ASSESSMENT OF IMPACTS, ADAPTATION, AND VULNERABILITY TO CLIMATE CHANGE IN EGYPT: FOOD PRODUCTION AND WATER NEEDS

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Egyptian Case Study
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Irrigation Water and climate change

Introduction

- *The inhabited area in Egypt does not exceed 3.5% of the total area and is confined to the narrow strip which boarders the main course of the River Nile from Aswan in the south to Cairo in the north plus the Nile Delta which covers the area from Cairo to the shore line of the Mediterranean Sea between the cities of Damietta in the east and Rosetta in the west.*
- *The main agricultural regions in Egypt are; Nile Delta, Middle and Upper Egypt.*
- *The agricultural land area is determined by climate and water availability.*
- *The country's total area is relatively large, spanning 9 degrees of latitude (from 31.5 ^{o} N to 22.0 ^{o}N) and presents north-south gradient temperatures.*
- *Temperatures increase form north to south.*

Introduction (2)

- *The only region with appreciable rainfall is the northern coast, with 100-200mm/year. Within the Delta, the precipitation is 40-60 mm/year; precipitation in the south and desert is non-existent.*
- *Egypt currently uses about 85% of the total water resources in irrigation.*
- *The share of Egypt from the Nile is 55.5 billion plus 1.4 Billion from the last two resources. The total is 56.9 Billion M3.*
- The sectoral water demand for irrigation used in 1980/1981 was 29.4 BCM. It increased to 40.8 BCM in 1995/1996. The increase in water used was limited in other sectors (Municipal, industry, Navigation was decreased).
- The evolution of per capita water availability as a result of the increase in the population, where it was 2376 M3 in the fifties it decreased over time till it reached 978 M3 in 1995 and it is expected to decrease to 886 M3 in the year 2000.

Irrigation System in Egypt (1)

- *The flooding irrigation system in Egypt is a closed system, which starts with one single inlet of irrigation water at the Aswan high dam and ends in the north with the Mediterranean Sea and the coastal lakes which are indirect connection with the sea.*
- On-farm irrigation from distributary canals is carried out in more or less 80% of the areas by lifting. Gravity irrigation takes place only in Aswan and Fayoum Governorates. Almost all irrigation canals in the old lands are unlined.
- The problems connected to these types of canals are:

  1. Aquatic weed growth includes three different types: emergent, submerged and floating.

  2. Seepage from irrigation canals is a function of the water level with respect to the adjacent land levels and with respect to groundwater elevation.

  3. Unstable and oversized cross sections are caused by sedimentation, erosion of canal banks by water scoring and animal traffic.

Irrigation System in Egypt (2)

- Water Distribution Control in Egypt
- Water delivery to farmers throughout Egypt is based on extensive canal systems served by major canals which off take from the Nile upstream of the river, s seven major barrages.
- Each main canal, sometimes with sub canals, feeds a number of canals and areas. Water is distributed within these command areas by secondary canals. These canals feed either tertiary canals, or in some cases Mesqas, which are small channels serving between fifty and five hundred feddans. It is from the Mesqas that individual farmers take their water supply. However many farmers take supplies directly from secondary canals.
- Sectoral water demand for irrigation used in 1980/1981 was 29.4 BCM. It increased to 40.8 BCM in 1995/1996. The increase in water used was limited in other sectors (Municipal, industry, Navigation was decreased).

Problems of the Egyptian agricultural system.

- *Any attempt to assess the future of Egyptian agriculture must consider the complex interactions between the factors that determine the use of the land, the choice of cropping systems and the socioeconomic characteristics and limitations.*

(a) Population and Urban Growth

- *The growth of population (now increasing at the rate of 2.3 percent a year) and urban encroachment (currently estimates at 10,000 to 20,000 hectares per year) are major factors that will determine the sustainability of the Egyptian agricultural system.*

(b) Loss of Agricultural Land and Deterioration of Crop Yields

- With no changes of current trends in crop patterns and water use, agriculture will experience an intensifying loss in available land to water logging and salinization, as well as to urbanization.
- Field water application efficiency values in Egypt are typically well around 50 percent. Such low values imply that about half of the water applied in the field looses.
- Drainage problems lead to reduced crop yields below potential. Irrigation water quality will deteriorate, altogether resulting in a decrease in agricultural productivity.

Egypt Case Study
Main Activities (1)

- **A. Impact detection:**

  1. Stakeholders field-based studies of the adaptation choices of small-holder farmers, commercial farmers and strategic resource managers. The methodology is a survey analysis and communication with stakeholders by local training and national workshops. Both to detect impacts and to choose the best adaptation options.

  2. The Empirical statistical analysis was used to evaluate how agricultural cropping systems interact with intra and inter-annual climate variability. Decadal climate variability was considered, in terms of direct agriculture impact, and in terms of possible modifications of longer-term crop-climate-economy relationships.

  3. Simulation models, mainly DSSAT was the tools been used for analysis and databases of historical climatic data, soils and crop management variables for Egypt, which are being used in the impacts assessment. Projected crop impacts and the impact of water shortage in the Nile Delta are being assessed according to future conditions derived form the scenarios formulation (GCMs/ MAGICC/SCENGEN).

Main Activities (2)

- **B. Adaptation Options Evaluation**:
- *Training farmers on water management technologies through improving surface irrigation system.*
- *Reducing the area under cultivation with high water consumer crops (Rice, Sugarcane) can save irrigation water*
- *The engagement of water user associations (WUAs).*
- *The evaluation of adaptation considered the adaptation effectiveness, adoption rate and constraints. The modeling studies considered on-farm adaptation techniques such as use of alternatives existing varieties and optimization of the timing of planting and other techniques can partially up to completely compensate for the yield losses.*

Objectives	Tasks / Deliverables
Stakeholders' engagement	**Case Studies** (a) Synthesis of knowledge and information; (b) Survey analysis; (c) contribution to WEB site. Contribution to the WEB site and case local reports **N. Africa - wide** WEB site; Synthesis across stakeholders and regions. WEB site and Regional Stakeholder Report
Impact detection	**Case Studies** (a) Historical analysis of cropping areas, productivity, and climate; (b) Scenario analysis at the site level. Report of Historical Analysis; Communication (lectures, seminars, etc.) **N. Africa - wide** (a) Historical correlation of climate and cropping areas; (b) Scenario development; (c) Scenario analysis. WEB site posting of correlation maps in current and future situation.
Evaluation of adaptation methods	**Case Studies** (a) Historical inventory of adaptation methods; (b) Evaluation in the context of climate change. (a) List of adaptation methods; (b) Guidelines for future management **N. Africa - wide** Post in WEB Synthesis report, Matrix of Adaptation-Stakeholders; Maps of adaptive capacity
Linkages between climate information, scenarios and vulnerability	**Case Studies** (a) Define climate indicators; (b) Quantify adaptation capacity; (c) Determine site representation; (d) Integrate regional scenarios. Matrix on current and future risk of adverse effects of climate **N. Africa - wide** Mapped index derived form a matrix that includes climate change, impacts, and adaptive capacity
Capacity building and training	**N. Africa - wide** (a) Advice for Regional Workshop Prototype. (b) Disseminate information of the Project to local stakeholders.
Relevance to decision making	**N. Africa - wide** Synthesis report with strategic evaluation of vulnerability as background to the Climate Chan and Desertification Conventions

Achievements

1. Stakeholders Analyses:

- **1. Stakeholder engagement:**
  It was conducted through four steps processes as follows:
- *Identifying Key Stakeholders,*
- *Determining Stakeholders' Interests,*
- *Determining Stakeholder Power and Influence and*
- *Formulating a Stakeholder Participation Strategy.*

  For irrigation water management, water user associations were involved.

- **2. Field-based studies:** Stakeholders in Egypt did field-based studies *of the adaptation choices of small-holder farmers, commercial farmers and strategic resource managers. The methodology is a survey analysis and communication with stakeholders by local training and national workshops.*

- *A list of farmers from El-Beheira, Khafr El-Sheikh, and El-Gharbia governorates was prepared as a selected sample to represent the Delta region.*

Achievements

- *Improving both the technical water application efficiency and the agronomic water use efficiency.*
- *This can be carried out by revamping the entire system of water delivery and control. Canals lining plays an important role in this connection.*
- *Learning farmers, with the objective of improving surface irrigation method; land leveling with slope, long furrows, long borders and others.*
- *In this connection and with the goal of increasing agricultural production and achieving the best possible use of water resources, the study of applying agricultural technologies was carried out in Behiera and Khafr El-Sheikh governorates.*
- *Training should be offered to farmers willing to modernalize their irrigation and also to know how to apply water timely and efficiently.*
- *The study depends on effective extension activities which provide the farmers with the knowledge needed and teach them how to apply this knowledge's. Extension efforts have been exerted to convince farmers that it is necessary to follow the agricultural practices which guide the use of water in irrigation.*
- *Among such activities were paying attention to the demonstration aggregates and fields to cultivate various crops where technologies are applied in order to increase production and guide to the use of water through the use of precession land levelling, long furrows, long borders, and planting dry berseem (as alternative to the traditional wet method), etc...*

Achievements

- *Also, to increase the educational effectiveness of the demonstration aggregates and fields, there are: The field days, the harvesting days, meetings, and field visits were made by researchers and extension workers.*
- *Much attention has been made to evaluate the educational effect for such demonstration aggregates and fields carried out on winter season, including wheat, sugar beet, and clover (berseem) crops, and summer season crops, including cotton and rice to know the extent of the farmers knowledge of the technologies used for each crop, find out the growers attitudes towards practices of water management, farmers adoption of water management practices, farmers reasons for using too much water in irrigation, and their suggestions for controlling the use of irrigation water. Basically, the analysis includes the process of learning by doing*

Achievements

Water Users Associations (WUAs) :

Involvement of (WUAs) in decision making during various stages to share a common water resource and management

- **The main functions of (WUA) is to participate in planning, design construction of old mesqas and operation, maintenance and follow up of the improved mesqas participation in the water management.**

- **Creation of much closer working relationship between water suppliers and beneficiaries which is reflected in the following issues:**

- *Reduction of financial and operational responsibilities of Ministry of public Works and water Resources.*
- *- Improved mesqas reduce evaporation and seepage losses and increase water delivery efficiency.*
- *- Equity of distribution between head and tail reach farmers.*
- *- Reduce size of canals by shifting from rotation to continuous flow, which can add to the area of cultivated land.*
- *- Less number of pumps and lower pumping costs is associated with.*
- *- Reduce irrigation timing and allow for more flexibility in irrigation.*
- *- Eventually all these actions would increase crop yield.*

Primary trends of stakeholder analysis on water management

- The different activities of on farm water management component achieve its goals towards teaching the farmers technologies and raising their awareness about good water management in their fields to obtain the highest production and increasing the water use efficiency.
- Also, enrich the cooperation between village extension workers (VEW) and irrigation advisory engineers (IAS)

Achievements
2. Modeling Analysis :

- *Empirical-Statistical analysis models was used to detect the climate impact on wheat crop productivity and water use. Primary results on the impact of climate on wheat crop productivity and water needs were obtained. Analysis on another crops is being carried out.*

- *Simulation models mainly **DSSAT** is the tools for analysis and databases of historical climatic data, soils and crop management variables for Egypt, which are being used in the impacts assessment. **CERES-Wheat** model was validated and is being used in the study.*
- *Projected crop impacts and the impact of water shortage in the Nile Delta will be assessed according to future conditions derived form the scenarios formulation (**GCMs/ MAGICC/SCENGEN**).*