Strategy for Integrated Assessment of Climate Change Impacts on Nexus (Water, Food and Energy) in Arid Area

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1-Abstract

Growing population, water sacristy, energy, food security and climate change are the main challenges facing arid areas including Egypt. Uncertainties of the impact assessment for adaptation and mitigation of climate change is scanty and not well documented. Therefore, there is a need of highlighting climate change mitigation in Egypt across assessment of various studies related to climate change and agriculture. Hereafter, in this study, climate change responsible sectors and states in Egypt are allocated. However, positively, the Ministry of Water Resources and Irrigation (MWRI) start mitigation in 1960 through implementation of subsurface drainage system. Originally was designed for preventing higher soil salinity in case of sea water rise. On the other hand, analysis of 30 years meteorological data shows increasing maximum temperature with 2 oC and minimum temperature with 0.5 oC. This led to increase the required evapotranspiration and then increase the demand of irrigation water. Therefore, increasing temperature in hyper-arid land countries, such as Egypt, occurrence of droughts which particularly is evidences of weather aberrations indicating climatic risks. However, marine life studies are not well identified. In the same context, Ministry of Agricultural (MALR) produce heat, salt tolerant and high yielding varieties. Planting dates shifted earlier due to farmers themselves experience. This also might be due to producing the short duration varieties. Effect of climate change on yield of main crops was predicted using simulation models. However, this study consider a base for future implementation and well-designed mitigation.

Keywords: Historical mitigation, Water resources, Agroecology, Egypt

2- Background

Developing countries experience shows that institutional weakness and malfunctions are a major cause of ineffective and unsustainable water management. Several reasons are responsible for this situation where many national and local institutions are not working neither efficiently nor effectively. However, this is very clear also in other Nexus parameters (food and energy). The challenges facing all stakeholders led to recommendations based on manifold expertise and a willingness to start where others have ended. Further warming is consequently expected to reduce crop productivity. These effects are exacerbated by the fact that agriculture and agro-ecological systems are especially prominent in the economics of Egypt as one of the African countries. The rapid growth of the country's population, the economic stress of reliance on food imports, and the limited area for agriculture requires finding new ways to increase agricultural productivity in general and oil crops in specific. If climate change as projected by atmospheric scientists adversely affected crop production, Egypt would have to increase its reliance on costly food imports. Studies on the drafting strategy for the effect of climate change impacts on Nexus are scanty and not well documented. It is therefore, the objectives of this study were to assess the challenges facing Egypt due to climate change.

3-Stakeholder classification and responsibilities

In many countries, there is over interaction on the responsibility of climate change. In Egypt, a lot of ministries and sectors are dealing with climate change. However, there is a great gap between worldwide actions to deal with climate change and national action plan. Therefore, the over interaction and unknown responsibility of each sector shows a negatively affect application of climate change strategy in Egypt.

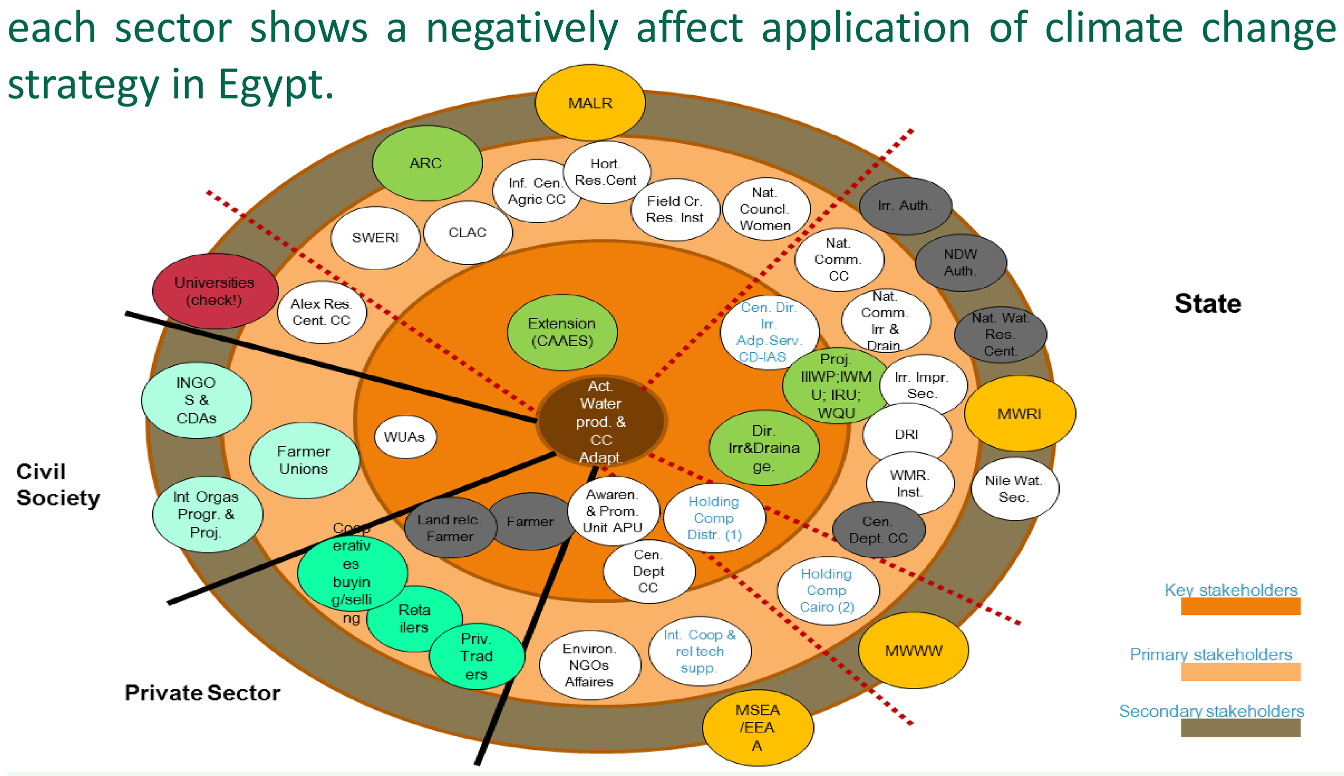

Figure 1 Climate Change related stakeholder mapping of Egypt (AWP-ACC, 2013)

4- MWRI and Climate change

Ministry of Water Resources and Irrigation (MWRI) start mitigation of sea water level rise then increasing soil salinity in 1960 through implementation of subsurface drainage system. Originally was designed for preventing higher soil salinity in case of sea water rise. The main activity in implementing subsurface drainage is the installation of covered field collectors of cement or PVC corrugated pipes and buried lateral drains of PVC corrugated pipes with envelope where necessary and associated structures. The depth of laterals design is to be 1.2 m at the upper end of the lateral and 1.5 m at its connection with the collector drain.

On the other hand, the average air temperature values (maximum and minimum) for the studied location during the last 30 years. Within the study period, it is noted that the maximum air temperature increased by about 2 degrees while the minimum air temperature increased by about < 1 degree. However, these changes in the air temperature did not significantly affect the observed ETo values. Therefore, increasing temperature in hyper-arid land countries, such as Egypt, occurrence of droughts which particularly is evidences of weather aberrations indicating climatic risks.

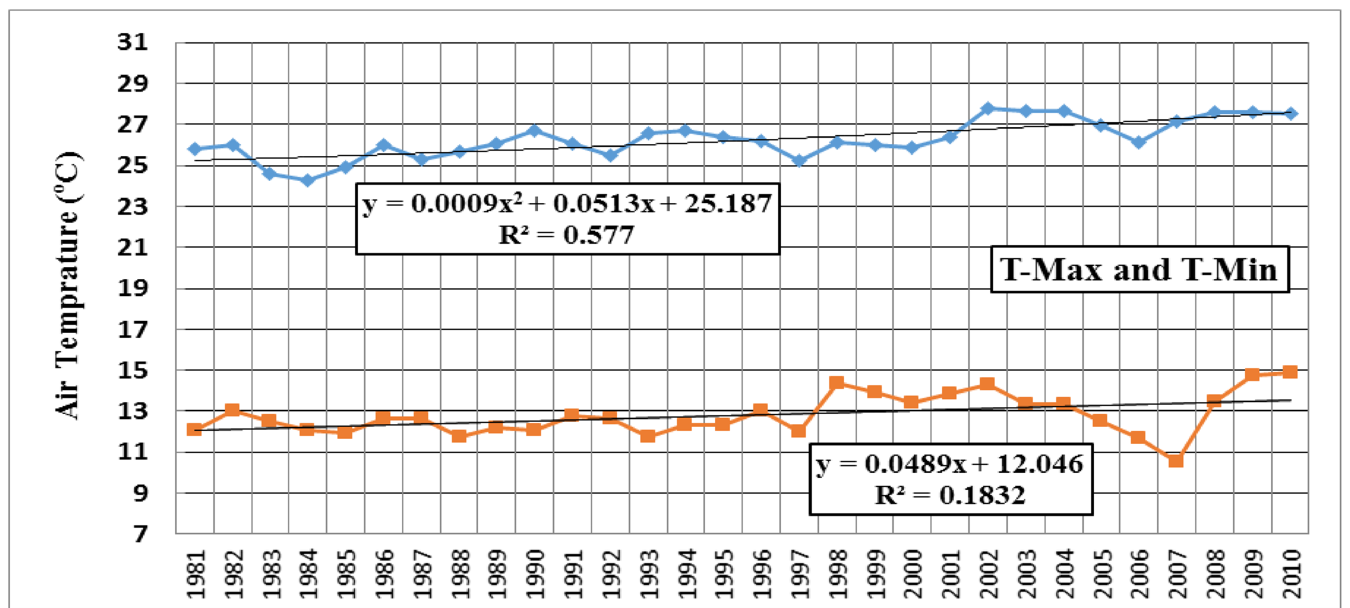

Figure 2: Air temperature trend in the study area over last 30 years in North Delta.

MWRI in Egypt recognized the fact of importance saving water to mitigate the predicted climate change. Therefore, water saving projects were initiated a number of development projects to mitigate water wastage. From 1977 to 1984, the Egypt Water Use Project was in effect; it aimed to improve agriculture and water-management programs (EWUP, 1984). In 1993, the World Bank launched the Irrigation Improvement Project (IIP) in a total area of 105,000 ha. The main objectives of the IIP are to improve irrigation infrastructure, water-distribution systems, and on-farm irrigation management.

In 2004, the World Bank and MWRI initiated the Integrated Irrigation Improvement and Management Project (IIIMP) to increase irrigation efficiency and agricultural productivity as well as improve drainage and groundwater management. The total target area under the IIIMP is 210,000 ha, and this area is located in lower, middle, and upper Egypt (MWRI, 2005). The entire project area has been divided into different command areas.

Picture 1: Actual Situation after and before IIP

5- MALR and Climate change

Ministry of Agricultural (MALR) produce heat, salt tolerant and high yielding varieties. Planting dates shifted earlier due to farmers themselves experience. Vulnerability studies were made to assessment the potential impacts of climate change on yield, water consumptive use (crop evapotranspiration, ETcrop) and farm net return. The studies indicated that most of crops productivity will decrease with about 18 % and water consumptive use will increase with about 10%. Only cotton will increase with about 17% with increasing water consumptive use with 10%.

Adaptation studies related to changing sowing dates, cultivars and amount of irrigation water were also applied. The main crops such as wheat and maize were optimized through shifting sowing dates with a range from 2-4% for wheat and from 7-11% for maize. Planting date of tomato shifted to middle of February with increasing air temperature (+3.5°C) but water consumptive use increased as well as yield. General outputs of MALR indicated that increasing air temperature have a negative impact on most of main crops productivity as well as increased its water consumptive use. The positive output from MALR is decreasing plant duration for some crops such as rice with increasing its productivity such as rice. Validation of MALR results using AQUACROP model were identified as presented in tables 1 and 2. This validation shows a same trend from productivity point of view while it shows a decrease in water consumptive use. This decrease is due to decreasing of growth required days in winter and summer seasons.

Table 1 Effects of rise in air temperature (+T) on crop growth and ET for main summer crops without ET reduction

Factor	Rice				Maize			
	Biomass (ton/ha)	Grain yield (ton/ha)	Growth days	ET (mm)	Biomass (ton/ha)	Grain yield (ton/ha)	Growth days	ET (mm)
Control	17.768	9.239	98	575.8	19.234	9.234	75	423.1
+1 °C	17.335	8.668	96	566.8	19.201	9.218	75	421.6
+3 °C	16.528	7.107	91	546.8	`19.117	9.177	76	418.8
+5 °C	15.812	4.861	87	526.8	18.414	8.840	74	409.9

Table 2 Effects of rise in air temperature (+T) on crop growth and ET for main winter crops without ET reduction

Factor	Wheat				Sugar Beet			
	Biomass (ton/ha)	Grain yield (ton/ha)	Growth days	ET (mm)	Biomass (ton/ha)	Grain yield (ton/ha)	Growth days	ET (mm)
Control	17.700	8.496	143	146.5	18.250	12.775	134	135.1
+1 °C	16.882	7.259	136	141.4	18.814	13.170	134	134.3
+3 °C	15.283	5.043	123	131.3	18.658	13.060	134	134.1
+5 °C	13.970	3.439	113	123.8	17.525	11.917	128	126.3

6- CONCLUSION

In general, there is urgent need for:

1. The challenges facing the climate change adaptation in Egypt indicate the need for strengthening the role of all involved stakeholders.
2. Within last 30 years, the maximum air temperature increased by about 2 degrees while the minimum air temperature increased. This lead to increasing water consumption use and without mitigation and finding heat tolerant varieties, crop productivity will decrease.
3. Validation using AQUACROP model shows that CC lead to decrease in crops productivity and water consumptive use. The decrease in water consumptive use is due to decreasing of growth required days in winter and summer seasons.
4. National adaptation plan should be developed and updated.

References

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