

## **POLICY BRIEF**

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# Climate Change Implications for Agriculture, Water and Migration: the case of Egypt

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## 1. Introduction

Egypt is located in the northeastern corner of the African Sahara Desert, one of the most arid deserts worldwide, without any forms of water bodies above or below ground, where summer heat rises to extreme temperatures, with no shaded areas, and where temperature varies significantly between day and night. For these reasons, Egypt has a hot desert climate, which ranges from extremely dry to dry, (dryness is a relationship between average precipitation and average evaporation), where average evaporation is about 100 times higher than precipitation. The Nile River crosses Egypt from the south to the north, flowing from the basins of Central and East Africa, constituting the almost only one source of water for Egypt, due to the rarity of groundwater in the deserts, especially as it exists on great depth and remain non-renewable, then due to the absence of precipitation on the valley and delta regions, with the exception of the Mediterranean coastal line and norther delta regions. Rainfall decreases and is non-existent to the south, except for some floods that cause more damage than good, due to heavy rainfall on Sinai, the Red Sea coast, and few governorates in Upper Egypt towards the end of summer and spring months. The alluvial agricultural lands in the valley and the delta, that was formed during the Nile annual flood seasons (from July to October) over thousands of years by the deposition of sediments brought by the river from the Ethiopian Plateau (as the White Nile does not carry sediments nor floods), represent only about 3% of the Egypt's area of 1 million km<sup>2</sup> (including 3.5 million hectares of agricultural lands), while urban regions, crowded on both sides of the Nile, represent about 3.5% more. Thus, Egyptians live on only 6.5% of the country's area, while deserts constitute about 93.5% of Egypt's area.

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## 2. Egypt's Vulnerability to Climate Change Impacts

Climate vulnerability is defined as the propensity or predisposition to be adversely affected by climate change. This includes susceptibility or exposure to risk, and lack of resilience and adaptability.

As for the impacts or implications: They are the impacts of climate change on natural, human, and biological resources. This includes impacts on lives, employment opportunities, public health, ecosystems, economic, social and cultural assets, services, infrastructure, and migration; Besides impacts on ecological systems, such as flooding, recurring droughts, and sea-level rise.

As for the adaptation: The process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects<sup>3</sup>.

Given Egypt's location between the Mediterranean and the Red Sea, and the low-lying Nile Delta on the Mediterranean coast, besides receiving 85% of the Nile water supply from its three tributaries in the Ethiopian Plateau of East Africa; the Blue Nile, the Sobat, and the Atbarah rivers (49, 11, 11 billion cubic meters annually, respectively), which will suffer from changes in climate and rainfall patterns and displacement to the north. Similarly, the sources of the White Nile in Equatorial Central Africa will be affected as well. Therefore, Egypt is highly vulnerable to climate change implications and global warming, whether externally on the sources of the Nile, or internally due to the Mediterranean sea-level rise threatening parts of the Delta, with both out of control for Egypt. Sea-level rise in the Mediterranean will also cause an increase in seawater intrusion from the Mediterranean to the groundwater sources of the Delta lands, which is Egypt's most fertile black soil (covering 4.35 million acres, 1.83 million hectares, producing 65% of the agricultural yields, and inhabited by 55% of the population<sup>4</sup>), consequently causing soil salinization above them. High evaporation rates associated with global warming are also projected to hit the Nile River along its course from the south to the north of Egypt, across 1200 km, besides is branches of open canals, which exceeds another 30 thousand km in length, causing tangible quantities of Nile water to be lost, in a country that suffers from a net water deficit amounting to 22 billion m<sup>3</sup> after the reuse of another 20 billion m<sup>3</sup> of wastewater<sup>4</sup>. This water deficit caused a deep food gap worth 65% of Egypt's total needs of strategic commodities from wheat and maize for fodder and cooking oils, beans, lentils, red meat, butter, and dried milk, which requires importation of virtual water in quantities equivalent to the water deficit. Global warming will widen that

<sup>3</sup> IPCC (2014). Climate Change Impacts, Adaptation and Vulnerability.

<sup>4</sup> Medany, M., Attaher, S., Abou-Hadid, AF. (2010). Land-use Change and Adaptation in the Nile Delta region, regional assessment of the FP6 project of adaptation of agriculture in European regions at environmental risk under climate change

<sup>5</sup> Ministry Of Water Resources and Irrigation, Egypt. <https://www.mwri.gov.eg/water-starety-2050/>

gap and lead to irrigation water loss resulting from the reduced soil moisture, in addition to increasing transpiration from plants leaves and stems, which means more water will be required to produce the same amount of current food in a country already suffering from water scarcity, with per capita water currently not exceeding 600m<sup>3</sup> annually, expected to decrease to 395m<sup>3</sup> in 2050<sup>6</sup>.

Soil salinization in agricultural lands due to increased evaporation and accumulation of irrigation water salts (0.5kg per cubic meter of Nile water) combined with the lack of irrigation water with the absence of extra water supply required to wash of accumulated salts deposited in the soil is another critical issue. Moreover, the increased evaporation rates due to rising temperatures will lead to the deterioration of food productivity as a result of the deterioration of soil quality and seawater intrusion from the Mediterranean, which will widen the current food gap and put pressure on the state's foreign currency resources required to import more food. In addition to that, climate change impacts on the sources of the Nile, whether in Ethiopia, which supplies about 71 billion m<sup>3</sup> of the total 84 billion m<sup>3</sup> of water carried by the Nile, or in the countries located within the African Great Lakes region feeding the White Nile (supplying 13 billion m<sup>3</sup> of water annually to the Nile).

### 3. Egypt and Climate Change

According to the United Nations definition of climate change, the term refers to long-term shifts in temperatures and weather patterns. Part of this change might be natural due to the increase in solar radiation, but it is largely attributed to human activity in the post-industrial period after 1750, especially the use of fossil fuels and the expansion of coal uses, besides agricultural activities such as rice cultivation, livestock farming, ponds and swamps, deforestation, land-use change, chemical fertilizers emissions, and organic fertilizers decomposition into the soil. In general, industrialization, transportation, and power generation together account for about 61% of global warming gas emissions, followed by agriculture with about 31%<sup>7</sup>, taking into account that agriculture contributes with only about 4% of the gross world product, while industry contribution is about 30%, meaning that agriculture is more influential to climate than industry. Carbon dioxide (CO<sub>2</sub>) is the first cause of global warming and heat-trapping by 66%, followed by methane (CH<sub>4</sub>) by about 16%, nitrous oxide (N<sub>2</sub>O) by 7%, in addition to significant effects caused by ozone (O<sub>3</sub>), fluorine (F), sulfur hexafluoride (SF<sub>6</sub>), perfluorocarbons, halocarbons, and finally, hydrofluorocarbons<sup>8</sup>. It appears that the four lungs of planet Earth, salt water of seas and oceans, polar ice caps, evergreen forests, and agricultural soils, which remove and/or store the accumulation of carbon dioxide, have become significantly saturated with the increasingly heavy CO<sub>2</sub> emissions due to human activities. Consequently, as carbon

<sup>6</sup> United Nations: climate action. <https://www.un.org/en/climatechange/what-is-climatechange#:~:text=Climate%20change%20refers%20to%20long,like%20coal%2C%20oil%20and%20gas>

<sup>7</sup> IPCC WGII Sixth Assessment Report 2022. Climate Change 2022: Impacts, Adaptation and Vulnerability; Summary for policymakers.

<sup>8</sup> WMO (Oct 2021). Greenhouse Gas Bulletin.

dioxide dissolves in saltwater, it forms carbonic acid, which breaks apart causing Ocean acidification, resulting in harmful effects such as coral bleaching and hindering shellfish ability to grow their shells, eventually affecting tourism and diving attractions. Vast amounts of the Polar ice caps are melting as well, with an annual loss estimated at 125 to 225 Gt of Antarctic ice due to thawing, as carbon dioxide melts at an increasing rate with lower temperatures. Additionally, the removal of large areas of ever green forests which absorb carbon dioxide and produce oxygen through photosynthesis, in order to replace them with seasonal agriculture, or housing and factories, or to trade in their timber, especially in Brazil, Indonesia and the Democratic Republic of the Congo, which are the countries with the largest areas of forests worldwide. Finally, agricultural soils are being exhausted with successive intensive growing cycles using high productivity seeds to meet food needs of growing population, which led to the deterioration and decline of soil productivity of about one-third of the agricultural land globally, undermining its role as a carbon sink and a single food producer (ibid.).

### 4. Climate Change Impacts on Egypt

2020 was registered among the world's warmest three years on record, and the previous six years until 2020 ranked the warmest as well. The first half of 2020 witnessed the displacement of about 6.8 million people due to climate-related disasters and hurricanes (5,6), in addition to accelerated sea level rise and saltwater acidification, with a decline in their capacity to absorb carbon dioxide and solar radiation (by absorbing about 95% of solar radiation life is made possible on Earth), and an increase in their temperatures. Similarly, concentrations of carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), and nitrous oxide (N<sub>2</sub>O) were 149%, 262% and 123% of the levels in 1750 (5, 6).

Generally, climate change impacts on agriculture result in:

- Affecting the quality of agricultural lands needed to grow crops and grazing.
- Degradation and desertification of some agricultural lands (Desertification is the process by which fertile land becomes desert and loses its food productivity forever, the term is used for agricultural land in particular), and arable lands due to the increased frequency of droughts, soil salinization, depletion or salinization of groundwater resources, sea rise and loss of land in some deltas, specially the low-laying deltas of the Nile, the Mekong, and the Ganges. Consequently, desertification and water depletion increase migration and conflict between migrants and locals.
- Increased extreme water-related weather events, especially the frequency of droughts due to the depletion of surface and ground water resources, causing losses in human lives, animals, and plants, which results in migration and the risks and violence associated with it.
- Depletion of certain major water resources, leading to violent conflicts and migration, such as the case of Lake Chad losing 10% of its area, causing violence and migrations across Cameroon, Niger, Nigeria, and Chad.

- Affecting the distribution and productivity of marine ecosystems due to ocean acidification.
- Changes in a large number of disease hosts, infection stages, pathogens, and pest insects.
- Damages in biodiversity and predator-prey balance.
- Increasing pollution and declining quality in water resources required for livestock production.
- Changing patterns of livelihood opportunities, increasing vulnerability and climate-induced migration.
- Increased health risks for agriculture workers with threats of illnesses related to heat stress and exposure to higher pollution.
- Changing the length of growing seasons.
- Internal or external migration in search of new livelihoods.
- Increased damages and incidence of diseases in livestock and fisheries.

#### **Overall Climate Change Impacts on Nutrition:**

- Changing food quality and consumption patterns.
- Changing and diminishing nutritional status, thus increasing the likelihood of health risks, particularly among women, children, young people, the elderly, and people with disabilities.
- Increasing waterborne diseases of humans, animal, and plants, due to the increased concentrations of pollutants in water resources as a result of high evaporation.
- Declining productivity of most food crops by 10% to 30%<sup>9</sup>.
- Increasing poverty and hunger rates with declining rural development rates in developing and poor countries (poverty is the ability to provide the calories necessary for individuals to be healthy and able to work, but of cheap quality and often plant-based) (hunger: The inability to provide the calories necessary for the life of individuals, even from cheap sources and in poor health)<sup>10</sup>.

<sup>9</sup> Müller, C., A. Bondeau, A. Popp, K. Waha, and M. Fader. (2010). Climate Change Impacts on Agricultural Yields. Background Note for the WDR 2010.

<sup>10</sup> First researcher Nader Noureldeen Mohamed (2010). kitābu taāyyarāt almanākh wālqiāā i alzzirā iyyi wa mustaqbil al'amn alāithā iyyi al'arabiyyi [The Book on Climate Change, Agriculture, and the Future of Arab Food Security]. Kitāb AlKhaleej: AlKhaleej Research Center, Dar AlKhaleej for Press, Printing, and Publishing.

## **5. The Egyptian Strategy for Climate Change Adaptation and Mitigation**

Egypt National Strategy for Climate Change 2050, launched by the Egyptian ministry of environment in May 2022, identified two main goals to address climate change impacts on Egypt:

1. Achieving sustainable economic growth and low-emission development in various sectors (transition to a green economy), especially in the fields of energy, industry, transport and communication, water and agriculture, which are key drivers of greenhouse gas emissions.
2. Enhancing adaptive capacity and resilience to climate change and alleviating the associated negative impacts.

To achieve these strategic goals, key risks and threats were identified as follows<sup>11</sup>:

- The decline of Egypt's share of the Nile water supply, whether due to the Ethiopian giant dams, or the effects of climate change on source countries or inside Egypt alike, [or] the increase in salinization and non-renewal of groundwater with while living under the pressures of the growing water crisis and water scarcity.
- The impacts of extreme weather event, especially torrential rain, rising temperatures, wind intensity, the Mediterranean sea-level rise, and recurring droughts.
- The impacts on poverty, and the decline in employment opportunities and income rates.
- The impacts on informal areas, rural extensions within in the desert periphery of governorates, and rural areas.
- Overpopulation growth rates, and its strain on energy sources and on the natural resources of water, soil and food, and future per capita shortages of all these resources.
- Lack of funding resources and grants, and their uncertainty in the future.
- The increased opportunities granted to women in development and employment, despite the fact that women are more vulnerable to climate change impacts, and empowering them to face these challenges, especially in rural areas and among the least educated groups.
- Lack of public awareness and poor infrastructure in many areas.

<sup>11</sup> Ministry of Environment. (May 2022). Egypt National Climate Change Strategy (NCCs) 2050. <https://www.eeaa.gov.eg/portals/0/eeaaReports/N-CC/EgyptNSCC-2050-Summary-En.pdf>

- The weak enforcement of law, legislation, and public policies due to the absence of critical legislation and lack of coordination between government, state institutions, and civil society.
- Lack of government funds necessary for climate change adaptation and building resilience.
- The absent role and unclear commitment of the private sector towards investing in climate change adaptation and resilience building; besides critical legislation contributions on environmental preservation.
- The absence of integrated mechanism in addressing environmental considerations, and the lack of trained technicians and future training institutes.
- Forming a strong climate change adaptation team, consisting of the Ministries of Petroleum, Industry, Energy and Transport, and we also suggest bringing the Ministries of Water Resources, Agriculture and Education into the team.

During the past five years, Egypt has focused on climate change adaptation in the sectors of agriculture, irrigation, and water resources development. The production of desalinated sea water has been increased to 1 billion m<sup>3</sup> which is targeted to reach 5 billion m<sup>3</sup> by 2050. In addition, Egypt managed to secure 5 billion m<sup>3</sup> of treated wastewater, another 15 billion m<sup>3</sup> or reused water. Other efforts include lining water canals, developing irrigation systems and enhancing its efficiency to prevent water wastage, protecting beaches and coastal areas, preventing delta land losses due to rising sea level, and preventing sea water intrusion from the Mediterranean. In agriculture, the state restructured its relevant policies to limit the areas allocated for water-intensive crops, and produce seed for new heat and drought tolerant varieties that are effectively less water-intensive. Together with the expansion in low-water consuming and high-yielding greenhouse farming, all these efforts aim to achieving higher agricultural production using less water, in line with the FAO recommendations.

## 6. Climate Change and Migration:

Climate change affects population lifestyle, often forcing them to leave their places of habitual residence and move to other areas, within the state or across international borders. Climate change also forces people to change their economic activities and daily lives, and increases the likelihood of shifting to different economic sectors, leaving the declining agricultural sector, and seeking other source of livelihood. These climate-driven population movements have led to the emergence of a new term in the field of migration studies called “climate migration.” Climate Migration refers to “The movement of a person or groups of persons who, predominantly for reasons of sudden or progressive change in the environment due to climate change, are obliged to leave their habitual place of residence, or choose to do so, either temporarily or permanently, within a State or across an international border.”<sup>12</sup>

<sup>12</sup> International Organization for Migration (2019) *Glossary on Migration, International Migration Law No. 34*, IOM, Geneva.

Climate migration is mostly internal migration. When migration is internal, the people who move through those migrations are under the responsibility of their countries. For slower climatic change impacts that would take longer to manifest negative effects, migration caused by such long-term impacts does not appear to be forced migration (displacement); yet, these effects must be taken into consideration, and governments must be well prepared to mitigate/tackle slower climate related implications as in the case of rapid impacts<sup>13</sup>.

### 6.1 Climate Change Impact on Migration

Within the country, citizens usually move from rural to urban areas, and from rural areas and small towns to the capital and major urban centers, which usually monopolize the largest share of economic activity, especially in the global south (where poverty prevails in rural communities). Internal migration becomes a nuisance only when it is driven by factors beyond a migrant’s control, at which point migration is no longer a choice but a matter of necessity. This type of internal migration is called “displacement”, which is the same as forced internal migration or the equivalent of forced migration and asylum for international migration. There are many types of forced internal migration (displacement), as it could result from forced displacement due to wars, conflicts, and natural disasters. Displacement can also be caused by development projects such as the construction of river dams, one example is the displacement of the Nubian people in Egypt after the construction of Aswan’s High Dam, which submerged their villages under the dam lake<sup>14</sup>. Finally, those displaced by climate related impacts that has intensified in recent decades are called “environmental migrants”. A World Bank report released in September 2021 indicates that the world will witness the a displacement of about 216 million people due to climate change by 2050. This figure represents about 3% of the world total population and is equal to the population of countries the size of Brazil. The report also showed that climate change is now one of the most important drivers of internal migration in many regions around the world. It also noted that the climate impact will intensify over time until 2050, by which time the number of displaced people will reach the above figure<sup>15</sup>.

The Global Compact for Safe, Orderly and Regular Migration<sup>16</sup> (Marrakech Compact) calls for a deeper understanding of climate change as one of the important drivers of migration. The compact includes specific commitments to address the drivers of environmental mobility and develop better protection policies for those involved in or affected by such movements. The Compact also recognizes the need to promote joint analysis of data on environmental migrations and information-sharing among different actors to improve monitoring,

<sup>13</sup> Khaled Hassan (2021) at-taḡayyarāti almunākhiyah wāl’ahdāfu al’ālamīyyatu lilttanmiyah [Climate Change and Global Development Goals], muktabatu jazīrat alward, Cairo.

<sup>14</sup> Ayman Zohry (2021) at-taḡayyuri almanākhi wāl’hijrah [Climate Change and Migration], ru’ā misriyya, Issue 82. Al-Ahram Center for Political and Strategic Studies. November 2021.

<sup>15</sup> World Bank (2021) *Groundswell: Acting on Internal Climate Migration, Part II*, The World Bank, Washington DC.

<sup>16</sup> International Organization for Migration. (2021). *Global Compact for Migration*, <https://www.iom.int/global-compact-migration>, 09.10.2021.

understanding, projecting and addressing migration trends, including those driven by sudden natural hazards, long-term risks and climate change impacts. The compact also calls for the development of coping and resilience strategies, taking into account the potential impacts on migration and displacement.

## 6.2 Climatic Change and the Egyptian Migration

Similar to many other countries around the world and the Mediterranean, Egypt suffers from climate change, especially with the majority of Egypt's population concentrated in the Nile Valley and Delta. Egypt is environmentally affected by climate change through sea level rise and the possibility of losing the agricultural land adjacent to the Mediterranean Sea, with the northern parts of the Delta and certain areas along its north coast, which will push the residents of those regions to migrate towards the inland parts of the country. In addition, intrusion of seawater into the soil and groundwater leads to salinization of the soil, rendering it nonarable, and forcing farmers to transfer other soil to these areas periodically if they want to continue growing seasonal crops with shallow roots, but it remains difficult to grow other types of crops<sup>17</sup>. Degradation and desertification of agricultural soils result in a shift towards other economic activities, with a surplus of agricultural labor force who are forced to migrate to other places, hence intensifying migratory pressures on neighboring communities with the associated competition for livelihood and conflicts. Climate change may also increase external migratory pressures as it increases the consideration of international migration [among those affected], including regular and irregular migration to countries of southern and western Europe and other typical diaspora countries<sup>18</sup>.

Estimates of citizens who will be forced to relocate inland from the Delta [and coastline] due to climate change vary in proportion to the forecast sea level rise; the higher sea levels are expected to rise, the more people are estimated to relocate. The most likely estimate in the Egypt case is about a 1.5 million citizen will have to leave their places of habitual residence due to climatic change during<sup>19</sup> the coming period, resulting in significant economic losses, not to mention the social and political difficulties arising with such mass migration.

## 7. Future Directions:

The inputs reviewed in this brief illustrate that Egypt is facing many challenges related to climate change, nevertheless, the Egyptian government arguably own many climate change adaptation and mitigation tools at its disposal, some of which have been reviewed in this brief. Hereinafter, we provide further recommendations for future interventions in this regard:

1. To focus on continued adaptation and mitigation of climate change impacts through concerted efforts between the government and relevant stakeholder, in civil society organizations.
2. To expand and maintain awareness raising on climate change and its economic, health, and environmental impacts, beyond CPP27 agenda, as such effort should not be tied to hosting the events of the conference alone.
3. To develop alternative plans to address climate change impacts on agriculture, water, and labor; and to achieve greater food security.
4. In response to the forecast climate change impacts on migration and the resulting forced population movements, alternative and safe plans for population movements shall be developed, especially concerning the northern Delta regions, in addition to assisting climate migrants to adapt to their new environments.
5. To expand in green economy projects (low gas emissions) and blue economy projects (associated with seas, marine resource, and local natural resources) to provide many job opportunities and reduce the risks of migration.
6. To pay attention to water provision, while improving its quality and limiting its pollution, in order to facilitate greater profitability for farmers, which will increase their commitment to their lands in return, so they would not abandon it to migrate.

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<sup>17</sup> See in this regard the article on the Egyptian efforts to address climate change and its impacts on agriculture, food, and water in Egypt. In Issue 82. Al-Ahram Center for Political and Strategic Studies. November 2021.

<sup>18</sup> Other common diaspora countries for Egyptians are typically the US, Canada, Australia, and New Zealand.

<sup>19</sup> Dalia Alakkad (2019). sayunāriyūhāt qātumuhu biḡaraqi alldeltā wālfāqri almā'iyi" [Bleak scenarios of delta sinking and water poverty]. majjalat al'insāniyyi, (65).