Annex 1:
The impacts of climate change on Egypt

1. This annex presents an introduction to the catastrophic consequences of climate change in Egypt.

2. The phenomenon of climate change and global warming negatively affects all areas of life in Egypt and around the world. Egypt is located in the north-eastern corner of Africa and has a total land area of 995,450 km^2 and a coastline of 3,500 km along the Mediterranean and the Red Sea. The Mediterranean shoreline is most vulnerable to sea level rise due to its relative low elevation compared to the land around it.[1]

3. Egypt is highly vulnerable to the catastrophic impacts resulting from climate change and is ranked 107 out of 181 countries in the 2019 ND-GAIN Index of States vulnerable to climate change. The degree of Egypt's vulnerability is relatively high for its primary dependence on the Nile River, which serves needs for potable water, agriculture, industry, fish farming, power generation, inland river navigation. This dependence on the Nile River's water makes the country vulnerable to heat waves, reduced rainfall for the upper Nile Basins as well as the reduction of rainfall and sea level rise on the east Mediterranean coastal zone.[2] This makes Egypt exposed to the critical impacts by the repercussions of climate variability and change with respect to food and water security, agriculture and livestock, increasingly adverse conditions to health, human settlements.

4. Egypt's climate is dry, hot, and dominated by desert. It is a highly arid country and receives very little annual precipitation. The majority of rain falls along the coast, with the highest amounts of rainfall received in the city of Alexandria, of 200 mm of precipitation per year. Precipitation decreases southward and areas south of Cairo receive only traces of rainfall.[3]

5. The combination of the country's high evaporation rate and the virtual absence of permanent surface water over large parts of the country result in water as a highly scarce resource. Primary challenges are centered around water resource availability, changing precipitation patterns and increasing population demands. Egypt has observed a statistically significant reduction of annual total precipitation amounts over the past 30 years, a reduction by approximately 22%. This has resulted in reduced water availability in some areas and

[1] Climate Risk Profile: Egypt (2021): The World Bank Group. URL: https://climateknowledgeportal.worldbank.org/sites/default/files/2021-04/15723-WB_Egypt%20Country%20Profile-WEB-2_0.pdf

[2] Egyptian Environmental Affairs Agency (2016). Egypt Third National Communication under the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/TNC%20report.pdf

[3] Climate Risk Profile: Egypt (2021): The World Bank Group, p.4.

increased periods of drought and dry spells.[4]

6. According to analysis from the German Climate Service Center (GERICS) of 32 Global Climate Models (GCMs), Egypt is expected to experience a change in annual mean temperature from 1.8°C to 5.2°C by the 2080s. Maximum temperatures are expected to increase by 2.1°C to 5.7°C by the 2080s. Heat waves will also increase significantly in their severity, frequency and duration.[5] Across all emission scenarios, temperatures will continue to increase for Egypt throughout the end of the century. Rainfall trends in Egypt are highly variable. Analysis from the German Climate Service Center (GERICS) global climate models (GCMs) indicate that the reduction in precipitation, observed over the past 30 years, is expected to continue by the end of the century. Reduced precipitation and increased temperature are expected to impact evaporation, water balance as well as drought conditions.[6]

7. Egypt has a high degree of risk to natural hazards and is highly vulnerable to climate change impacts. Future projections indicate Egypt will suffer from sea level rise, water scarcities and deficits, as well as an increase in the frequency and intensity of extreme weather events such as heat waves, sand and dust storms, flash floods, rock slides and heavy rains.[7]

8. Egypt's Nile Delta is recognized as one of the world's three 'extreme' vulnerability hotspots.[8] Most of the country's population and infrastructure are concentrated in the Nile Delta and along the Mediterranean coast, making the country additionally vulnerable to the impacts of sea level rise. The rise of the sea level due to climate change is projected to lead to the loss of a sizable proportion of the northen part of the Nile Delta due to a combination of inundation, erosion and salt water intrusion with consequential loss of agricultural land, infrastructure and urban areas. Key sectors impacted include water resources, agriculture, fisheries, health, housing, biodiversity, telecommunications, energy, tourism, and coastal zones.[9]

9. The country is expected to become generally hotter and drier under a projected future climate. Egypt is already severely impacted by and susceptible to droughts, which are expected to be more frequent and pronounced. Disaster risks arising from increased temperatures are expected to exacerbate existing tensions for water resources between agricultural and livestock needs and human population needs, especially during periods of high aridity and drought. The existing quality of available water from surface water and groundwater, is also expected to be altered.[10]

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[4] GERICS (2019). Climate Fact Sheet – Egypt. URL: https://www.climate-service-center.de/products_and_publications/fact_sheets/ climate_fact_sheets/index.php.en

[5] *Ibid.*

[6] Climate Risk Profile: Egypt (2021): The World Bank Group, p.8.

[7] Climate Risk Profile: Egypt (2021): The World Bank Group, p.9.

[8] UNDP (2018). National Adaptation Plans in Focus: Lessons from Egypt. URL: https://www.adaptation-undp.org/sites/default/files/ resources/naps_in_focus_lessons_from_egypt.pdf

[9] *Ibid.*

[10] Climate Risk Profile: Egypt (2021): The World Bank Group, p.10.

10. Climate change is expected to increase the risk and intensity of water scarcity and drought across the country. The primary sectors affected are water, agriculture, forestry, human health, and livestock. Water scarcity and changing rainfall patterns are also expected to play a significant role for the agricultural sector. Increased temperatures and degraded agricultural conditions will adversely affect 'working days', impacting livelihoods and economic resilience of vulnerable groups.[11]

11. Additionally, increased frequency of intense precipitation events will lead to a heightened risk of flooding, river bank overflow and flash flooding. This may also result in soil erosion and water logging of crops, thus decreasing yields with the potential to increase food insecurity; particularly for subsistence-scale farmers.[12]

12. Higher temperatures, coupled with increased aridity may also lead to livestock stress and reduced crop yields. This is likely to result in economic losses, damage to agricultural lands and infrastructure as well as human casualties. Furthermore, land degradation and soil erosion, exacerbated by recurrent flood and drought adversely impacts agricultural production, further affecting the livelihoods of the rural poor. Small rural farmers, are more sensitive to impacts of disasters (floods, dry periods) because they have limited resources with which to influence and increase adaptive capacity.[13]

13. Egypt remains highly vulnerable to climate variability and change in the immediate as well as longer-term. The negative impacts from climate change in Egypt are already being experienced across various sectors including coastal zones, water resources, agriculture, and health, in addition to damages related to food security, which leads to economic losses estimated at billions.

1. Coastal Zones

14. Sea Level Rise "SLR" is one of the main negative impacts of Climate Change. Global sea level rose by about 2 millimeters per year over the past century. About half of this rise may be attributed to thermal expansion of the ocean and glacier melting.[14]

15. Egypt enjoys coastal zones that extend for about 3,500km along the Mediterranean and the Red Sea. These costal zones are perceived as vulnerable to the impacts of climate change due to the direct impact of SLR and other potential impacts of climate changes on their water resources, agriculture, tourism and human settlements. The Nile Delta and its north coast are hosts to important historic and industrial cities such as Alexandria, Port Said, Damietta, and Rosetta, all with populations of several million, and large investments in industrial, touristic, maritime and agricultural activities and

[11] Climate Risk Profile: Egypt (2021): The World Bank Group, p.10.
[12] Climate Risk Profile: Egypt (2021): The World Bank Group, p.11.
[13] FAO (2018). Drought Characteristics and management in North African and the Near East. URL: http://www.fao.org/3/CA0034EN/ ca0034en.pdf
[14] Dyurgerov, M.B., and Meier, M.F., "Twentieth Century Climate Change: Evidence From Small Glaciers", PNAS, Vol. 97, No. 4, pp. 1406-1411, 1997.

infrastructure.[15] These cities would be victims of SLR.[16]

16. The Nile Delta region constitutes the main agricultural land of Egypt and hosts over one-third of the population and nearly half of all crops.[17] It is identified as one of the most vulnerable areas in North Africa and the Middle East due to the impacts of SLR based on the present rates of relative SLR to 2050.[18]

17. The expected SLR's effects include flooding, the erosion of coastal barriers, increase of soil salinity, degrading its fertile quality, threats to food security and damage to the large investments in the tourism sector along the North West Coast [19] Further implications will be the relocation of more than 10 million people from the coastal zone to other areas to the already over populated Nile Valley that will have a direct and critical effect on Egypt's entire economy.

18. The IPCC estimates that the Mediterranean Sea will have risen by one meter by 2050 as a result of global warming, ending in the loss of one third of the most productive land in the Nile Delta.[20] Further scientific studies estimate that 0.5 m SLR would lead to the permanent submersion of 1,800 km2 of cropland in low areas of the Nile Delta and accelerate the trend of desertification in the form of increased soil salinity in the remaining land.[21] Several studies on the vulnerability of Alexandria, the second largest coastal city in Egypt, indicated that a 0.3 m SLR would inundate large parts of the city, resulting in billions of dollars' damage to infrastructure. displacement of over half a million inhabitants, and a loss of about 70,000 jobs.[22]

19. "Changes in global and regional weather patterns are also altering the seasonal timing and intensity of rainfall in Egypt's coastal areas, which will cause more frequent and intense flash-flood events in Egypt, putting an additional 1.1 million people annually at risk[23].

20. Densely populated cities and urban areas in the Nile Delta will be significantly impacted by the combined effects of sea level rise, increasing flood events and water availability challenges. 2 Sea levels rose in Egypt from 1.8 mm annually until 1992 to 3.2 mm annually after 2012 and are

[15] Egyptian Environmental Affairs Agency (2016). Egypt Third National Communication under the United Nations Framework Convention on Climate Change, [hereinafter: "EEAA, 2016"] URL: https://unfccc.int/sites/default/files/resource/TNC%20report.pdf

[16] M. Hagag, A. EL-Shazly, K Raka, Impact of the Sea Level Rise on the Nile Delta, Egypt, Journal of Engineering and Applies Science, VOL. 60, No. 3, June 2013, pp.211-230.

[17] El Raey, M., "Vulnerability Assessment of the Coastal Zone of the Nile Delta, Egypt, To the Impacts of Sea Level Rise", Ocean and Coastal Management, Vol. 37, No. 1, pp. 29-40, 1997.

[18] Nicholls, R. J., "Planning for the Impacts of Sea Level Rise. Oceanography", Vol. 24, No. 2, pp. 144-157, 2011.

[19] EEAA, 2016.

[20] IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.

[21] EEAA, 1999.

[22] Green Climate Fund, 2017.

[23] World Bank (2022). Egypt Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099510011012235419/pdf/P17729200725ff0170ba05031a8d4ac26d7.pdf

expected to rise 1-6 mm/year along the coastal zones[24].In addition, Egypt's updated NDC underlined that the spatial concentration of cities and fertile agricultural lands in the Nile Delta, which lies ~1 m above mean sea level, and along the Mediterranean Sea and Red Sea coasts, amplifies the potential climate change impacts of SLR on Egypt's population and economic productivity.

21. Egypt ranks fifth in the world in terms of SLR's potential economic impact on urban areas, with damage costs of around 1% of GDP annually by 2030[25]. Greater Cairo contributes between 47% and 49% of Egypt's GDP, while coastal governorates contribute between 24% and 28% of GDP[26]. A major proportion (between 80% and 100%) of the people in the major cities is exposed to at least one major climate risk, and a substantial fraction faces more than one such risk[27]. These risks include flooding, heat stress, air pollution, desertification, and, for coastal areas, SLR[28]."

2. Water Resources

22. Egypt is a hyper-arid country, suffering from absolute water scarcity, that depends almost entirely on the Nile for its existence. The Nile provides Egypt with 98% of its annual renewable water resources, making it the second most dependent country on external water resources. The water per capita in Egypt is currently less than 550 cubic meters/per capita/per year, which is far below the global water poverty line defined as 1000 cubic meters/per capita/per year. Furthermore, water per capita is projected to drop to below the absolute water poverty line, 500 cubic meters/per capita/per year, by next year 2025. Moreover, the water available for Egypt is already insufficient. Although Egypt receives 55.5 billion cubic meters annually from the Nile River, the reality is that Egypt's water needs are over 120 billion cubic meters. This deficit is bridged by intensive water-recycling and reuse and virtual water, i.e. water embedded in food imports.

23. Furthermore, Egypt has a water-dependent economy, whose water-stressed agriculture

[24] Climate Change and Future Flood Impacts in Alexandria Egypt, CCDR Background Note, World Bank (2021); Resilient Cities and Coastal Economies, Egypt's CCDR Background Note, World Bank (2021).
[25] Medium SLR (RCP 4.5, SSP2) scenario follows the historical growth SLR patterns, with an estimates SLR of .13 meters by 2030, .24 meters by 2050 and .58 meters by 2100, The SLR estimates for Egypt were produced using the DIVA model (Dynamic Interactive Vulnerability Assessment model 2.0.1, database 32), a global model to estimate the long-term impacts of SLR. For details in the model, please refer to Nicholls RJ, Hinkel J, Lincke D and van der Pol T, 2019. Global Investment Costs for Coastal Defense through the 21st Century, World Bank Policy Research Working Paper 8745, World Bank, Washington DC. The latest estimates of the DIVA model were updated for the Egypt CCDR background paper, Resilient Cities and Coastal Economies. Egypt CCDR Background Note. World Bank (2021).
[26] GDP data from Ministry of Planning and Economic Development. (https://mped.gov.eg/Governorate/Index?lang=en).
[27] Source: Resilient Cities and Coastal Economies. Egypt CCDR Background Note. World Bank (2021) using data from the Urban Climate Risk Analysis (World Bank,GFDRR City Resilience Program)
[28] Resilient Cities and Coastal Economies, Egypt's CCDR Background Note, World Bank (2021).

sector sustains the livelihoods of more than half its population. A decrease of only 1 billion cubic meters of water in Egypt would lead, in the agricultural sector alone, to 290,000 people losing their incomes, a loss of 130,000 hectares of cultivated land, an increase of $150 million USD in food imports, and a loss of $430 million USD of agricultural production. As water shortages increase and continue over an extended period, the impacts on every sector of Egypt's economy and its socio-political stability are immeasurable.

24. The wide range of water utilization increases concern and vulnerability regarding climate change trends which may impact the natural flow of the River Nile due to the reduction of rainfall on the upper Nile Basins, reduction of rainfall on the east Mediterranean coastal zone as well as the effect of sea level rise on the quality of groundwater in the coastal aquifers.[29]

25. There remains significant uncertainty regarding the anticipated impacts of climate change on Nile River flows, with some studies suggesting increased evaporation rates due to rising temperatures could decrease water availability by up to 70%. As the Nile River's sources are located outside Egypt, the country is highly vulnerable to changing climate conditions and shocks both within and outside the country's borders.[30]

26. The impact of climate change and climate variability will further complicate the management of shared water resources of the Nile River. Additional projected climate impacts on the Nile include, the Upper Blue Nile River Basin becoming wetter and warmer in the 2050s.[31] Moreover, Egypt is the most downstream state on the Nile River, and is affected by the impacts of climate change not only within its borders, but also within the whole basin, which is shared with 10 other riparian states. In addition, Egypt, as the most downstream country, is particularly vulnerable to unplanned and unsustainable adaptation actions and projects across the Nile basin. Maladaptation could have the opposite of the intended effect by increasing vulnerability rather than decreasing it. Thus, the selection and implementation processes of water-related climate action measures in transboundary water basins must be inclusive and complying with the principles of cooperation, mutual benefit, and no harm.

27. The expected impacts from increased temperatures and decreased rainfall is likely to increase water demand, particularly from the agricultural sector which currently consumes approximately 80% of all available freshwater resources. Water demand will not only be tied to

[29] Egyptian Environmental Affairs Agency (2016). Egypt Third National Communication under the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/TNC%20report.pdf
[30] Climate Risk Profile: Egypt (2021): The World Bank Group,p.16.
[31] Climate Risk Profile: Egypt (2021): The World Bank Group,p.16.

rising temperatures but also by the rising population in the region.[32] Egypt is projected to experience significantly heightened dry conditions and significant drought severity, which will increase pressure on water resources for the country.

28. Rainfall and evaporation changes also impact rates of surface water infiltration and the recharge rates for groundwater. Water scarcity and drought conditions are expected to continue to increase risks of food insecurity and may exacerbate conflict situations over scarce resources, settlements, and population movements. Additionally, the majority of the population lives in close proximity to the Nile River, increasing potential exposure to flood events, with the urban poor particularly exposed and vulnerable.[33]

3. Agriculture

29. Agriculture contributes about 14% to the GDP, making it a key sector of the Egyptian economy. Just 2.8% of Egypt's land is arable, largely located along the Nile. The country's agriculture is predominantly irrigated and almost entirely dependent upon the flow of the Nile River.[34] The sector consumes about 80% of the freshwater resources. Egypt's agricultural land in the Nile Valley and the Nile Delta represents about 80% of the cultivated area.[35]

30. Egypt's agricultural sector is particularly vulnerable to climate change, due to its dependence on the Nile River as the primary water source, as well as the intensifying development and erosion along coastal areas. The country faces increasing challenges to agriculture and food security, which are expected to be negatively impacted by climate stressors. Climate change is also predicted to result in increasing crop-water stress, as well as significant land inundation, salt water intrusion, and salinization of about 15% of the most fertile arable land in Egypt.[36]

31. The combined effect of temperature increase, SLR, water shortage and other environmental conditions would worsen Egypt's agriculture productivity and food security.[37] The potential impact of climate change could decrease national agricultural production by 11 to 51%. An estimated 55% of the labor is engaged in agricultural activities and any reduction in such activities would push down employment in the agricultural sector presenting considerable risks to the fragile socioeconomic situation of many rural Egyptians.

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[32] USAID (2018). Climate Risk Profile – Egypt. Fact Sheet. URL: https://www.climatelinks.org/sites/default/files/asset/document/ 2018_USAID-ATLAS-Project_Climate-Risk-Profile-Egypt.pdf

[33] Climate Risk Profile: Egypt (2021): The World Bank Group, p. 16.

[34] *Ibid*.

[35] Climate Risk Profile: Egypt (2021): The World Bank Group, p. 13.

[36] Climate Risk Profile: Egypt (2021): The World Bank Group,12.

[37] Egyptian Environmental Affairs Agency (2016). Egypt Third National Communication under the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/TNC%20report.pdf

4. Health

32. The Egyptian health care system faces multiple challenges. The expected increase in heat waves, dust storms and weather events are likely to have a significant impact on the health of the population. The intensity and severity of such weather conditions are associated with numerous infectious and noninfectious diseases that will adversely impact vulnerable groups such as children, the elderly and outdoor laborers.[38]

[38] Egyptian Environmental Affairs Agency (2016). Egypt Third National Communication under the United Nations Framework Convention on Climate Change. URL: https://unfccc.int/sites/default/files/resource/TNC%20report.pdf