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Review Paper

Environment in Jeopardy: Consequences of climate change in Egypt

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Egypt is at risk to the possessions of global warming and potentially facing "catastrophic" consequences in sea level rise (SLR), water scarcity, agriculture and food insufficiency, loss of biodiversity and habitats and new pressures on human health and national economy. To confront these adverse impacts, the Prime Minister re-established in 2007 a National Climate Change Committee consists of scientists and experts from different ministries and relevant bodies responsible to manage climate in Egypt and to set a strategy to adapt to potential global changes.

Key words: Environment, sea level rise, water scarcity, agriculture and food insufficiency, biodiversity and human health

INTRODUCTION

In 2009 the World Bank described Egypt as particularly vulnerable to the effects of global warming, potentially facing "catastrophic" consequences. Egypt is the fifteenth most populated country in the world and particularly susceptible to negative environmental consequences of human-induced climate change that would worsen prevalent problems (El-Shahawi, 2004). Projected consequences consist of sea level rise (SLR), water scarcity, agriculture and food insufficiency, loss of biodiversity and habitats and new pressures on human health and national economy.

Average temperature increases are expected to reach +4°C in Cairo and from + 3.1 to 4.7°C in the rest of Egypt by 2060 (Tealeb, 1999) and drops in annual precipitation may account to 10 to 40% over most of Egypt by 2100. As for the impacts of SLR on coastal areas, the agricultural sector will be the most harshly impacted (90% loss), followed by the industrial (65% loss) and tourism sectors (55% loss) due to an SLR of 0.5m. Fisheries and tourism are thus two further economic activities likely to be negatively impacted by climate change .

In addition to its local impacts, climate change has secondary regional impacts. Increasing temperature, soil erosion and wind speed would increase the amount of Saharan dust carried across the Mediterranean to European countries causing health and economic problems, increased immigration pressure to Europe, water scarcity increases conflicts among countries sharing the same water resources (e.g. Nile and Euphrates) and leads to political unrest and increases in temperature and humidity increase deterioration rate of Egyptian archaeological treasures which are considered among the most important world-wide.

VULNERABILITY TO CLIMATE CHANGE

Sea Level Rise (SLR)

Although the Nile Delta makes up only 2.5% of Egypt's area, it is home for more than 27 million people (400 capita per 2.6 km^2). Three scenarios of SLR of 0.5, 1.0 and 2.0 m, over the next century are assumed. A 0.5 m SLR is projected to cause migration of more than two million people, a loss of more than 214,000 jobs and value losses stratospheric ozone would cause displacement of almost 1.5 million people and the loss of about 200000 jobs by the middle of the century (El-Raey and Frihy, 1999). In Rosetta, a historical coastal city, it is estimated that 50 cm in SLR could affect one third of the city's employment.

Similarly, the city of Port Said is vulnerable to SLR with possible adverse impacts. A rise of one meter or more would flood a quarter of the Delta and force about 10.5% of Egypt's population out of their homes. Underground water is expected to be contaminated with salty water if the SLR increases. Wetlands will face dual threats of dry-

ing out and being inundated by seawater. Up to 85% of coastal wetlands in Egypt could disappear with a 3 - 4 °C rise in temperatures.

Egypt's coastal zones, extending for over 3500 km in length along the Mediterranean and Red sea being home for more than 40% of the population. The SLR threatens the coasts of Mediterranean and the Red Sea with potential damages to fish catches, recreational beaches, archaeological sites and hence socioeconomic implications (Halim, 2004).

Water scarcity

The first impact of climate change in Egypt is likely be felt in water domain**.** Water is already a limited resource, with per capita share just below 1000 m^3 per year and is thus at the edge of the so-called poverty line (El Quosy, 1999). River Nile, provides more than 95% of all water to Egypt and the annual rainfall varies from a maximum of 180 mm/year on the North coast, to an average of 20 mm near the city of Cairo and diminishes to as little as 2 mm close to the city of Aswan in upper Egypt. Both water supply and demand are expected to be exaggerated by climate change. Impacts on the supply side are likely to arise from possible changes of precipitation patterns over the Ethiopian highlands and equatorial lakes. These effects of predicted climate change on both components are uncertain Decline in rainfall on the upper White and Blue Nile catchments and Middle Nile basin may exacerbate the set-up.

Yet It is expected by 2050 that climate change will increase water demand by an average of 5% (Eid, 1999). Meanwhile, most of the population of Egypt are linked to the agricultural sector which constitutes 20% of gross national products and consumes about 80% of the water budget. However, there are conflicting projections of the future availability of Nile water as a result of climate change. While some simulation studies foresee an increase in Nile water increase by 25% over current yearly levels, a larger number of studies project declines reaching up to 70% (El-Quosy, 2008). The difference in results indicates that more robust studies are needed to provide a more solid base for the design of public policy. However, the most plausible projections seem to point to less availability of Nile water in the future.

Agricultural and food insufficiency

Egyptian agriculture faces two major potential threats; the first is that River Nile might lose 30 to 60% of its main resources due to climate change. The second is that all estimates show that North Africa rain-fed farming would decrease to 50% owing to climate change. No detailed quantitative assessment of the actual impacts of climate change on agriculture has been carried out yet, though it is expected to decline by 10 - 60% (Pam, 1990). It is worthy to state that seasonal (winter and summer crops) and geographical distribution of Egyptian crops are temperature controlled.

The major crops in Egypt (wheat, maize, clover, rice, cotton, sugar-cane, bean, sorghum and soybean) are expected to decrease due to global change and water shortage. A doubling of CO_2 might increase photosynthetic rates significantly, but crop harvests will decline due to water scarcity and heat-associated damage to plant pollination, flowering and the formation of grains. By 2050 decline in yields due to climate change is expected to reach 28% for soybean, 18% for wheat and barley, 19% for maize and sorghum and 11% for rice, while that of cotton would be increased (Eid, 1999).

Livestock production would also suffer due to reduced range quality and availability. Hotter and drier conditions would widen the area prone to desertification which would also be aggravated by increases in erosion and reductions in soil fertility. The economic and human costs of desertification would be tremendous (El-Bagori, 2008).

Loss of biodiversity and habitats

Climate changes will reshape the main habitats in Egypt (El-Bagori, 2004) which must be maintained to safeguard biodiversity (Figure 1). Although wild species will react differently to climate change, negative impacts are expected in areas adjacent to the Egyptian Northern lakes, Eastern desert habitats, marine habitats, marginal pasture in Sinai, natural mangrove vegetation in the Red Sea coasts. In the Western desert and the Southern valley habitats, the expected increase in temperature will increase the water requirements of field and horticulture crops. A substantial number of the currently endangered species might be lost as coastal habitats are lost and native communities invaded by competitors.

Red Sea coral reefs are among the most spectacular in the world, boasting a high level of biodiversity with over 1,000 named species and many more yet to be identified. They are especially sensitive to variation in sea surface temperatures, and when physiologically stressed, corals may lose symbiotic algae, which supply nutrients and colors. At this stage, corals appear white and are referred to as bleached. In 2006, two phenomena of coral reefs' bleaching had been monitored in Egypt (Figure 2).

The first represented in the extreme low tide exposing coral reefs to direct air and losing vitality. This phenomena continued for a few days during spring season, where some areas were still affected and did not recover till now

Biological diversity has many benefits for human beings, its different kinds and species contribute in providing agricultural, fishing and livestock services, scientific research and cultural heritage. Some flora and fauna species with their genetic components help in developing medical, agricultural and industrial sectors. Additionally, it provides daily essential needs for the life of many local communities, Biological diversity support, ecotourism with

Figure 1. Red sea marine hábitat.

Figure 2. Bleached Coral Reef in Red Sea**.**

its great economic potential

Human health

Climate change is expected to have adverse impacts on human health in Egypt, which will be aggravated by high population densities. These may include increased prevalence of severity of asthma and infectious diseases, vector borne diseases, physiological disorders, skin cancer, eye cataracts, respiratory ailments, heat strokes, weakening public health infrastructure as well as extra deaths from cardiovascular and respiratory illness, diarrhea and dysenteric infections, children mortality rates and malnutrition. However, comprehensive studies that contain detailed estimations and correlations between climate change and human health are still lacking in Egypt.

Confronting jeopardy

As the home of one of the oldest civilizations on the planet, Egypt is concerned about climate change on sustainable development (EEAA 2008a) and is among the first MENA countries to join the cooperative global efforts to confront climate change threats. Since the Rio de Janeiro Earth Summit in 1992, Egypt ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994 and the Kyoto Protocol has been signed in1999.

Egypt is also an active participant in African plans related to climate change (Saber, 2008). Close partnerships and alliances in achieving shared goals between MENA countries are now considered as a priority issues. A Strategy and action plan for the region, supported by international organizations became a must. Implementation of the action plan should count on recent achievements in the sciences of atmosphere, hydrosphere, meteorology and hydrology .

Egypt emits only 0.64% of the world GHG, that is, 0.36 tons/per capita (EEAA, 2008c). The industry sector is the major contributor to CO_2 emissions in 2016/17 (49%), followed by the electricity sector (29%) and the transportation sector (14%). Based on a technology assessment study that was undertaken within the support for a national action plan, three GHG mitigation scenarios were developed; “Fuel Substitution”, “Renewable Ener-gy”, and “Energy Efficiency” (Figure 3). Current Egyptian energy policy calls for shifting the demand from liquid fuel oil to natural gas in electricity generation, industry and residential sectors.

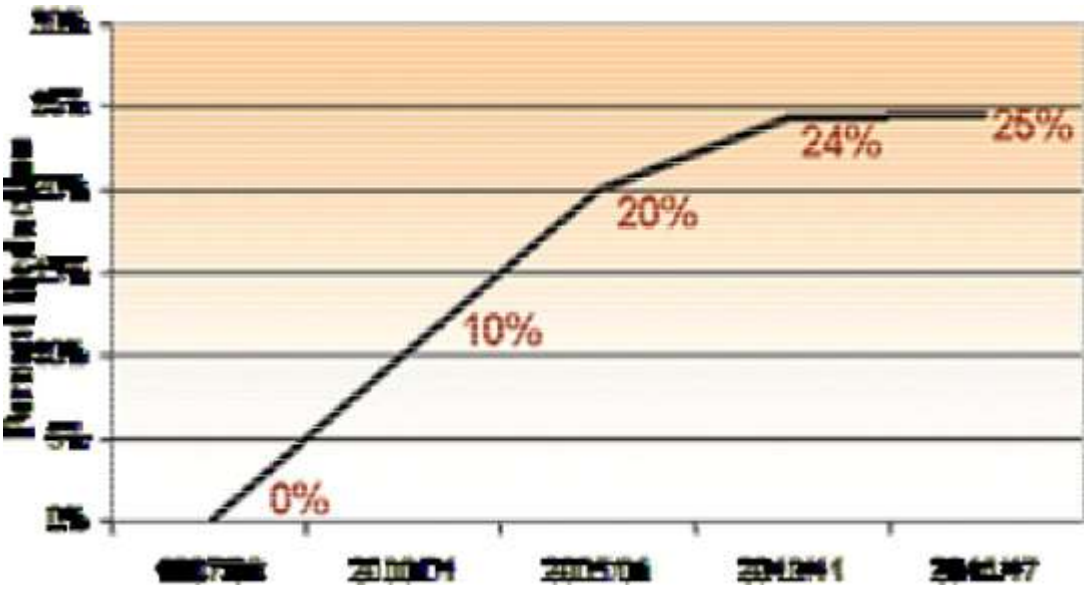

Figure 3. Projected reduction in co_2 emission.

Observing its obligations under the Montreal Protocol and the amendments thereto regarding protection of the Ozone layer, Egypt formed a National Ozone Committee with representatives from all concerned bodies, to supervise the implementation of projects of alternatives and activities of air conditioning and refrigeration using instead Ozone-friendly materials. As early as the instructions were given, the customs authority has totally banned releasing shipments using Ozone destructive materials except after being reviewed and approved by the EEAA. Meanwhile, the Ministry of agriculture was provided to find alternatives for the methyl bromide such as the Metam-sodium, Bezamite and Phosphine.

To confront adverse impacts, Egypt's Second National Communication Project (SNC) is developing a comprehensive study on climate change impact on Egypt started in June, 2006 and will be completed in June, 2009 (EEAA, 2008b). A strategy is prepared to adapt to potential changes in agriculture, water resources, irrigation, health, coastal zone in the light of SNC outputs. Within the framework of MSEA (Ministry Sate of Environmental Affairs) efforts to manage climate change impacts, NCCC (National Climate Change Committee) has been re-established by the Prime Minister Decree No. 272/2007 to be chaired by MSEA and consists of scientists and experts from different line ministries and relevant bodies. NCCC makes effort to manage climate.

Technology transfer of climate-friendly technologies for both adaptation and mitigation is critical for Egypt and MENA countries to cope with the challenges posed by climate change. Capacity building on vulnerability assessments, climate change impact assessments and environmental management are badly needed. It is within the national interest to institute and strengthen nation-wide systematic observation and monitoring networks for sea level modeling and climate change modeling.

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