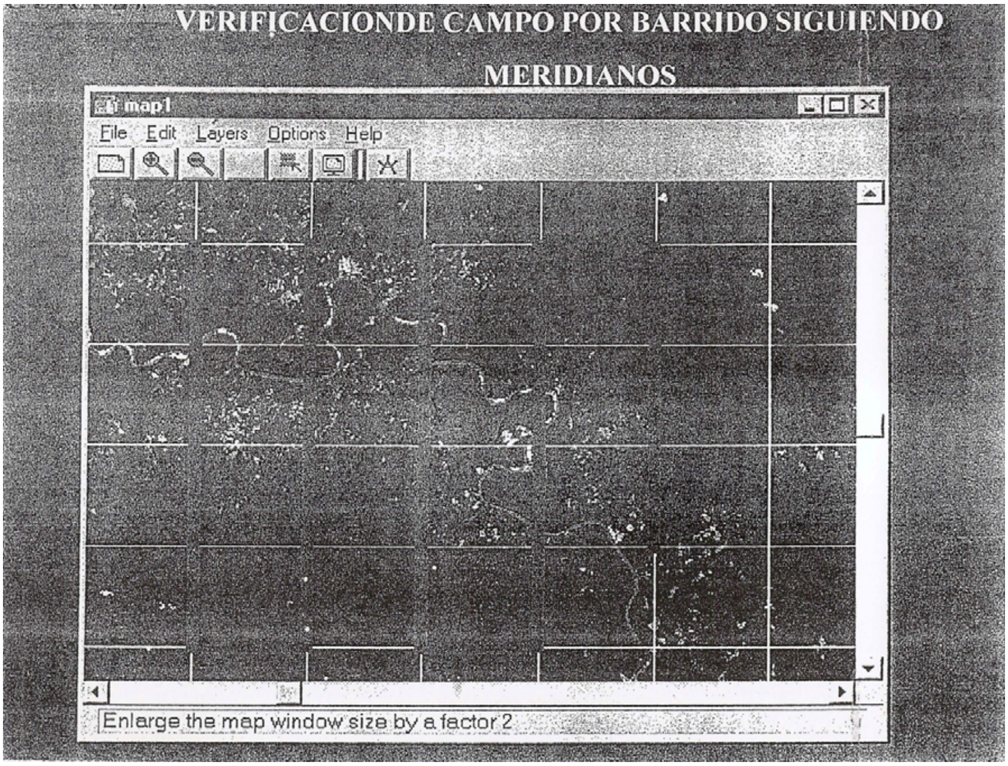


**FIGURE 26 3D VIEWING – LA GABARRA IMAGE**

**FIGURE 27 FIELD VERIFICATION BY SWEEP FOLLOWING MERIDIANS**



During verification the following are evaluated:

- Photo interpretation and assignment of coverage
- Definition of the plot forms
- Identification of new plots that do not appear in the image due to the date of the image

In each plot verified, a corresponding photographic or video record is made and general observations are made for the area (see Figures 28 and 29)

The photographic record includes not only the plots established for verification, but also the different areas to get the closest approach possible to the crop culture and behavior in the region accompanied by voice and visual records of what is found in each point.

These field files and observations in analog format are transferred to digital imaging for complementation and/or correction in two ways:

- Mapping of points with their corresponding flat and geographic coordinates (Gauss-Krugger) and identifier (See Figure 30)
- Comparison of analog (field) image coverage or photographs with interpreted image, which provides the accuracy or inaccuracy in the interpretation (see Figure 31)

The records of verified plots and coverage are taken to "verification tables," where each point is assigned its corresponding attribute with regard to verified coverage location, area, and accuracy or inaccuracy of the coverage previously interpreted. These tables provide an estimate of the quality of the interpretation process. (See Figure 32)

With the final editing completed by using the same techniques as the preliminary edition, a theme map of land coverage is obtained for each of the images interpreted.

It is important to bear in mind the possible sources of error or discrepancy between coverage interpreted and coverage identified in the field, among which are the following:

**FIGURE 28 AERIAL PHOTOGRAPH FOR EDITION**

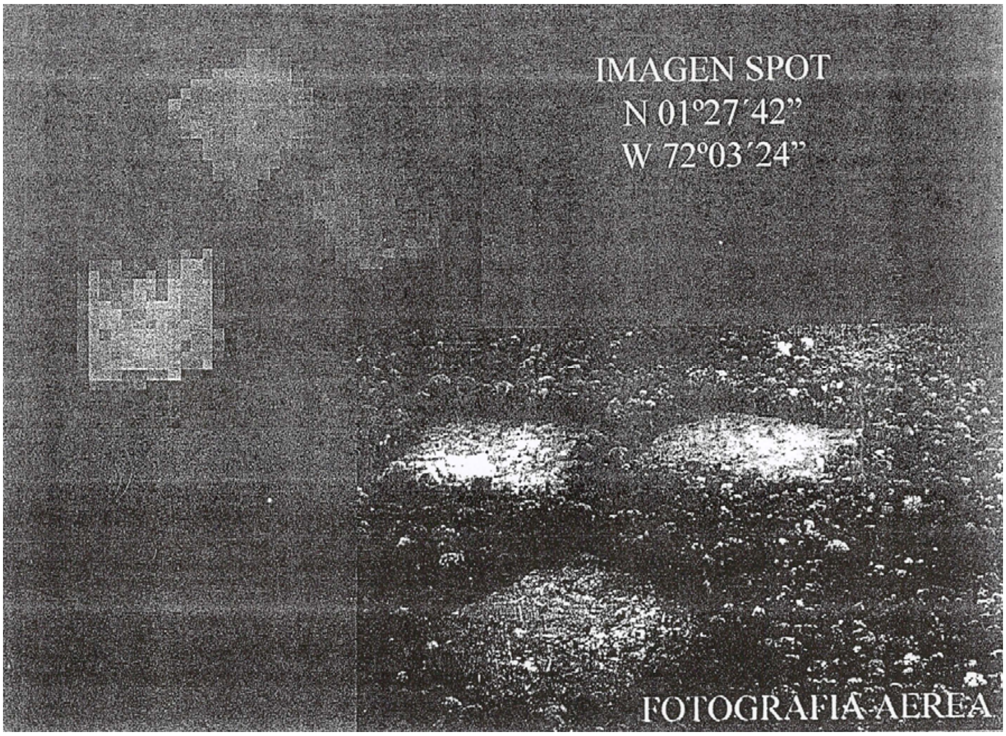


**FIGURE 29 AERIAL PHOTOGRAPH FOR EDITION**

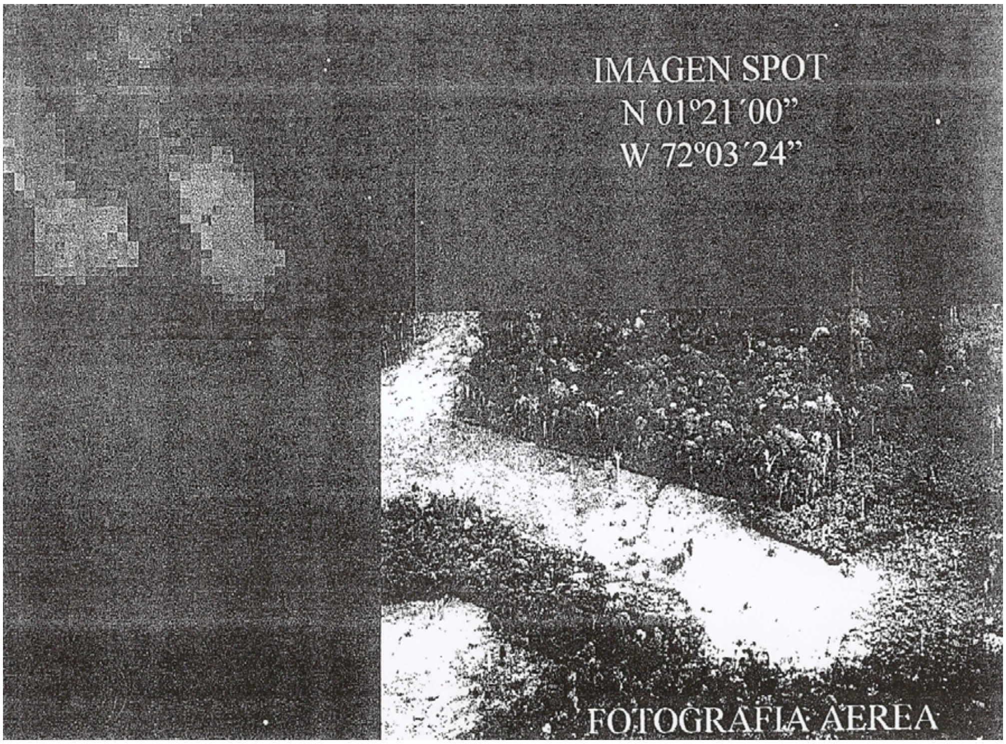


**FIGURE 30 COMPARISON OF COVERAGE AREAS BY LOCATION OF POINTS**

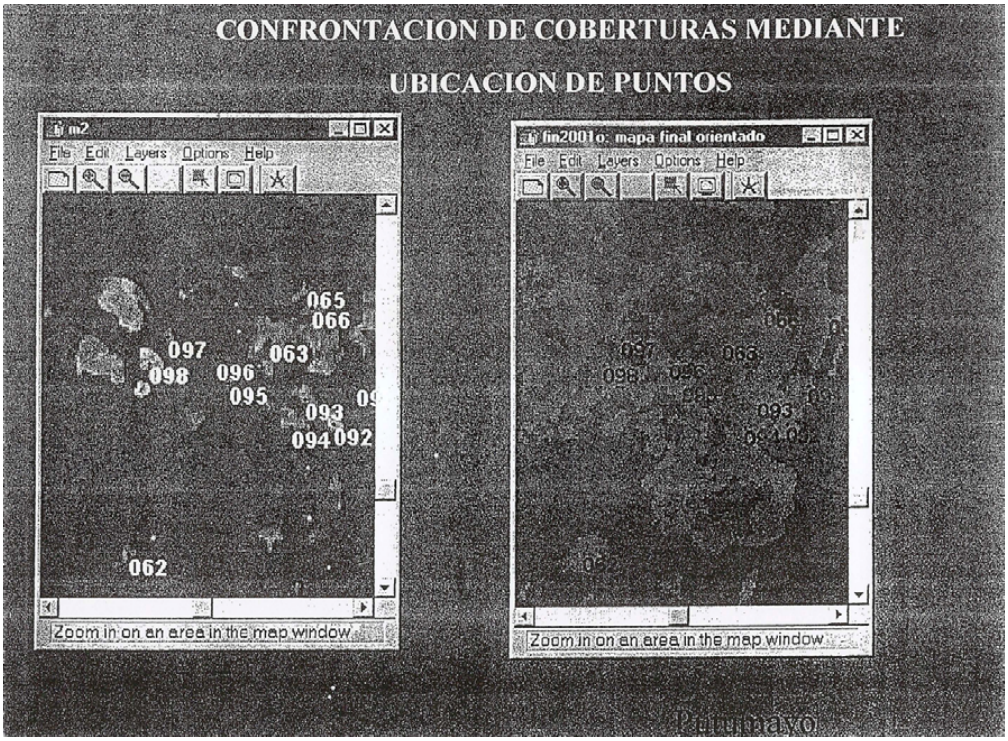
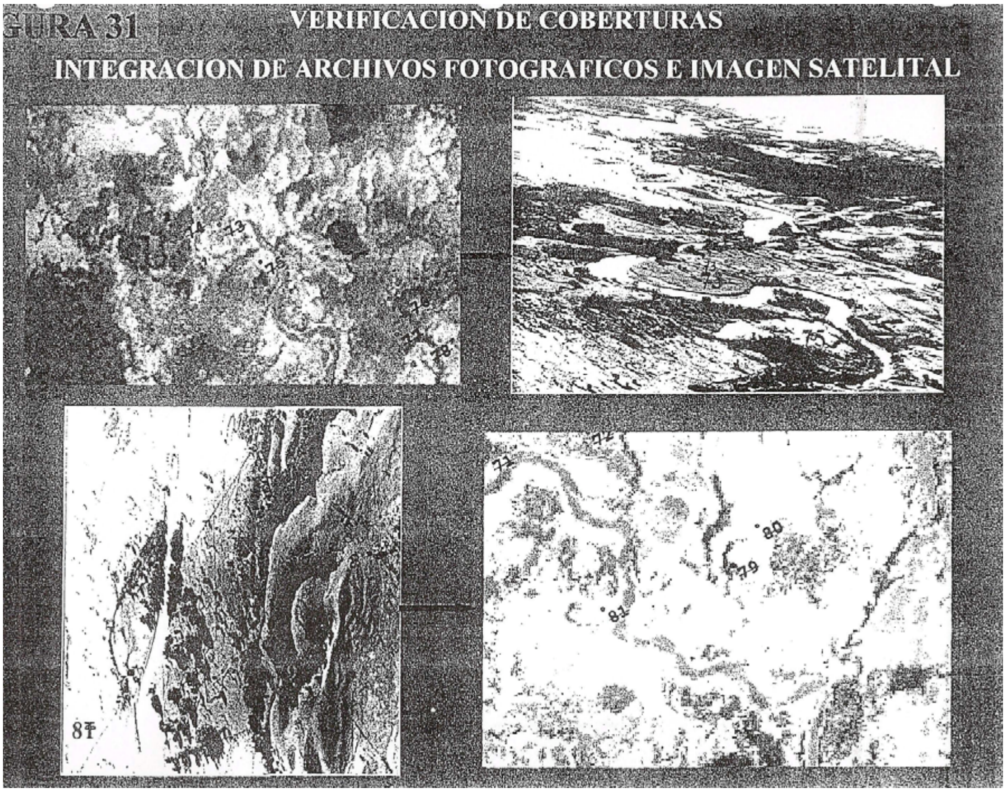


**FIGURE 31 VERIFICATION OF COVERAGE AREAS, PHOTO AND SATELLITE IMAGE**



## FIGURE 32 FIELD VERIFICATION CHART

| IMAGE 646350 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DATE OF TAKING: /FIELD VERIFICATION FEBRUARY 2001 | | | | | | | | |
| ORIGIN 2 | | | | | | | | |
| | | | | | | | | |
| POINT # | North | East | X | Y | COVERAGE | AREA IN M | SUCCESS | AREA *VERIFIED COVERAGE |
| 001 | 0.052 | -75.650 | 825330.000 | 497150.000 | Coca in all its states | 2800 | - | 3949200 |
| 002 | 0.055 | -75.639 | 826570.000 | 497570.000 | Pastures, stubble | 270800 | + | 2708800 |
| 003 | 0.051 | -75.629 | 827690.000 | 497050.000 | Pastures, stubble | 275200 | + | 2708800 |
| 004 | 0.078 | -75.660 | 824172.500 | 500032.500 | Coca in all its states | 46400 | + | 3949200 |
| 005 | 0.075 | -75.659 | 824357.500 | 499752.500 | Coca in all its states | 56800 | + | 3949200 |
| 006 | 0.074 | -75.671 | 822937.500 | 499647.500 | Coca in all its states | 30800 | + | 3949200 |
| 007 | 0.073 | -75.666 | 823512.500 | 499477.500 | Coca in all its states | 78400 | + | 3949200 |
| 008 | 0.071 | -75.661 | 824092.500 | 499322.500 | Coca in all its states | 41200 | + | 3949200 |
| 009 | 0.071 | -75.654 | 824812.500 | 499277.500 | Coca in all its states | 33200 | + | 3949200 |
| 010 | 0.070 | -75.652 | 825137.500 | 499157.500 | Coca in all its states | 118800 | + | 3949200 |
| 011 | 0.074 | -75.650 | 825347.500 | 499657.500 | Coca in all its states | 15200 | + | 3949200 |
| 012 | 0.075 | -75.648 | 825502.500 | 499747.500 | Coca in all its states | 19600 | + | 3949200 |
| 013 | 0.073 | -75.647 | 825652.500 | 499542.500 | Coca in all its states | 46000 | + | 3949200 |
| 014 | 0.075 | -75.643 | 826117.500 | 499707.500 | Flooding areas | 88800 | + | 88800 |
| 015 | 0.072 | -75.642 | 826232.500 | 499402.500 | Coca in all its states | 33600 | + | 3949200 |
| 016 | 0.072 | -75.636 | 826902.500 | 499422.500 | Coca in all its states | 61200 | + | 3949200 |
| 017 | 0.073 | -75.644 | 825940.000 | 499530.000 | Coca in all its states | 57200 | + | 3949200 |
| 018 | 0.065 | -75.640 | 826400.000 | 498690.000 | Coca in all its states | 52800 | + | 3949200 |
| 019 | 0.059 | -75.630 | 827500.000 | 497980.000 | Coca in all its states | 96800 | + | 3949200 |
| 020 | 0.059 | -75.625 | 828080.000 | 497970.000 | Coca in all its states | 47200 | + | 3949200 |
| 021 | 0054 | -75.617 | 828940.000 | 497400.000 | Coca in all its states | 56800 | + | 3949200 |

Structure of the land: Errors related to the structure of the territory include those confusions arising from the spatial arrangement in the coverage areas which are objects of study. This may include aspects such as shape, orientation and above all, the size of parcels; also the spatial contrast between neighboring coverage areas, the degree of mixing in the different types of coverage areas. In the case of the Guaviare nucleus, this concept is considered in terms of the more defined form of the coca fields, size and analysis of the environment coverage in the event of a spectral confusion between the different theme coverage areas. The effect of the parcel morphology is particularly sensitive in those regions which have undergone colonization of the territory. This originates, quite often, plots of very small size, even lower than the pixel size, which results in the sensor's detection of a radiometric signal averaging between two or more coverage areas, making discrimination practically impossible, which is known as boundary error.

Level of disaggregation: In most cases, the attempt to establish subdivisions in a theme class involves assignment problems, since the purpose is to discriminate spectrally similar covers. For example, a study in southern Germany found that the combination of the "low density" urban and "high density" classes in a regular "urban" class increased the final mapping accuracy in 83%. In this aspect and in terms of the sensors used, it is not possible to discriminate the different vegetative states of coca (scraped coca, newly planted coca and coca with high leaf density) and facing the high dynamics of the crop, the decision was to classify the illicit coca crop with the theme legend of coca in all its vegetative states, ensuring an optimum level of reliability in identifying the coca areas.

Taking of images: Errors related to image taking mention problems in the functioning of the sensor or platform, the atmospheric influence, or to flaws in the image reception and/or recording systems. Also included here could be the confusion arising from a possible incorrect selection of the image.

When the image has problems of cloud cover, this means that the coverage areas under them will not be censed, affecting the procurement of figures close to reality. Also when there is high influence of haze in the scene, the spectral response will be affected, which will therefore affect interpretation.

In the case of images taken during heavy rain, it has occurred that it can generate a mistake because the spectral response of areas of flooding or waterlogging is similar to the spectral signature of coca crops, which means more visual editing work in order to correct this error.

### 1.10 FINAL EDITING

The final editing process based on field verification is undertaken with the same techniques as the rough cut to achieve a theme map of land cover for each of the images interpreted.

The final theme map is the input for the obtainment of statistics per image, nucleus, province and municipality, that is, the quantified information of areas of each of the coverage areas as well as maps or map products. (See Figures 33 and 34)

The final theme map obtained (see Figures 35 and 36), becomes an input for the GIS, which is the tool that will allow direct queries to the database such as: what is there in a specific area, how much is there, what information surrounding it is there, and so on. From the information provided by the GIS, new theme maps can be produced based on the attributes of the database, such as the range by areas, estimation of future behaviors regarding the dynamics of change in land use by nucleus, simulation of environmental effects before they are irreparable, monitoring of potential new areas of illicit crops, environmental characterization of the illicit crop areas and exchange of information with other institutions, etc. This way, the project becomes an important source of multidisciplinary type information generation.

**FIGURE 33 THEME MAP OF LAND COVERAGE**

City area

Secondary Forest

Coca

Pastures

River

Primary forest

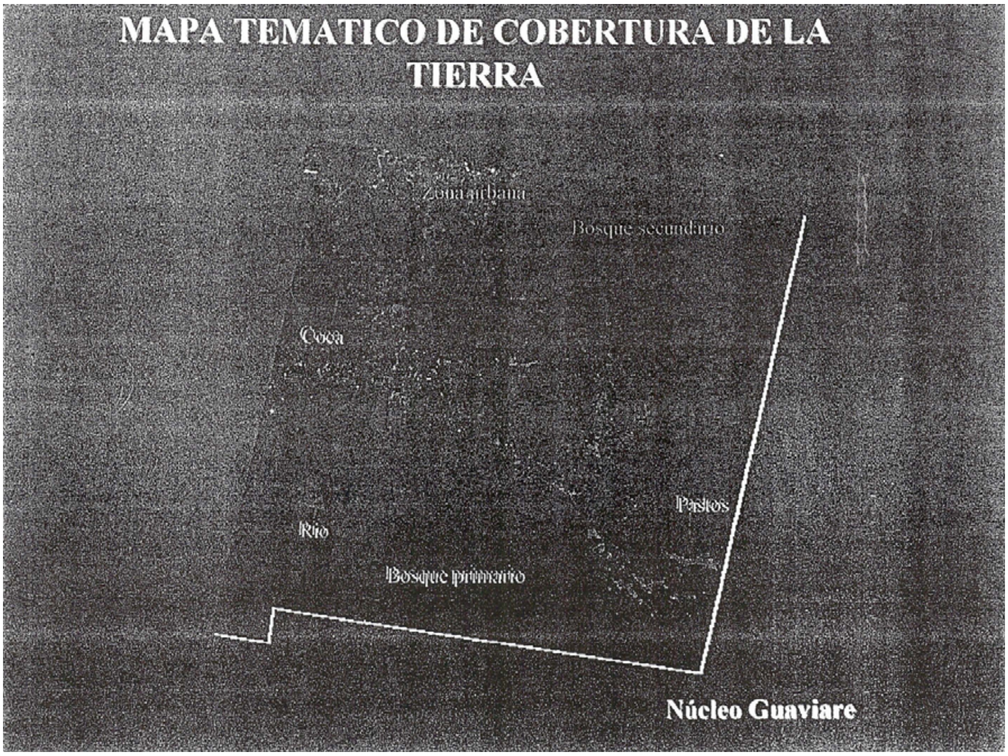


**FIGURE 34 APPROACH TO THEME MAP**

Pastures

Secondary Forest

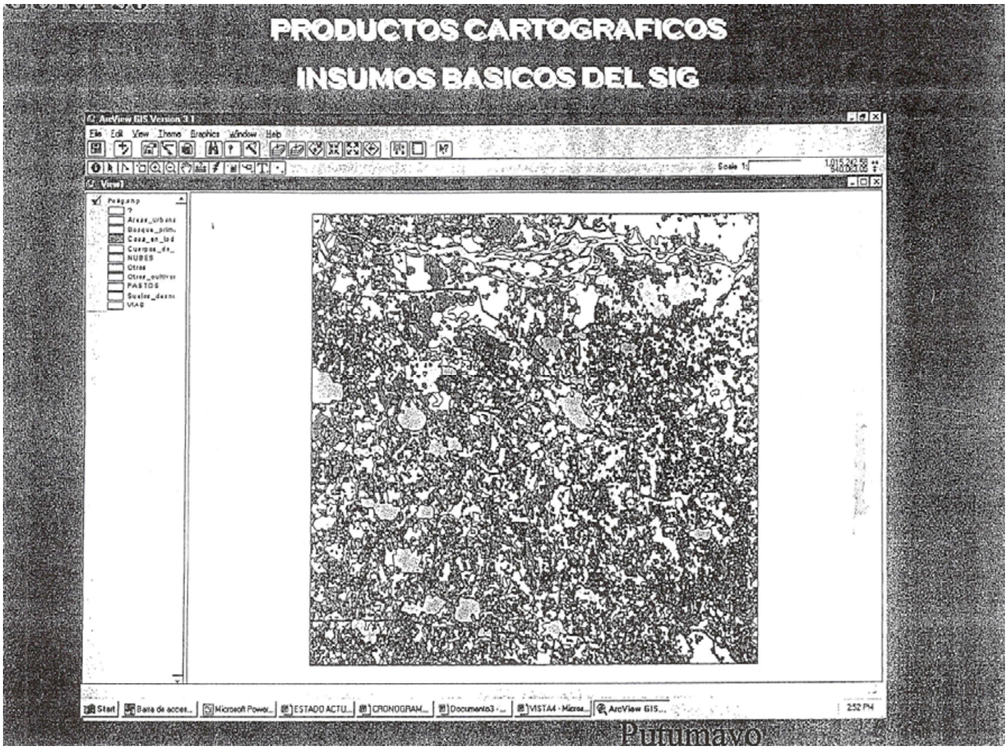
Coca crops

River

Primary forest

**FIGURE 35 PREPARATION OF SPACE MAPS**

**FIGURE 36 MAPPING PRODUCTS**



## 2. METHODOLOGY FOR FIELDWORK

Fieldwork is an essential tool for improving the quality of interpretation. It is conducted in two stages as follows:
First phase: Aerial reconnaissance
Phase Two: Verification of interpretation

The first phase is intended to widen the reference point of the engineer interpreter so that he recognizes the social, economic and environmental dynamics of the area that is to be interpreted and that he may assign coverage values, consistent with the geographical space, to the different spectral responses of the image to be interpreted.

In the second phase, the fieldwork is directed to verify, from the aircraft, that the coverage areas assigned to certain patterns are correct. Additionally, specific areas where there is doubt about their interpretation are visited.

The two phases are developed through field visits, but the methodologies of planning and preparation, as well as assessment, and the products of each visit differ according to the phase that is being developed.

### 2.1 FIRST PHASE: AERIAL RECONNAISSANCE

Aerial reconnaissance is conducted before starting the interpretation of images and its major aim is to expand the respective interpreter's reference on the specific area to be interpreted. The reconnaissance can be done together with the evaluation of the reliability of the above figure, since there are no specific restrictions on reconnaissance. Indeed, programming of routes is susceptible to changes, since the main aim rather than visiting specific sectors, is to know the area to interpret.

The methodological process for aerial reconnaissance has three stages:
Selection of areas
Flight Schedule
Evaluation of results

### 2.1.1 SELECTION OF AREAS

The field reconnaissance has no special restrictions on the selection of areas, however it is useful to identify specific sectors covered in the image such as:

Areas of concentration of illicit crops according to the results of the census of the previous year. This allows the identification of the spectral response of coca in the image to be interpreted.

Areas with economic dynamics of legal activities, such as consolidated agricultural, agro-industrial, industrial and livestock areas since, in general, the presence of these areas reduces the existence of illicit crops.

Colonization fronts where there is high likelihood of implementation of illicit crops.

Areas where the program of eradication by aerial spraying has been developed, in order to observe how coverage has evolved in these areas

The selection of the reconnaissance areas has as a main tool the census results of the previous year and the team's knowledge of the area. It is also convenient to compare the distribution of illicit crops in accordance with the previous census and to identify areas prone to growth, and areas prone to reducing the area with illicit crops.

### 2.1.2 FLIGHT SCHEDULE

Once the reconnaissance areas are identified, they are accompanied by maps, preferably on a 1:100000 scale. If the images are already available, it is ideal to bring plottings of all images in scenes on a 1:50000 scale; otherwise images from the previous census may be used. The scenes should include the outline of geographical coordinates at intervals of up to two (2) minutes and expressed in degrees, minutes and seconds in the WGS84 system, since this is the system within the managed aircraft.

Two sets of scenes should be plotted, which will be used to identify the coverage on each of the sides of the aircraft. Once the scenes are plotted, rivers and towns are identified to facilitate referencing, and the scenes are located on the image mosaic.

The areas surveyed are identified on the images and maps, and the flight lines are traced following two distributions in particular:

Block sweep considering aspects such as viewing angle, visibility, flight altitude, required intensity, among others. This sweep is done following the parallels or meridians with the help of the geographic positioning system of the aircraft and it is recommended for the reconnaissance of coca areas.

Fly-by guided by the elements in the landscape that serve as reference points. This method is recommended for the identification of coverage in new colonization sources.

Trips between specific points: it is recommended for the reconnaissance of areas with economic dynamics of legal activities, such as consolidated agricultural, agro-industrial and livestock areas.

A mosaic is then prepared for the commander of the aircraft, which must also include the corresponding images, scheduled routes, restricted areas for the flyby, the main names of the places in the area, the towns present and the most outstanding geographical accidents in the terrain.

Likewise, a second plotting is prepared for the field engineer, which should include all information necessary for navigation by the interpreters, that is, identification of images and scenes into which they were decomposed for detailed level plots, place names, scheduled flight lines and specific points of interest.

The plotting and mapping must contain enough information for the interpreter to identify areas of interest, so it is recommended to include municipal boundaries, rivers and sites.

During the trips at least 10 specific plots of each of the forms of coverage present in the area should be identified, which will serve to identify the spectral patterns of the forms of coverage.

**2.1.3 EVALUATION OF RESULTS**

The information obtained in the reconnaissance is marked on the maps and is compared with what is reflected in the images for the corresponding figure. The 10 plots are identified in the images by coverage form and the spectral signature is evaluated. With these parameters, the interpretation begins.

## 2.2 SECOND PHASE: FIELD VERIFICATION

The methodological process for the development of the field verification work includes four stages, which are described below:

Selection of verification areas

Flight programming

Estimation of verified areas

Evaluation of the results

### 2.2.1 SELECTION OF VERIFICATION AREAS

The selection of the areas being verified is performed by applying the following criteria:

Visit the areas where interpreters have identified the presence of illicit crops to identify possible ways of coverage with spectral responses similar to that of coca

Visit areas where there is doubt about the presence of illicit crops according to the respective interpreters and/or secondary information sources

Visit the areas where illicit crops have been interpreted, but the local social, economic and environmental dynamics raise doubts about their presence

Visit the areas where the excessive presence of clouds renders image interpretation difficult

Visit areas with different spectral responses to coca where coverage has not been able to be qualified

It is important to remember that at this stage, there is already a partial interpretation of the coverage areas, therefore the trips  are scheduled to specific points.

**2.2.2 FLIGHT SCHEDULE**

After defining the areas to be verified, an "assembly" of all georeferenced images present in the nucleus is done and the plotting of the respective mosaic takes place.

The areas subject to verification are identified on this plotting and the flight lines are drawn along two distributions in particular:

Sweeping of blocks considering aspects such as viewing angle, visibility, flight altitude, required intensity, among others. This sweep is done following the parallels or meridians aided by the geographic positioning system on the aircraft.

Fly-by guided by the elements of the landscape that serve as reference points

After tracing the flight lines, the images are broken down into more detailed scenes (1:30000 to 1:50000 scales), providing enough overlap to facilitate the transition from plate to plate. Likewise, the scenes should include the outline of geographical coordinates at intervals of up to two (2) minutes and expressed in degrees, minutes and seconds. Two sets of scenes should be plotted which will be used in similar fashion as those in the reconnaissance process, for the identification of coverage on each of the sides of the aircraft. Once the scenes are plotted, the rivers, and towns are identified to facilitate referencing and the scenes are located on the mosaic images.

Later, a mosaic is prepared for the aircraft commander which also include the corresponding images, scheduled routes, restricted areas for the flyby, the main place names in the area, the towns present and the most outstanding geographical accidents and which could affect the scheduled flight altitude and the route with the specific points to visit. A list of the coordinates of specific points to be covered is also prepared.

Finally, a second plotting is prepared for the field engineer, which should include all information necessary for navigation by the interpreters, that is, identification of the images and scenes that were divided for the detailed level plotting, place names, scheduled flight lines and specific points of interest that must be verified.

### 2.2.3 ESTIMATION OF AREAS VERIFIED. PROGRAMMED SAMPLING AND REAL SAMPLING

The scheduled sampling is determined considering the flight altitude over the terrain and the permissible angle of view and it expresses the total area intended for verification. However, upon verification, some factors may affect the schedule (climatic conditions, law enforcement, resource availability, among others) and cause a reduction in the area finally verified. The final area covered becomes the actual sampling.

During the field trips, the scenes are marked with the identified forms of coverage, not only in the specific verification points but also throughout the plane trip to reach them; this means that coverage is verified provided the fly-by is over an area covered by the images. This is of great importance since it allows identifying errors in the interpretation and controlling the quality of interpretation.

Identifying the coverage of coca is done, as possible, by defining specific plots when there is complete certainty of the plot. Otherwise it is marked as coca areas mixed with pastures, forest or other cover as appropriate.

It is important to note that, unlike the phase of reconnaissance, field verification does not allow modification of scheduled routes, and therefore the amount of points or areas covered satisfactorily in field trips (real sample) must be assessed versus the number of areas or points to be covered as scheduled (programmed sampling).

The ratio between scheduled sampling and real sampling cannot be less than 70%, and if so, it is necessary to set up supplementary visits to the area. This decision is made jointly between the interpreter and the field engineer, considering that although it would be ideal to cover on the field the total polygons interpreted, the high cost of this procedure mandate a partial sampling.

### 2.2.4 EVALUATION OF RESULTS

Upon returning from the field trip, the information obtained is contrasted with the preliminary interpretation that has been developed and a prior control of the quality of interpretation is conducted. The specific plots whose coverage area was identified in the field are placed on the images, and the coverage assigned in the previous interpretation is verified, qualifying a match between the information interpreted and that verified as a success. Later, the number of correct interpretations regarding the number of polygons identified in the field is calculated and the quality of interpretation is controlled.

The field verification work allows timely correction of errors of interpretation. Some spectral responses tend to get confused and wrongly classified, and only through field verification is it possible to identify errors of interpretation that would otherwise be systematic and would significantly decrease the final reliability of the process.

**2.3 QUALITY CONTROL OF THE FIELDWORK**

Quality control is a concept that should apply to each stage of a project and in the implementation of each. Mechanisms should be established to ensure that the stage is developing satisfactorily. For the fieldwork, quality is controlled in the following aspects:

Control of georeferencing: the fieldwork involves 3 georeferencing models, which are the coordinates of the image, the coordinates of the GPS (navigator) of the aircraft and the actual coordinates of the terrain. Therefore the differences of the three models are established, so that the location in the field is as accurate as possible. For this, control points are taken, the coordinates are derived for each system and the error is known. It is important to note that as a result of this difference, the location of specific plots should be made in detail and not by coordinates. However, to have a coordinate system that is very close to reality and to know the possible error will greatly facilitate the location.

Identification Control: the control of identification is made achieving such flight altitudes to allow a clear identification of the coverage. As an exercise in interpretation quality control, before starting the visit of specific points, there is a test to ascertain that that coverage of one area is identified by all the participating team, and this information is compared. In case of a difference between the participants, the area is visited again and the fly-by is lower in order to clarify doubts. This way the parameters for aerial interpretation are established, which will be replicated in the entire area.

Control of the intensity of fieldwork: Fieldwork must have an intensity such to allow correcting possible errors of interpretation to acceptable levels. For this an evaluation is performed of what was scheduled compared to what was done. When the ratio between these two points indicates that less than 70% of the proposed route was covered, a new field trip is scheduled.

## 2.4 QUALITY CONTROL OF THE CENSUS

The estimate of the theme accuracy achieved by the census can be prepared using various criteria which include i) comparing the census with that obtained by other conventional sources, ii) studying the reliability obtained by classifying the training areas (this is for the coverage areas different from coca) and iii) selecting verification areas for which there is actual cover present in the soil.

## 2.5 THE QUALITY OF THE INFORMATION

It is not easy to establish the overall measure of quality of information gathered during the process of identification and measurement of illicit crops in Colombia. However, it is possible to describe it by identifying the most important sources of error and provide them, if appropriate, with quantitative measures to express their magnitudes. To find these magnitudes, it is necessary to know the way the data were collect and the processing methodology.

The quality of information is basically described in terms of sampling and non-sampling errors committed in the process of obtaining the information. The sampling error is simply defined as the distortion between the estimated and the true value by the fact of having collected only a part of the elements of the sample universe. The non-sampling error is generated by physical and material difficulties that cannot be controlled entirely but may be minimized by improving the processes of correction and adoption of controls. Therefore the total error is the accumulation of sampling and non-sampling errors committed during the process of gathering information.

## 2.6 APPROACH AND ESTIMATION OF THE DEGREE OF RELIABILITY OF THE INFORMATION

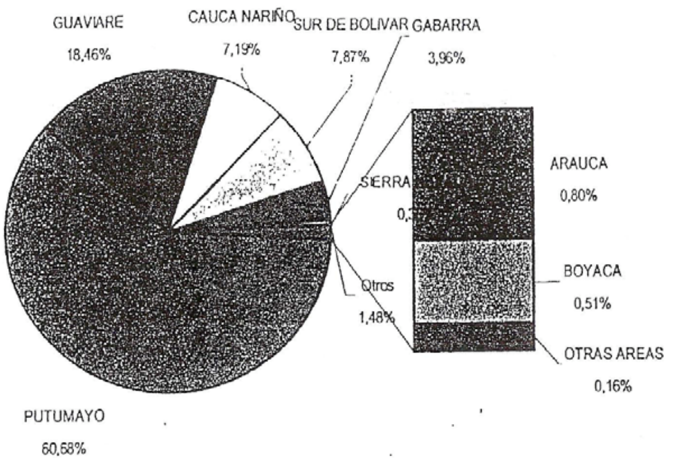
The purpose of data collection techniques is to obtain proven evidence that it is significant to answer the questions asked in research. The significance is explained in terms of validity, accuracy and reliability.

The resulting interval between the upper and lower limits where the true value is located is called the confidence interval with an x% of reliability. If the difference between the boundaries is small, it means that the information will have a high accuracy with the specified reliability.

In addition to obtaining accurate information, it is important to ensure that the result remains within this accuracy for any other process undertaken to make the same measurement, that is, that the amount be consistent with any other measure gathered. This means in practical terms, that if the same process were repeated many times, the x% of them would have the property that the result would be within this range of accuracy. This is called the reliability of the information.

| QUALITY OF THE INFORMATION | ⇨ | RELIABILITY AND ACCURACY VERIFICATION OF QUALITY | ⇨ | ANALYSIS AND CONSISTENCY OF INFORMATION TOLERABLE ERRORS |
|---|---|---|---|---|

DISTRIBUTION BY NUCLEI IN THE AREAS OF COCA CROPS




**Scheme 1 Distribution by nuclei in the areas of coca crops**

Quality control is based on the demonstration of the existing vegetation coverage with respect to vegetation cover interpreted of a statistically valid sample. This allows extrapolation of results using statistical techniques on the entire census. Whether the coverage interpreted for a given polygon is correct or not is specifically assessed.

**2.6.1 SELECTION OF THE SAMPLE**

Quality control was initially conducted for the nuclei with the highest incidence in the total number of coca crops (Putumayo, Guaviare and South of Bolivar), which possess 87% of the national total, in order to achieve the greatest representation possible. However, considering that in most cases, the spatial distribution of the coca polygons is not homogeneous for all the nucleus, it became necessary to define the images that shape it and within them, enclose in amoebae the areas of coca in order to not direct the sample to non representative sectors.

Once the sectors with illicit crops were identified, polygons were classified which were interpreted within the same according to area ranges, and identified considering that the smaller the area of the polygon, the degree of difficulty of identification is higher, and that the smaller the area, its impact on the figure is lower. The selected ranges are as follows:

Table l Area ranges used for defining the statistical sample size for the quality control of the 2000 figure

| RANGE | DEFINITION |
|---|---|
| 1 | Polygons between 0.25[1] ha and 2 ha |
| 2 | Polygons between 2 ha and 10 ha |
| 3 | Polygons greater than 10 ha |

The application of this classification enables the assurance of a statistically reliable sample and facilitates the analysis of results since the weight of each rank is established on the final result.

The series obtained by applying this classification are analyzed to determine the appropriate statistical parameters. The frequency distribution curve of the areas of polygons is defined, the

[1] Plots smaller than 0.25 ha are not considered given that the spatial resolution of the images used do not allow obtaining pure coverage areas with areas smaller than 0.25 ha

standard deviation, coefficient of kurtosis, the interquartile range and the population mean. Later, the sample size is defined for a reliability level of the experiment of 95% with a maximum acceptable error of 5%. With this information the next step is to select the statistical sample to be qualified.

It is critical to remember that the basic population of the quality control are the coca crops of each nucleus. Identification of the sample size is made by applying the following formula:

$$n = \frac{Npq}{(N-1)\,D + pq}$$

Where:

$$D = \frac{B^2}{4}$$

N: indicates the size of the population from where the sample will be taken
p: Probability that the estimator is in the experiment zone of acceptance
q: (l-p)
B: Limit for the estimation error
In this case the parameters taken into account were:
p = 0.05
B = 0.05

The statistical model described allows assessment of the success rate for polygons interpreted as illicit crop. However, it is necessary to consider whether some polygon was not interpreted as an illicit crop when in reality it was; for this reason, 50% of the sample was established directly over the control tools and not over the image interpreted, seeking the polygons that were coca but had not been interpreted as such. The remaining 50% was established in the opposite way, that is, selecting the polygons interpreted as coca on the satellite images and verifying if the interpretation was consistent with reality; in this way polygons interpreted as coca when in fact they are not can be identified.

**2.6.2 QUALIFICATION OF THE STATISTICAL SAMPLE**

Qualification as an error or a success of a given polygon represents a particular degree of difficulty due to the dynamics of the crop. Indeed during the course of time between taking the image and the assessment by quality control, it is very likely that new coca crops have ben established and that these have developed enough to reach considerable heights in just four months. Conversely, the "disappearance" or "abandonment" of coca crops, except when there is fumigation, is highly unlikely.

Assessment of the quality of interpretation should consider this aspect. The issue of temporality inherent in the process is partially solved by establishing a decision matrix, which serves as a guide, to qualify as a mistake or a success a specific polygon within the sample.

For quality control three tools were used:
Aerial photographs of detailed scales (greater than 1:11000)
High-resolution images (multispectral high-resolution photos and IKONOS images)
Field visits

These tools enable the extreme accuracy of identification and spatialization of coca crops, which are considered viable tools for quality control. As an additional tool, SATLOC records for the eradication program by aerial spraying are used; if a plot identified as coca is covered by fumigation lines after the date of the image, it is seen as proof that the plot was interpreted correctly. Thus spraying ensures that a plot of the sample which appears covered with spray lines after the date of the image is actually coca. However, it cannot be assured that a plot interpreted as coca but not covered by lines of fumigation, is not so, since spraying does not have 100% reliability and it does not cover 100% of the plots. This means that the plots not covered by lines of fumigation must be verified with some of the control tools.

**Aerial photographs:**
There are 38 rolls, with an average of 263 pictures each, which cover four nuclei in the sites with the highest concentration of illicit crops. The photographs show detailed scales and enough overlapping to ensure easy identification of details and geographical accidents. The following table summarizes the general characteristics of aerial photographs available.

**Table 2 Aerial photographs available per nucleus**

| NUCLEUS | Total rolls |
|---|---|
| Putumayo Caquetá | 11 |
| Guaviare - Meta-Vichada | 8 |
| Gabarra | 2 |
| South Bolivar | 17 |

**High-resolution images:**

There is a mosaic of high-resolution multispectral images, which covers approximately the southwest of the Putumayo nucleus. The images were taken in 1999. These images have a spectral resolution of 3 bands and a spatial resolution of 4 meters, allowing the identification of coca accurately.

Likewise there is an IKONOS image with a 4 m spatial resolution and a 4-band spectral resolution. This image covers an area of the center of the nucleus Putumayo - Caqueta.

**Field visits:**

The points not covered by any of the tools above should be verified directly in the field. For this the coordinates of the polygons are established to be verified and the lines of flight are traced so the plane does not pass directly over the point as this would impede visibility and enough time for an objective qualification. Likewise, the points near rivers and roads, easily identifiable on the ground must be preferred for field verification. Field visits should be limited to the points that are definitely not possible to qualify with the tools available.

### 2.6.3 ESTIMATION OF RESULTS

To determine the reliability of the figure in each of the selected nucleus, the percentage of correct answers over all the polygons of the statistical sample assessed should be identified.

Two main results are established: first, the reliability regarding the number of existing coca polygons, that is, how many of each of the 100 existing polygons were interpreted accurately. Secondly, the reliability regarding the area, considering the area ranges of the polygons interpreted, that is, out of every 100 hectares, how many were interpreted accurately.

To estimate the area correctly, the ratio of the successful areas of polygons compared to the sum of the areas of the polygons selected in the sample of each nucleus was considered.

Finally, the results from each nucleus are weighted and applied to the national total for the reliability of the national figure.

## 3 FINAL RESULTS

The project has enabled the creation of a geographic framework where illicit crops have been developing in Colombia. This framework consists of 8 nuclei which group domestic production of coca leaf. The images used for the evaluation of the mentioned nuclei are listed on the *GEOGRAPHIC COVERAGE OF SATELLITE IMAGES OF THE YEAR 2000* map.

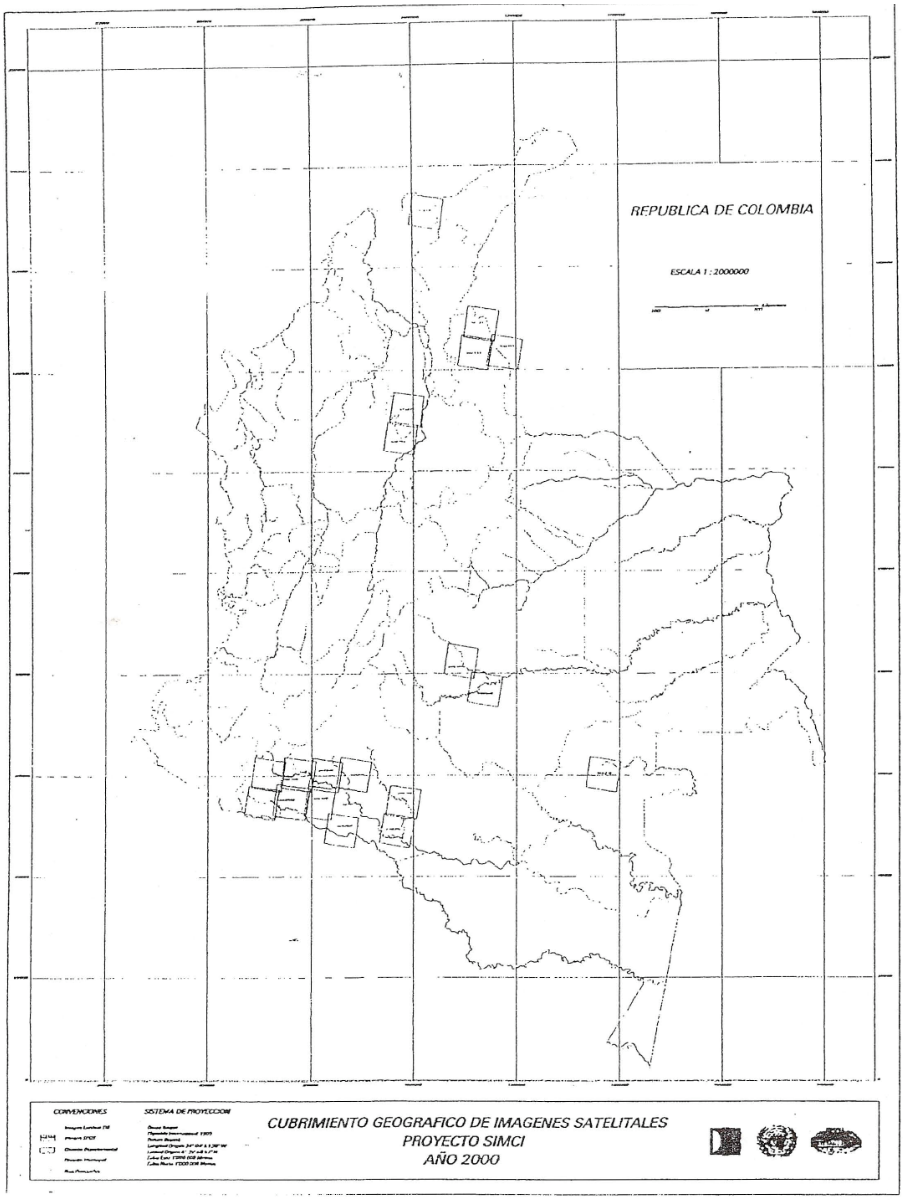
The geographic framework was defined initially with the areas identified by DIRAN as illicit crop areas in the visual census of March 1999. These areas were clustered in nuclei. The 1999 census results are shown in Table *FINAL RESULTS BY NUCLEUS - AREAS COVERED WITH COCA CROPS IN 1999.*

It is important to note that in the 1999 figure, the area corresponding to the demilitarized zone for peace talks was excluded from the nuclei of Putumayo-Caqueta and Meta-Guaviare-Vaupés. The 2000 figure, however, includes the demilitarized zone in the respective nuclei.

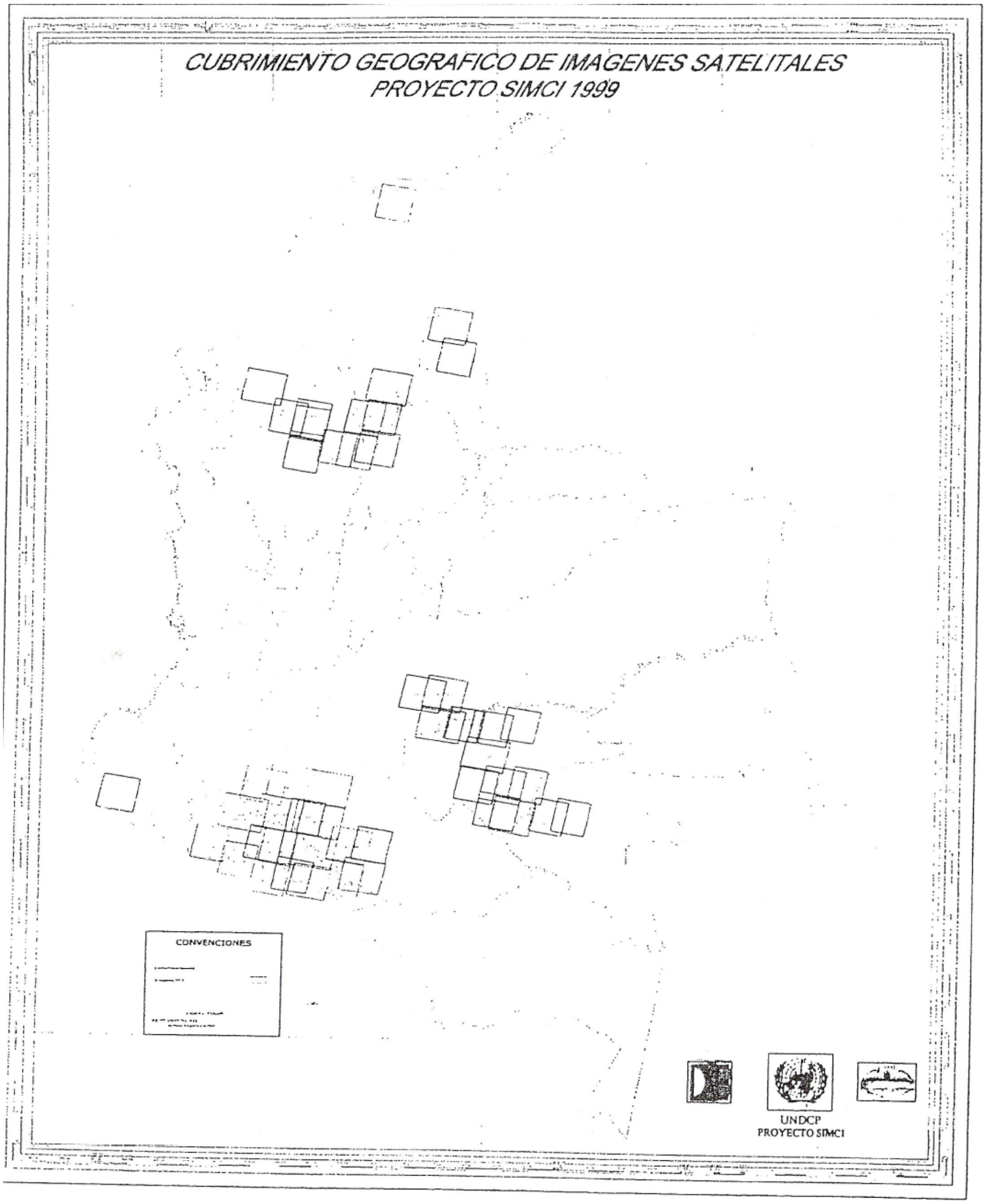
The interpreted illicit crops are clustered in clearly differentiated nuclei, as presented in the map of *LOCATION OF AREAS WITH COCA CROPS YEAR 2000*. The spatialization of these areas is an essential tool that serves as a starting point to address the drug problem in Colombia.

Importantly, the annual development of the illicit crop censuses allows identifying the dynamics of their growth; in this way there are valid criteria to direct efforts and assess the results of the different strategies of eradication and control. The *LOCATION OF AREAS OF COCA CROPS YEAR 1999* map shows the location of illicit crops in the corresponding year. Contrasting this information, the permanence of the nuclei identified can be observed.

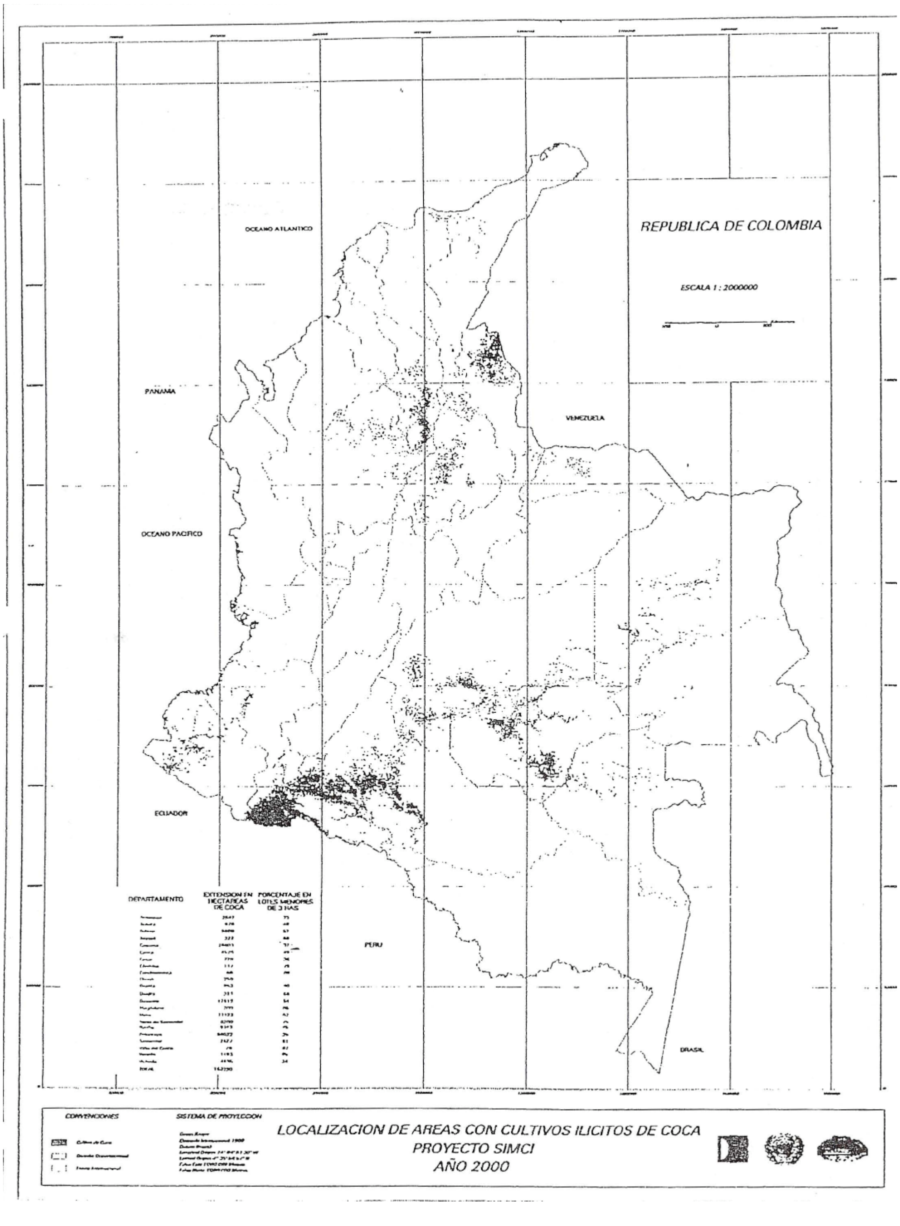
GEOGRAPHIC COVERAGE OF SATELLITE IMAGES
SIMCI PROJECT
YEAR 2000



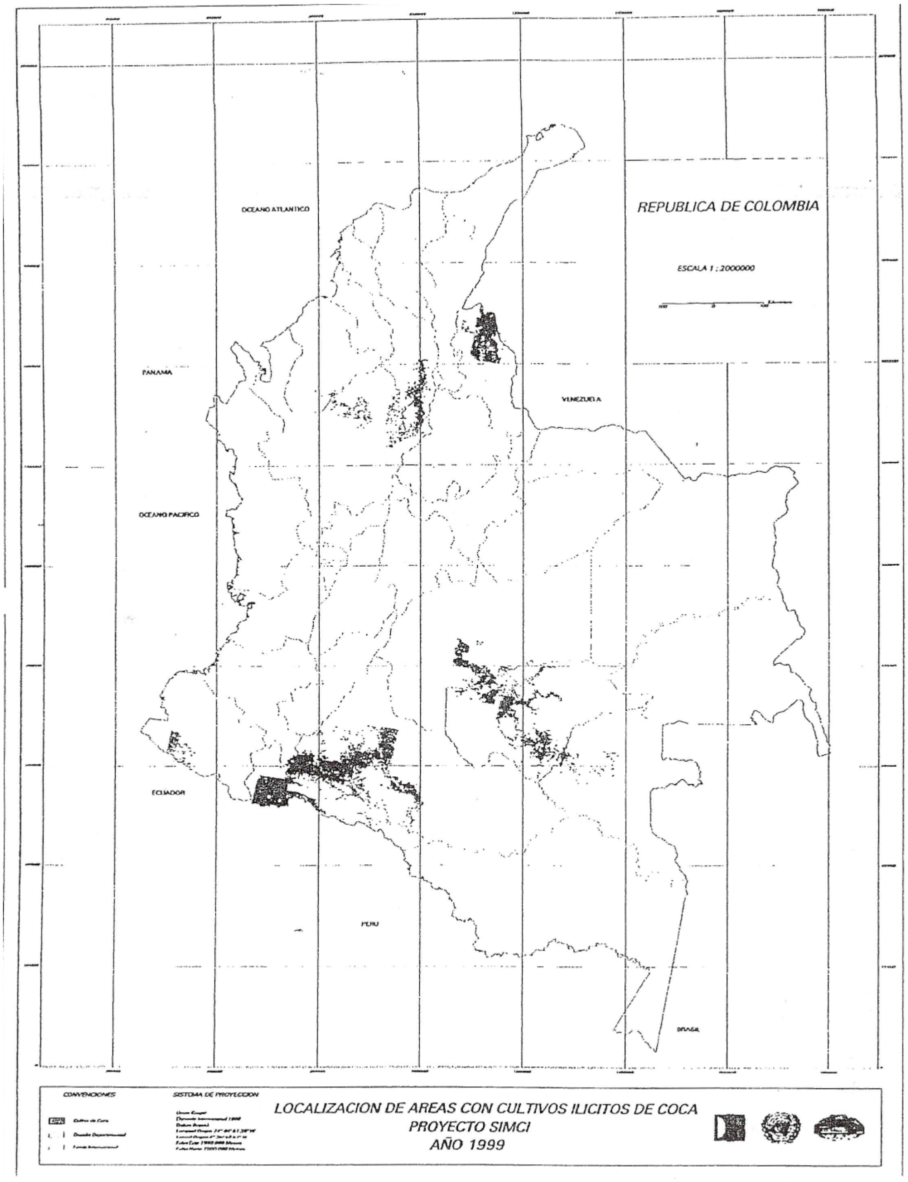
GEOGRAPHIC COVERAGE OF SATELLITE IMAGES
SIMCI PROJECT
YEAR 1999



LOCATION OF AREAS WITH ILLICIT COCA CROPS
SIMCI PROJECT
YEAR 2000



LOCATION OF AREAS WITH ILLICIT COCA CROPS
SIMCI PROJECT
YEAR 1999



FINAL RESULTS BY NUCLEUS
AREAS WITH COCA CROPS IN AUGUST 2000

| Nucleus | Total nucleus in ha (adjusted) | % National | Total nucleus in ha (interpreted) | Coca area in plots smaller than 3 ha | % Nucleus | Coca area in plots larger than 3 ha | % Nucleus | Number of municipalities affected |
|---|---|---|---|---|---|---|---|---|
| Putumayo Caquetá | 96,694 | 59.2 | 88,712 | 31,538 | 35.6 | 57,174 | 64.4 | 27 |
| Meta Guaviare Vaupés | 34,878 | 21.4 | 34,945 | 18,086 | 51.8 | 16,859 | 48.2 | 24 |
| South Bolívar Antioquia Córdoba | 11,959 | 7.3 | 11,883 | 6,894 | 58.0 | 4,989 | 42.0 | 49 |
| Cauca Nariño | 10,906 | 6.7 | 7,545 | 3,646 | 33.5 | 3,899 | 66.5 | 21 |
| La Gabarra | 6,103 | 3.7 | 6,103 | 4,631 | 75.9 | 1,472 | 24.1 | 15 |
| Arauca | 1,234 | 0.8 | 1,234 | 598 | 48.4 | 636 | 51.6 | 5 |
| Boyacá Santander | 743 | 0.4 | 743 | 486 | 65.4 | 257 | 34.6 | 31 |
| Sierra Nevada de Santa Marta | 522 | 0.3 | 522 | 389 | 74.5 | 133 | 25.5 | 5 |
| Chocó | 250 | 0.2 | --- | -- | -- | -- | -- | 2 |
| TOTALES | 163,289 | 100 | 151,687 | 66,268 | 43.7 | 85,419 | 56.3 | 183 |

NOTES:

1. Adjustments to interpretation

| | | |
|---|---|---|
| For cloudiness | 10,254 ha |
| For seniority | 2054 ha |
| For fumigation | 956 ha |
| Aerial census Chocó | 250 ha |
| TOTAL | 11,602 ha |

2. The adjustments did not take into account the number of plots and their percentages

FINAL RESULTS BY NUCLEUS
AREAS WITH COCA CROPS IN AUGUST 2000

| Nucleus | Total nucleus | % National | Number of plots smaller than 3 ha | % Nucleus | Number of plots larger than 3 ha | % Nucleus | Number of municipalities affected |
|---|---|---|---|---|---|---|---|
| Putumayo Caquetá | 33,658 | 46.0 | 26,501 | 78.7 | 7,157 | 21.2 | 27 |
| Meta Guaviare Vaupés | 20,024 | 27.3 | 17,205 | 85.9 | 2,819 | 14.4 | 24 |
| South Bolívar Antioquia Córdoba | 7,090 | 9.7 | 6,163 | 86.0 | 927 | 13.4 | 49 |
| Cauca Nariño | 5,714 | 7.8 | 5,122 | 89.6 | 592 | 10.4 | 21 |
| La Gabarra | 5,261 | 7.2 | 4,952 | 94.1 | 309 | 5.9 | 15 |
| Arauca | 512 | 0.7 | 375 | 73.2 | 137 | 26.8 | 5 |
| Boyacá Santander | 467 | 0.6 | 415 | 88.9 | 52 | 11.1 | 31 |
| Sierra Nevada de Santa Marta | 482 | 0.7 | 452 | 93.8 | 30 | 6.2 | 5 |
| Chocó | -- | -- | -- | -- | -- | -- | 2 |
| TOTALES | 73,208 | 100 | 61,185 | 83.6 | 12,023 | 16.4 | 183 |

NOTE: The adjustments do not take into account in the number of plots

FINAL RESULTS BY NUCLEUS
AREAS WITH COCA CROPS IN MARCH 1999

| Nucleus | Total nucleus | % National | Number of plots smaller than 3 ha | % Nucleus | Number of plots larger than 3 ha | % Nucleus | Number of municipalities affected |
|---|---|---|---|---|---|---|---|
| Putumayo Caquetá | 47,865 | 57 | 41,324 | 86 | 6,541 | 14 | 25 |
| Meta Guaviare Vaupés | 12,297 | 16 | 9,515 | 77 | 2,782 | 23 | 10 |
| South Bolívar Antioquia Córdoba | 4,411 | 5 | 3,209 | 73 | 1,202 | 27 | 26 |
| Cauca Nariño | 8,801 | 13 | 8,361 | 95 | 440 | 5 | 15 |
| La Gabarra | 7,240 | 9 | 6,103 | 84 | 1,137 | 16 | 10 |
| Arauca | -- | -- | -- | -- | -- | -- | -- |
| Boyacá Santander | -- | -- | -- | -- | -- | -- | -- |
| Sierra Nevada de Santa Marta | 291 | -- | 243 | 84 | 48 | 16 | 4 |
| Chocó | -- | -- | -- | -- | -- | -- | -- |
| TOTALES | 80,905 | 100 | 68,755 | 85 | 12,150 | 15 | 90 |

The project has developed a methodology for estimating the reliability of the reported figure, which yielded reliability approaching 85% for the 1999 figure and above 90% for 2000

**3.1 GIS APPLICATIONS**

The Geographic Information System provides a consistent storage of spatial information that can be updated or manipulated. This way, it is possible to access mapping models, from the transformation or combination of different variables: signal buffers within a certain distance from rivers, roads, schools, city centers; make tables of matches between maps, calculate slopes, analyze two or more layers of information etc. Also, the GIS allows being used as simulation models for studying the environmental processes or analysis of impacts of decisions in planning,

The Geographic Information System provides valuable information for different applications from different disciplinary fields; the first results that can be obtained with the interpretation of satellite images are the statistics by image, which give information on coverage area of the different kinds interpreted. (See Figure 37)

The second results obtained from the structure of the GIS is the identification of each plot and different coverage, with their corresponding attributes. These are based on the needs of the project and its users and once structured in the GIS they can be spatialized and represented in mapping products and become input for studies, analysis, and multiplying trends. This way, information can be obtained, for example, from the number of plots that are in a certain municipality as well as their specific location, one by one. (See Figure 38)

Among the advantages of having a GIS is to have the information quickly and updated of the area or point of interest since the system provides simultaneously all its attached information and that has previously been uploaded to the database. (See Figure 39) The reference figure provides information on said plot regarding their Gauss plane coordinates, identifier, coverage area, whether or not it has been fumigated and the category to which it corresponds according to ranges established by the DNE.

**FIGURE 37 STATISTICAL PRODUCTS OF AN IMAGE – BASIC GIS INPUT**

FIGURA 37 PRODUCTOS ESTADISTICOS DE UNA IMAGEN INSUMOS BASICOS DEL SIG

fin2001o: Histogram of fin2001o

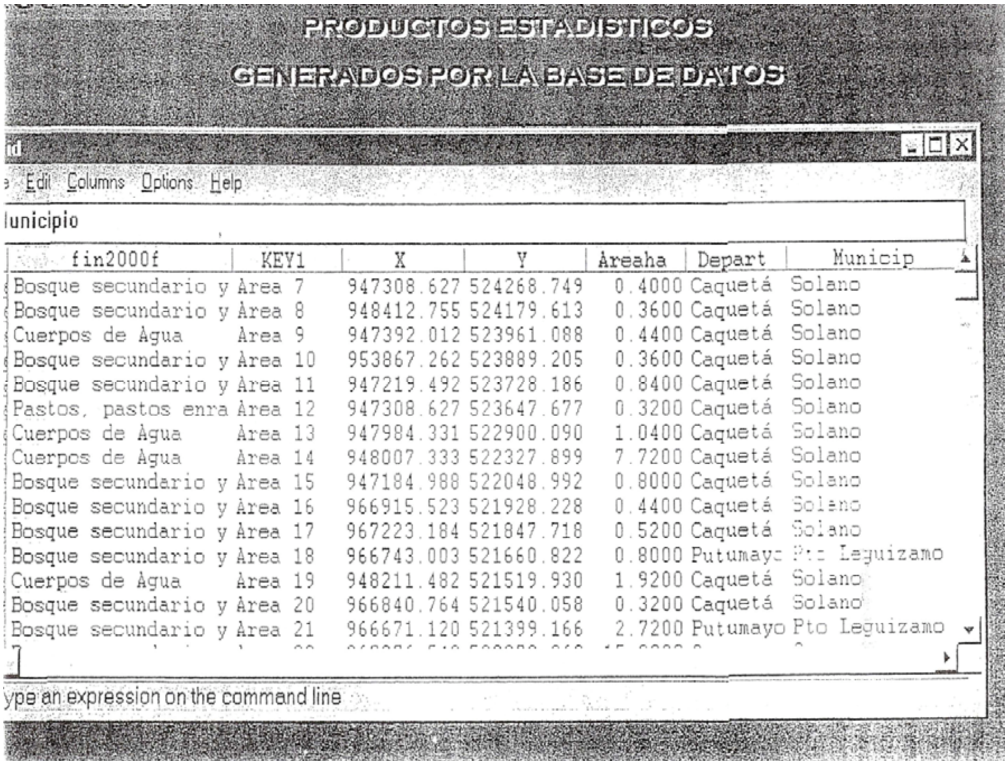
File Edit Columns Options Help

AREA DE COBERTURAS EN METROS CUADRADOS

| | npixpct | pctnotund | Area |
|---|---|---|---|
| Coca en todos sus estados | 1.14 | 1.55 | 58606400 |
| Bosque primario | 65.62 | 89.19 | 3364435200 |
| Bosque secundario y rastrojo alto | 2.92 | 3.96 | 149564000 |
| Pastos, pastos enrastrojados y rastroj | 0.58 | 0.79 | 29918400 |
| Cuerpos de Agua | 0.99 | 1.35 | 50762800 |
| Banco de Arena | 0.07 | 0.09 | 3388800 |
| Otros cultivos | 0.00 | 0.00 | 0 |
| Nubes y sombras | 1.79 | 2.43 | 91757200 |
| Vias | 0.00 | 0.00 | 46400 |
| Zona urbana | 0.00 | 0.00 | 73200 |
| Zonas de inundacion | 0.46 | 0.63 | 23591200 |
| Afloramientos rocosos | 0.00 | 0.00 | 0 |
| Otros | 0.00 | 0.00 | 0 |
| Bosque secundario fumigado | 0.00 | 0.00 | 0 |
| Coca fumigada | 0.00 | 0.00 | 0 |
| Pastos fumigados | 0.00 | 0.00 | 0 |
| Suelo desnudo | 0.00 | 0.00 | 0 |
| Suelo desnudo fumigado | 0.00 | 0.00 | 0 |

Press F1 for Help

**FIGURE 38 STATISTICAL PRODUCTS GENERATED BY THE DATABASE**



PRODUCTOS ESTADISTICOS

GENERADOS POR LA BASE DE DATOS

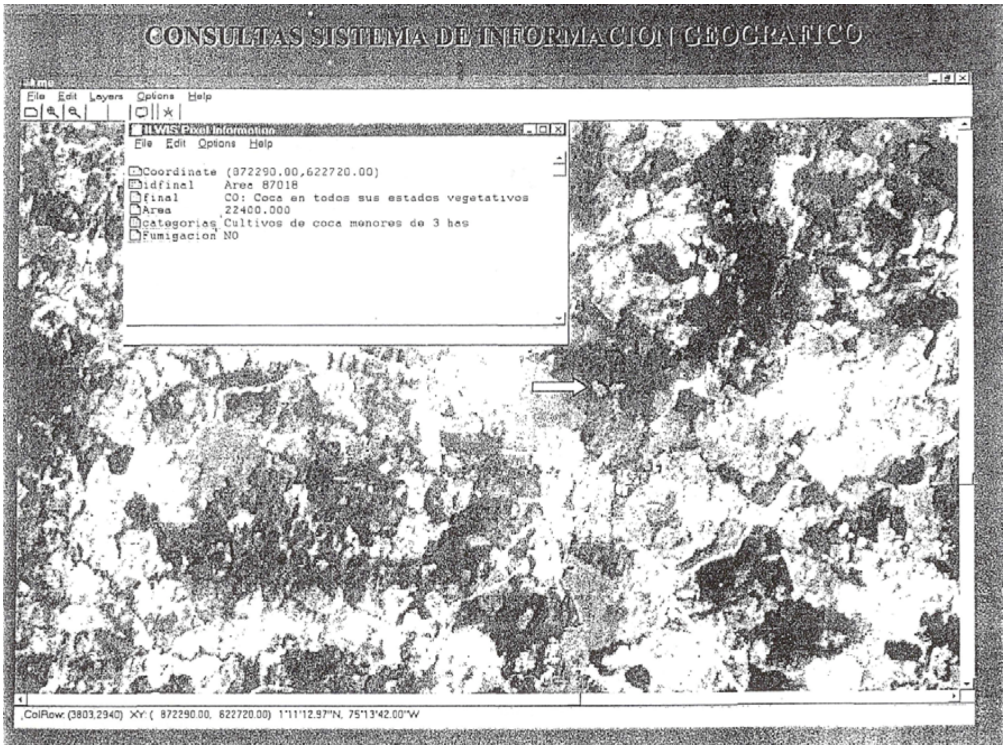
e Edit Columns Options Help

lunicipio

| fin2000f | KEY1 | X | Y | Areaha | Depart | Municip |
|---|---|---|---|---|---|---|
| Bosque secundario y | Area 7 | 947308.627 | 524268.749 | 0.4000 | Caquetá | Solano |
| Bosque secundario y | Area 8 | 948412.755 | 524179.613 | 0.3600 | Caquetá | Solano |
| Cuerpos de Agua | Area 9 | 947392.012 | 523961.088 | 0.4400 | Caquetá | Solano |
| Bosque secundario y | Area 10 | 953867.262 | 523889.205 | 0.3600 | Caquetá | Solano |
| Bosque secundario y | Area 11 | 947219.492 | 523728.186 | 0.8400 | Caquetá | Solano |
| Pastos, pastos enra | Area 12 | 947308.627 | 523647.677 | 0.3200 | Caquetá | Solano |
| Cuerpos de Agua | Area 13 | 947984.331 | 522900.090 | 1.0400 | Caquetá | Solano |
| Cuerpos de Agua | Area 14 | 948007.333 | 522327.899 | 7.7200 | Caquetá | Solano |
| Bosque secundario y | Area 15 | 947184.988 | 522048.992 | 0.8000 | Caquetá | Solano |
| Bosque secundario y | Area 16 | 966915.523 | 521928.228 | 0.4400 | Caquetá | Solano |
| Bosque secundario y | Area 17 | 967223.184 | 521847.718 | 0.5200 | Caquetá | Solano |
| Bosque secundario y | Area 18 | 966743.003 | 521660.822 | 0.8000 | Putumayo | Pto Leguizamo |
| Cuerpos de Agua | Area 19 | 948211.482 | 521519.930 | 1.9200 | Caquetá | Solano |
| Bosque secundario y | Area 20 | 966840.764 | 521540.058 | 0.3200 | Caquetá | Solano |
| Bosque secundario y | Area 21 | 966671.120 | 521399.166 | 2.7200 | Putumayo | Pto Leguizamo |

ype an expression on the command line

**FIGURE 39 GIS QUERY**



Likewise, socio-economic information can be added. This is just one example of the versatility and importance of information generated and the supplementary characteristic of the areas where illicit crops are developed and that may allow rapid access and reliable information base for management and decision-making.

### 3.1.1 CATEGORIZATION

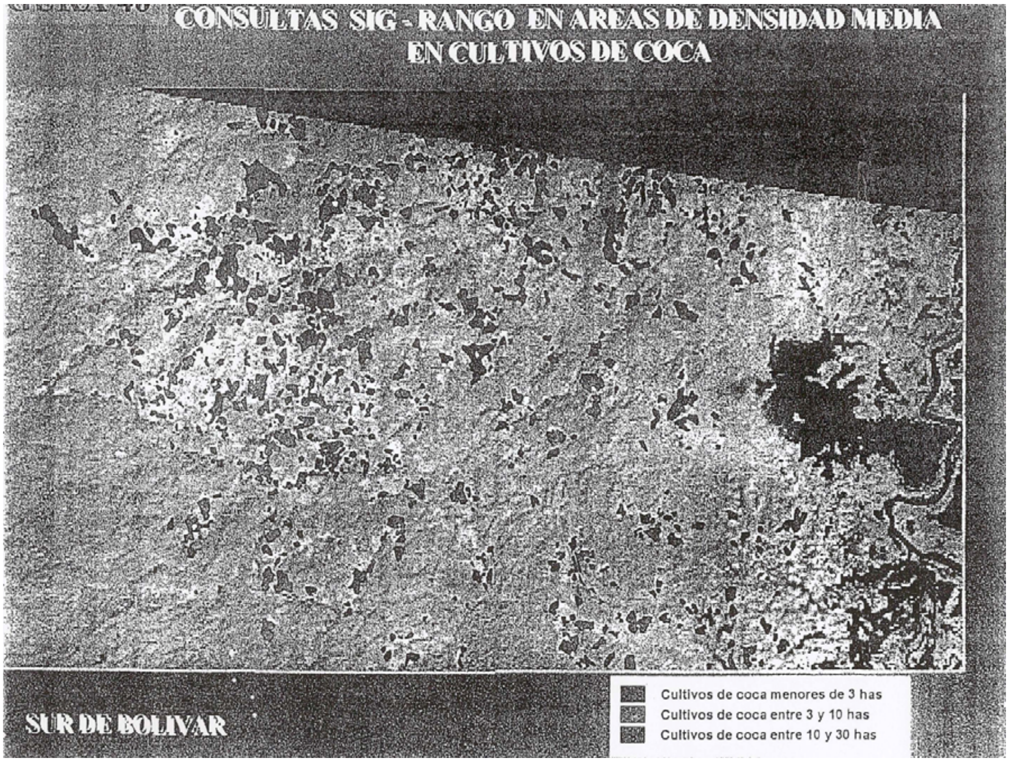
Figures 40 and 41 show another application of the GIS, with information of illicit crops, referring to the categorization of coca cultivation by areas in accordance with the parameters established by the DNE, where clearly differentiated are the coca plots below 3 or 2 hectares, those that are in the 3-10 hectare range and so on for all ranges. This theme map is derived from information provided by the attributes for each plot in the database; this information, coupled with socioeconomic information, allows among other things, analyzing the environment and estimating the behavior of the areas.

### 3.1.2 NEIGHBORHOOD ANALYSIS (BUFFERS)

Figure 42 shows a section of the Guamuez River, which was selected as the axis, starting from which buffers and corridors were generated at specific distances, using the neighborhood and connectivity features characteristic of GIS and the elements that comprise it. This information is very important because under existing rules regarding the eradication of illicit crops, they must meet certain parameters, including special handling to those plots that are at distances less than 100 meters from bodies of water. Therefore and complementing with the categorization of crops, the location of plots that meet the parameters required for eradication and alternative treatment in any form can be pinpointed. (See Figures 43 and 44)

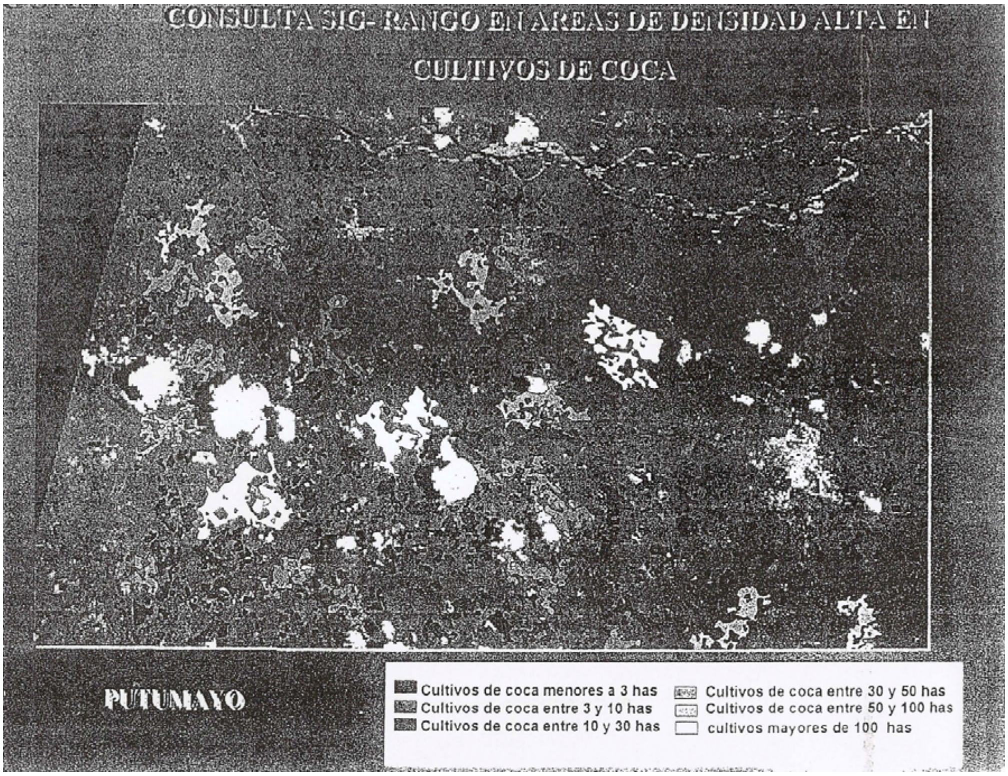
This analysis of the information also provides vital statistics for the knowledge of the area where, among many other things, the number of plots and the corresponding area that meets specific parameters can be specified (See Figure 45) including the list, if it applies, of each one of the plots required by the query, with the corresponding identifier and assigned attributes (History).

**FIGURE 40 GIS QUERY – RANGE OF MEDIUM DENSITY AREAS IN COCA CROPS**




Coca crops smaller than 3 ha
Coca crops between 3-10 ha
Coca crops between 10-30 ha

**FIGURE 41 GIS QUERY – RANGE OF HIGH DENSITY AREAS IN COCA CROPS**




| | |
|---|---|
| Coca crops smaller than 3 ha | Coca crops between 30-50 ha |
| Coca crops between 3-10 ha | Coca crops between 50-100 ha |
| Coca crops between 10-30 ha | Coca crops larger than 100 ha |

**FIGURE 42 BUFFER TO VARYING DISTANCES OF GUAMUEZ RIVER – NEIGHBORHOOD SURVEY**

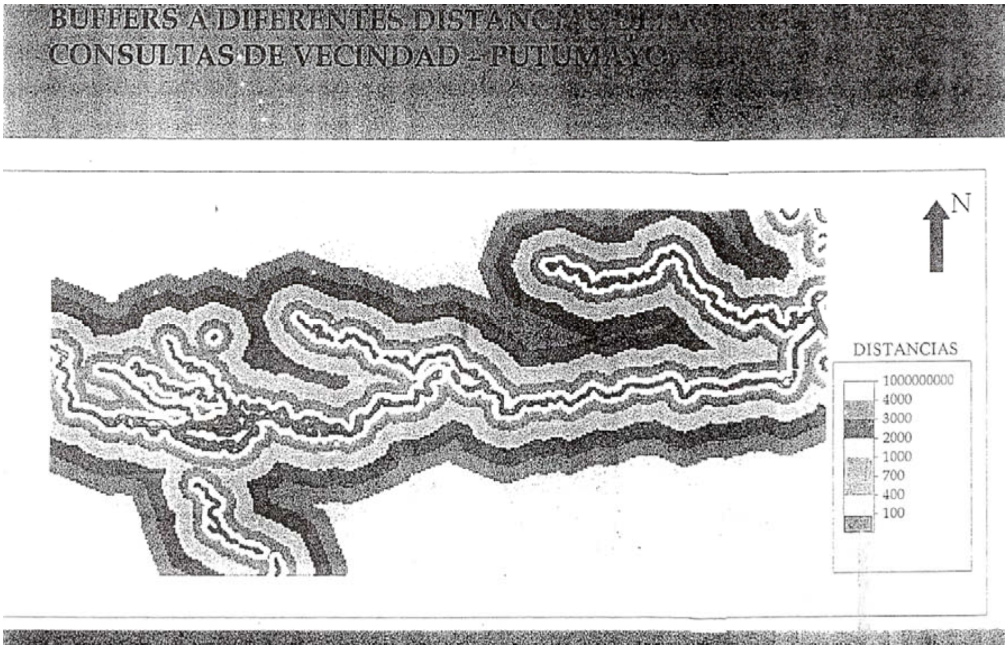
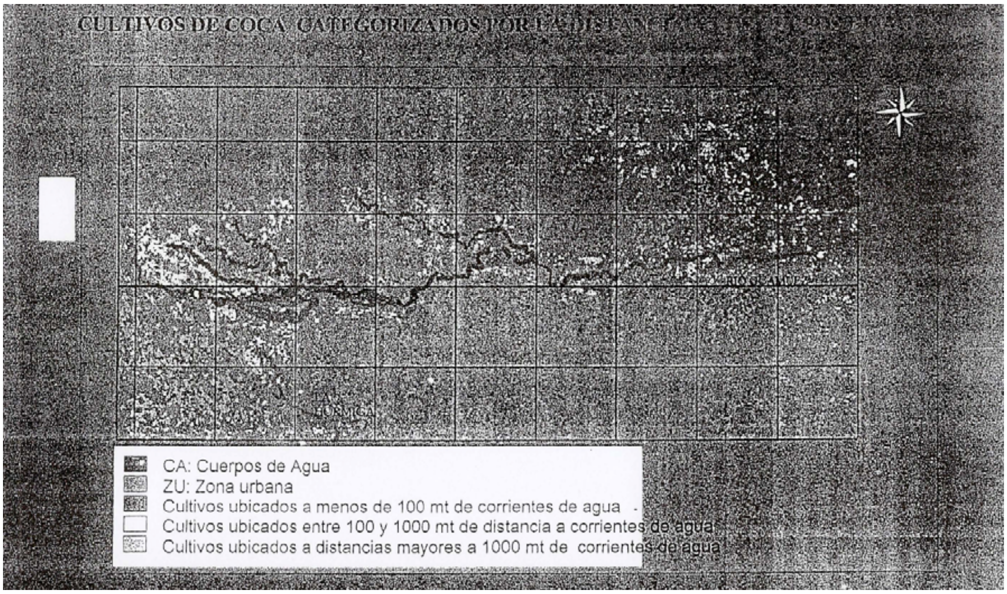
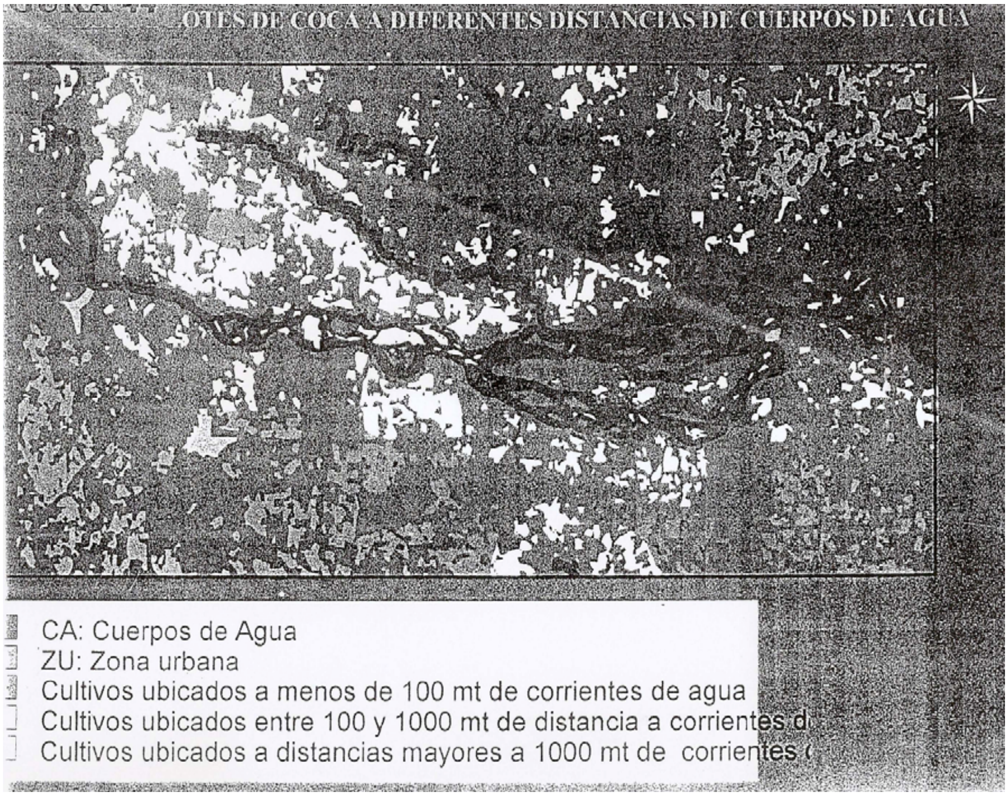


**FIGURE 43 COCA CROPS CATEGORIZED BY DISTANCE TO WATER BODIES**




CA: Bodies of water
ZU: City area
Crops located less than 100 m from water sources
Crops located between 100 m and 1,000 m from water sources
Crops located at distances greater than 1,000 m from water sources

**FIGURE 44 COCA PLOTS AT VARIABLE DISTANCES FROM WATER BODIES**




CA: Bodies of water
ZU: City area
Crops located less than 100 m from water sources
Crops located between 100 m and 1,000 m from water sources
Crops located at distances greater than 1,000 m from water sources

**FIGURE 45 STATISTICS BY BUFFER STUDIED – GUAMUEZ RIVER – PUTUMAYO NUCLEUS**

RIO GUAMUEZ- NUCLEO PUTUMAYO

| ATEGORIAS | # LOTES | PERIMETRO | AREA |
|---|---|---|---|
| ultivos ubicados a menos de 100 mt de corrientes de agua | 446 | 187894.10 | 4164798.32 |
| ultivos ubicados entre 100 y 1000 mt de distancia a corrientes de agua | 1459 | 1113662.04 | 37943906.5 |
| ultivos ubicados a distancias mayores a 1000 mt de corrientes de agua | 3823 | 3256062.58 | 110057438. |

| Categories | No. Plots | Perimeter | Area |
|---|---|---|---|
| Crops located less than 100 m from water sources | | | |
| Crops located between 100 m and 1,000 m from water sources | | | |
| Crops located at distances greater than 1,000 m from water sources | | | |

### 3.1.3 PLANTE PROJECTS

At the moment a Pilot project for the municipality of Puerto Asis is being developed, with the aim to design and implement a georeferenced base oriented to geographically integrate the information currently owned by Plante with additional information but vital for the efficiency of the management in areas with problems with illicit crops. This additional information mainly originates in the SIMCI Project results related to the generation of coverage maps and land use, as well as and basic mapping information.

Specific project objectives are:

- Delineation of areas of eradication agreements signed (see Figure 46)
- Generation of geographic information consisting of attributes of the agreements and projects (See Figure 47)
- Delineation of buffer areas for productive projects (Figures 48 and 49)
- Delineation of plots of illicit crops under 3 or 2 hectares
- Generation of a map of land conflict
- Monitoring the use of areas of agreements and projects with the frequency supports by the SIMCI Project
- Determination of potential areas for alternative development and its possible uses

The project will be extended to other municipalities where PLANTE develops its activities since it will provide important information for actions carried out on project viability and its consequent monitoring and follow up of compliance with voluntary eradication agreements.

### 3.1.4 MULTI-TEMPORAL ANALYSIS

The frequency with which the Project generates information allows access to multi-temporal analysis, providing information about changes in land use, trends, not only in the aspect of quantification of hectares but its geographic component. Multi-temporal analyses constitute basic input for monitoring since it provides access to information on the area studied in certain historical periods with which a history of the area is created, or individual crops that allow analysis of trends and dynamics.

**FIGURE 46 VIEWING OF PLANTE - DEM PRODUCTIVE PROJECTS PUERTO ASIS MUNICIPALITY**

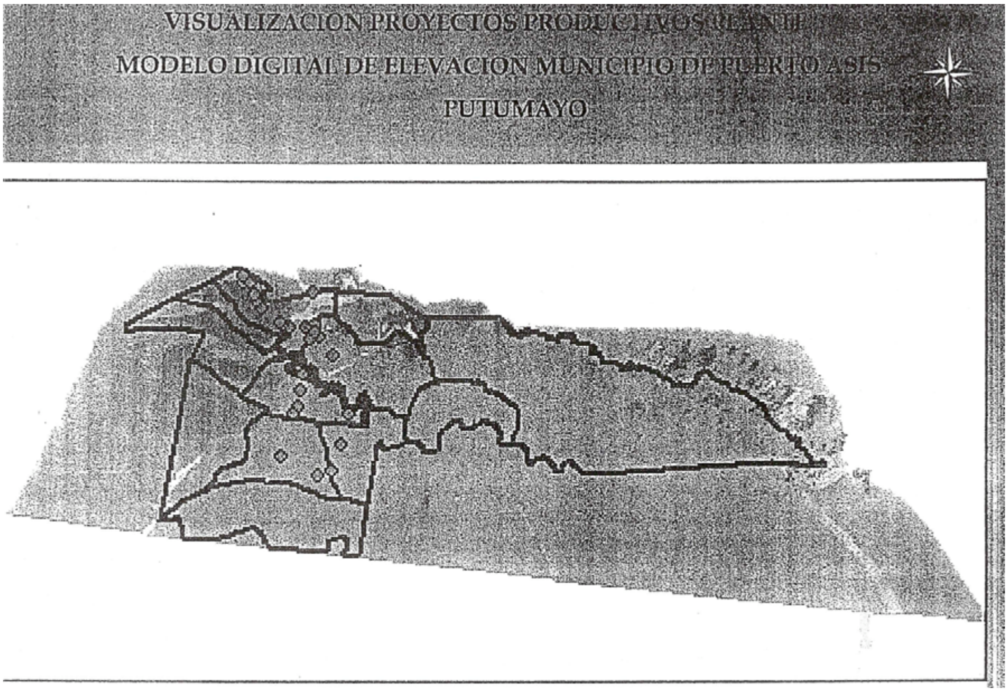


**FIGURE 47 PLANTE PROJECTS COORDINATES**

puntasis

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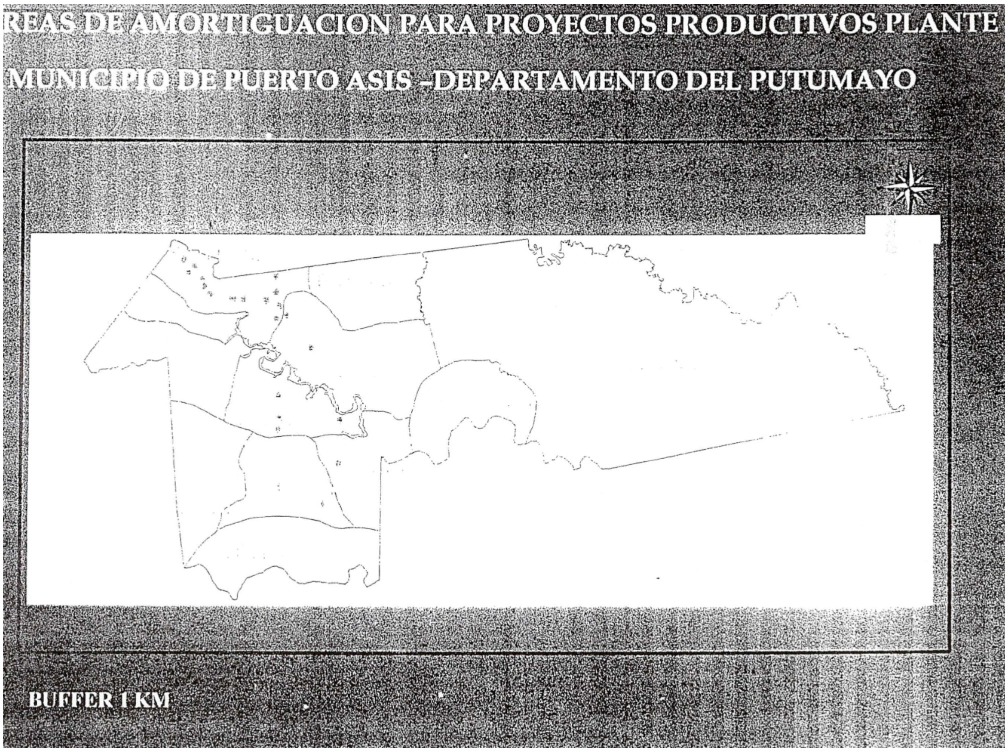
| | ID | X | Y | NAME |
|---|---|---|---|---|
| 77 | 77 | 1060116.008 | 553501.225 | Ganaderia |
| 78 | 78 | 1060339.287 | 546258.219 | Palmitos |
| 79 | 79 | 1060469.412 | 543180.404 | Ganaderia |
| 80 | 80 | 1060580.951 | 540342.178 | Proyecto Indigena |
| 81 | 81 | 1060451.193 | 538646.600 | Ganaderia |
| 83 | 83 | 1060600.109 | 531256.144 | Proyecto Indigena |
| 84 | 84 | 1066630.488 | 528879.017 | Proyecto Indigena |
| 85 | 85 | 1068226.111 | 530132.378 | Proyecto Indigena |
| 86 | 86 | 1068671.137 | 534279.232 | Proyecto Indigena |
| 87 | 87 | 1068874.794 | 539992.651 | Ganaderia |
| 89 | 89 | 1064810.538 | 549668.189 | Piscicola |
| 90 | 90 | 1061526.066 | 553943.679 | Area de Pactos |
| 91 | 91 | 1060542.582 | 555270.554 | Ganaderia |
| 92 | 92 | 1058705.683 | 555989.153 | Ganaderia |
| 93 | 93 | 1055699.961 | 556099.458 | Proyecto Indigena |
| 94 | 94 | 1054475.408 | 556191.500 | Piscicola |
| 95 | 95 | 1054085.779 | 556209.896 | Ganaderia |
| 96 | 96 | 1051284.132 | 556762.555 | Proyecto Indigena |
| 97 | 97 | 1050486.248 | 557720.842 | Ganaderia |
| 98 | 98 | 1050133.647 | 558734.454 | Palmitos |
| 99 | 99 | 1048278.226 | 559618.932 | Piscicola |
| 100 | 100 | 1049075.960 | 560393.050 | Palmitos |
| 101 | 101 | 1047610.160 | 561369.708 | Palmitos |

**FIGURE 48 LOCATION PLANTE AGREEMENTS FOR VOLUNTARY ERADICATION**


City center
2 km area on both sides of the road
Agreement areas
Area of projects developing with damping area
Indigenous group processes to be strengthened or implemented

**FIGURE 49 DAMPING AREA FOR PLANTE PRODUCTIVE PROJECTS**



### 3.1.5 CHARACTERIZATION

One of the important contributions of the SIMCI project for handling the problem of illicit crops in the country is the characterizing of the environment in which they develop. Indeed, the identification of specific sectors of illicit crops and surrounding forms of coverage are an essential input to identify the social, economic and environmental dynamics of the areas with illicit crops. Issues such as land coverage, use, successional dynamics of forested areas, etc., are developed as sub products of great importance to land planning.

The tools available to the project also allow integration of the information produced by different entities at the national level (see Figure 50), with information produced by the project and this way additional information can be procured on areas of interest. Among many possible aspects the following is worth noting:

Ecosystems that are being affected by the development of illicit crops (See Figures 51 and 52)
Environmental offer of the areas where illicit crops are developing
Human settlements and population dynamics
Legitimate economic activities developed in an area with illicit crops
Alternative projects developed in the area
Areas with environmental or legal restrictions threatened by the presence of illicit crops

From this type of information, the surroundings of illicit crops can be environmentally characterized.

The information generated by the project is updated annually enabling the evaluation of the dynamics of each region through vital multi temporal analysis.

It is important to note that the proper characteristics of the activity have made it develop in marginal areas with modest development, where very poor levels of information were the norm.

**FIGURE 50 SUPPLEMENTARY INFORMATION TO ACHIEVE NEW THEME MAPS**

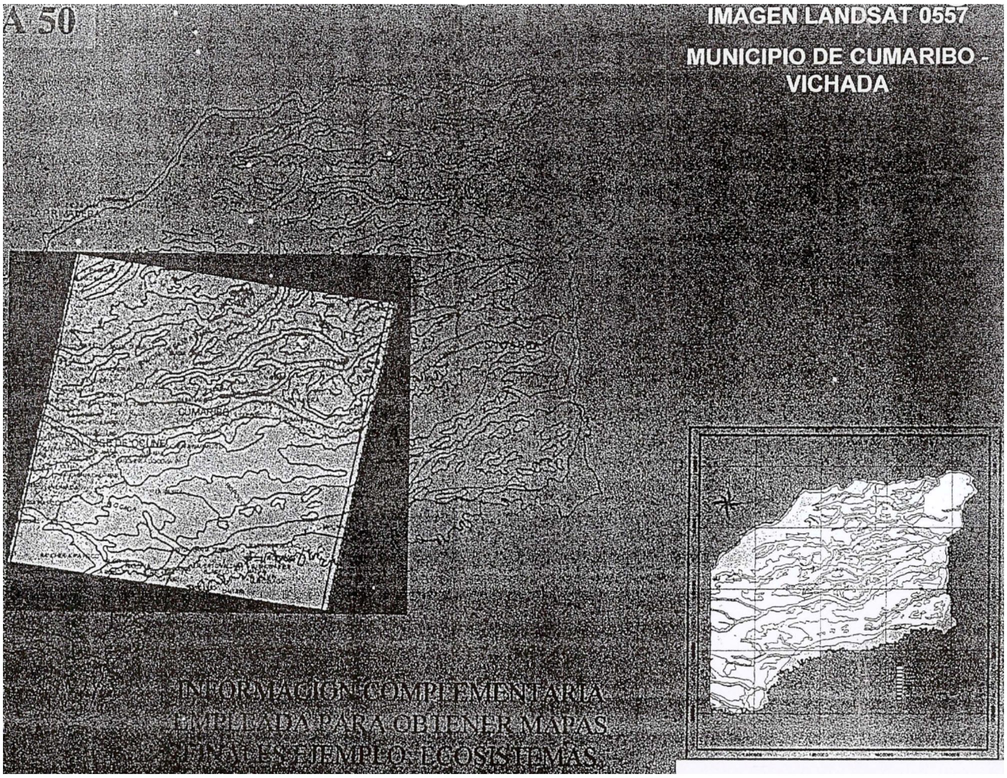
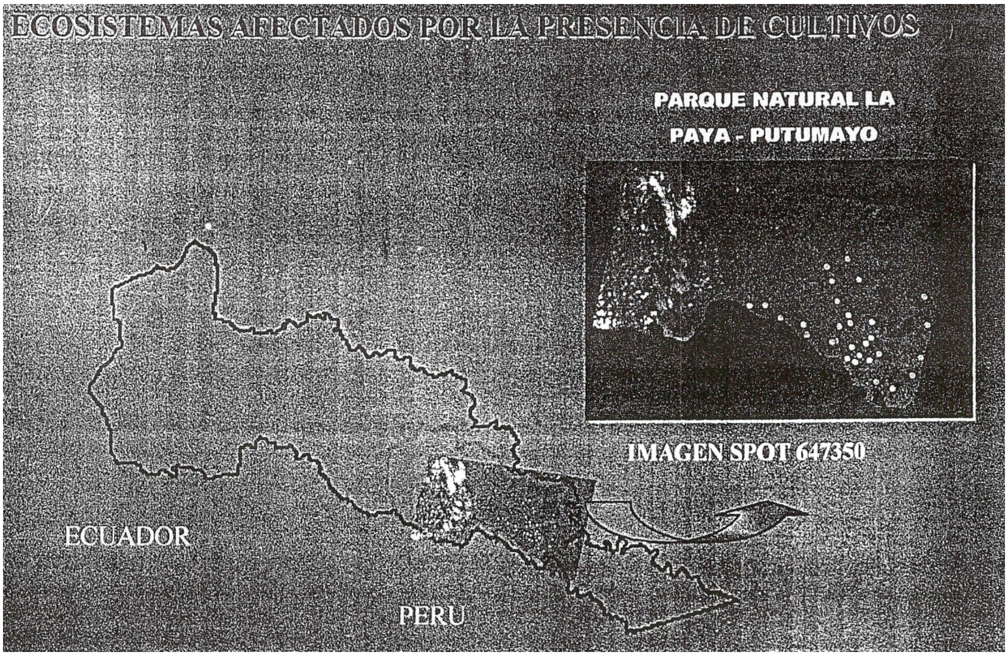


**FIGURE 51 ECOSYSTEMS AFFECTED BY ILLICIT CROPS**



## FIGURE 52 TABLE - ECOSYSTEMS AFFECTED BY ILLICIT CROPS

ECOSISTEMAS AFECTADOS POR LOS CULTIVOS ILICITOS

Microsoft Excel - Parques

CULTIVOS ILICITOS DE COCA EN EL AREA DE PARQUES NACIONALES NATURALES DE COLOMBIA
PROYECTO SIMCI - AGOSTO 31 2000

| UBICACION | NOMBRE DEL PARQUE | AREA PARQUE NATURAL (HAS) | AREA EN COCA (Has) | NUMERO DE LOTES |
|---|---|---|---|---|
| ANTIOQUIA | LAS ORQUIDEAS | 31260.55 | 3.2763 | 3 |
| ANTIOQUIA CORDOBA | PARAMILLO | 467861 | 29.1935 | 29 |
| ARAUCA-BOYACA-CASANARE | EL COCUY | 308614.8 | 45.9294 | 13 |
| VALLE-CAUCA | LOS FARALLONES DE CALI | 200363.8 | 21.2354 | 19 |
| NORTE DE SANTANDER | CATATUMBO-BARI | 164143.1 | 107.8068 | 127 |
| CAQUETA - GUAVIARE | CHIRIBIQUETE | 1319572 | 79.0131 | 10 |
| CAQUETA HUILA META | CORDILLERA DE LOS PICACHOS | 273873.7 | 64.8871 | 21 |
| GUAINIA | PUINAWAI | 1072873 | 84.1555 | 68 |
| META | TINIGUA | 224297.3 | 927.8568 | 466 |
| META-VAUPES | SIERRA DE LA MACARENA | 617665.3 | 1152.5396 | 1009 |
| VAUPES-GUAVIARE | NUKAK | 860161.4 | 743.237 | 498 |
| CESAR-GUAJIRA-MAGDALENA | SIERRA NEVADA DE SANTA MARTA | 413928.4 | 134.4216 | 140 |
| MAGDALENA | TAYRONA | 22987.15 | 0.9763 | 2 |
| PUTUMAYO | LA PAYA | 432958.8 | 1295.5968 | 515 |
| TOTAL | | 6410560.3 | 4690.1272 | 2920 |

The SIMCI project has provided for updating the information in these areas and improving the knowledge thereof, creating theme mapping at a semi-detailed level.

Obtaining this information allows learning about the environment in which illicit crops are developed and providing coherence in policies and strategies to combat this problem.

**3.1.6. INTERNATIONAL VISION OF THE PROJECT**

The problem of illicit crops brings the international community together, as seen in the past TECHNICAL COMMITTEE FOR ALTERNATIVE DEVELOPMENT OF THE ANDEAN COUNTRIES, where each of the participating countries presented the current situation in each country, showing the objectives achieved in accordance with the scope of the projects and programs in areas with problems of illicit crops. In this seminar Colombia was represented by the SIMCI Project, and it showed the Group its progress in the development and methodological implementation for the detection and monitoring of illicit crops and their environment, as well as the applicability of this information for the formulation and feasibility of alternative development plans. Thus, Colombia is a pioneer in Latin America in the formulation and development of a methodology in accordance with the requirements and characteristics of the region; the advancement in methodology and results shown by the project became an example to follow by the other countries, tailoring the methodology developed to their interests and characteristics. Representatives of the different countries requested at the panel the technical training and technology transfer from Colombia to their respective countries. This ended in the unanimous appointment of Colombia as Coordinator for the group in the development of a Regional Geographic Information System to strengthen Alternative Development.

# GLOSSARY

**SPECTRAL BAND**: This term refers to a selection of wavelengths with similar electromagnetic behavior.

**DATA BASE**: Collection of data that can receive, store and provide data to several parties

**DIGITAL CLASSIFICATION**: The process whereby a pixel or pixels in a finite amount of multispectral image is assigned to one of the categories of the legend, usually based on similarities between the numerical values that define it.

**COLOR COMPOSITIONS**: They are created by combining the spectral values of three individual bands. Each band is disassembled using one of the three primary colors.

**FALSE COLOR COMPOSITION**: Red is assigned to the infrared band; green goes to the band of visible red; and blue to the green visible band.

**COMPOSITION IN TRUE COLOR**: Red is assigned to the visible red band; green goes to the band of visible green; and blue to the blue visible band.

**LAND COORDINATES**: Set of conventional magnitudes established to determine the exact position of a point on the surface of the earth

**ELECTROMAGNETIC SPECTRUM**: It is the clustering of electromagnetic radiation in different bands, depending on the wavelength or frequency, which have a similar spectral behavior.

**VISIBLE SPECTRUM**: (0.4 to 0.7 μm) This is the only electromagnetic radiation that our eyes can perceive.

**LINEAR EXPANSION**: It is the simplest contrast enhancement. A low value of the digital level of the original histogram is assigned to black and a high value is assigned to white. Intermediate values are distributed linearly.

**HISTOGRAM EQUALIZATION**: A non-linear expansion. The digital levels are redistributed based on their frequency. Different shades of gray are assigned to digital levels that occur with greater frequency in the histogram.

**FILTER**: This is an enhancement operation, used to improve image display.

**BSQ FORMAT**: Type of storage of image data in sequential bands

**BIL FORMAT**: Form of storing image data in bands interleaved by line

**IMAGE FUSION**: The process of combining digital images. If the values of the data are modified, the result is a new set of data.

**HISTOGRAM**: The graphical representation of the frequencies observed in a given image.

**IMAGE**: Any form of pictorial representation of the data not obtained by photographic means

**VEGETATION INDEX**: This is the result of an operation between image bands used to obtain a better discrimination between soils and vegetation.

**LANDSAT**: A series of satellites built by NASA specifically dedicated to the remote detection of natural resources

**LATITUDE**: Distance in degrees, minutes and seconds of a degree, between any point and the parallel 0°. Measured from 0° to 90° and may be N or S.

**LENGTH**: Distance in degrees, minutes and seconds of a degree from any point of the prime meridian. It is measured from 0° to 180° and may be E or W.

**WAVELENGTH**: Separation distance of 2 identical states of the wave at a given time

**CONTRAST ENHANCEMENT**: Also called global improvement, it transforms the raw image data using statistics calculated from this.

**SPATIAL IMPROVEMENT**: These are procedures that modify a pixel value in an image based on pixel values of their closest neighbors.

**DIGITAL LEVEL**: Whole value which numerically translates radiometric intensity received by an electro-optical sensor

**VISUAL LEVEL**: Corresponds to the intensity of color with which a pixel is displayed on the monitor

**PIXEL**: The smallest pictorial element of the images that is capable of being processed

**PRODUCT COMPATIBILITY**: The product of 2 ERS, SAR images taken in identical conditions, which made by interferometry techniques, give a new layer of information.

**CONTROL POINTS**: These are geographic elements that can be located precisely on an image and on a map to be used in mapping correction of the image.

**RADAR**: active microwave system that emits energy beam on the surface and then collects its reflection on it. The same antenna emits the radar pulse and receives the response of the land. In the range of wavelengths characteristic of radar there is virtually no water absorption band, which allegedly makes this system suitable for studying the tropics.

**RADIANCE**: Total energy radiated per unit of area and per solid angle of measurement.

**IMAGE ENHANCEMENT**: Digital processes that aim to improve the visual quality of the image by increasing the internal contrast or the creation of new bands that illustrate better about the original features.

**REFLECTIVITY**: Percentage of incident radiation that is reflected by a two-dimensional surface.

**RESOLUTION**: The resolution is a measure of the ability of a system sensor to discriminate information within the image.

**SPATIAL RESOLUTION**: The system's ability to distinguish the smallest possible object in an image. This will define the size of the pixel.

**SPECTRAL RESOLUTION**: The sensor's ability to discriminate the radiance detected in different wavelengths of the electromagnetic spectrum. Only the radiance extended to a certain range of wavelengths called a band can be measured.
The spectral resolution is determined by the number of bands that the sensor can capture.

**RADIOMETRIC RESOLUTION**: The sensor's ability to discriminate levels or intensities of spectral radiance. In the optical-electronic systems, the radiance is assigned to each pixel as a value number proportionate to the amount of electromagnetic energy received.

**TEMPORARY RESOLUTION**: This refers to the time at which a sensor obtains an image of a particular area.

**SAT-LOC**: spatial positioning system supported on satellite records of the lines of fumigation

**SENSOR**: Any instrument that detects electromagnetic energy, converts it into a signal and presents it in a form capable of being used in a studio.

**SPECTRAL SIGNATURE**: a peculiar way of reflecting or radiating a certain object. Since each material has different absorption bands according to their chemical composition and certain properties of its surface, the reflected solar energy will be complementary to the incident plus the one virtually emitted by the surface itself.

**GEOGRAPHIC INFORMATION SYSTEMS**: A set of programs that allow storing, retrieving, modifying and combining any type of georeferenced variables

**REMOTE SENSING**: The technique to procure information on an object, area or phenomenon through the analysis of data acquired by an instrument that is not in contact with the object, area or phenomenon under investigation

**TEXTURE**: visual interpretation criteria resulting from the ratio between the size of objects and the sensor resolution

**TONE**: visual interpretation criterion resulting from the amount of energy received in a spectral band

*Probability.* The value calculated on the number of times that a given loss may arise in a given period of time.

*Basic response.* The action of initial response to a loss, using means normally available in the system, and developed without changing the initial structure of its functioning.

*Rescue.* Actions undertaken by trained groups external to the loss area, to remove a threatened person, who has not been able to leave by his own means in the process of evacuation

*Loss.* Undesirable incident or event which has not been programmed, and which may generate negative consequences on the system

*Victim*. Person who has suffered damage to physical damage or damage to his health as a consequence of a loss.