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Egypt Country Paper
Potential of soil degradation through salinization

and

A Case Study on
Egypt Experience of Using Agricultural Drainage Water in Irrigation

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ABSTRACT

Egyptian agriculture is wholly dependent on irrigation from the Nile River. One exception is the small areas of irrigated land in several depressions in the Western Desert where fossil groundwater is the source of irrigation water. Rainfall is so negligible as a source of water for agriculture. This is except for a small area along the Mediterranean Coast with less than 200 mm/year. Outside the Nile Valley and Delta and the Mediterranean Coast, the bulk of Egypt (almost about 97% of the total area) is arid desert. Consequently the agricultural development has always been, and still is today, closely associated with the Nile water. Almost more than 84% of Nile water are consumed by the agricultural sector. The rest is allocated for industrial, municipal and navigation uses.

Soil Resources are expected to increase by 40 % by the year 2017 through adding about 3.2 million feddans to the present cultivated soils which are 8.2 million feddans. The main water resource (Nile Water) is expected to be constant (55.5 BCM/y) in the short term time.

According to the governmental plan non-conventional water resources, i.e. agricultural drainage water, the treated sewage water and groundwater of Nile aquifer (floodplain and Nile fringes, will be used and reach about 35 % of the water resources used in agriculture. The salinity levels of this water vary but these levels are higher than those of conventional primary irrigation water sources and consequently could easily contribute to the salinization problem by the miss-use and the absence of proper on-farm water management as well as monitoring water and soil quality (salinity).

Taking into consideration the environmental condition of the agriculture sector, e.g. fine textured soils with low permeability, arid climate, high water table, sea water intrusion, used of non-conventional water resources…., soil salinization must be considered as the main threat for soil degradation

I. POTENTIAL OF SOIL DEGRADATION THROUGH SALINIZATION

A. LOCATION

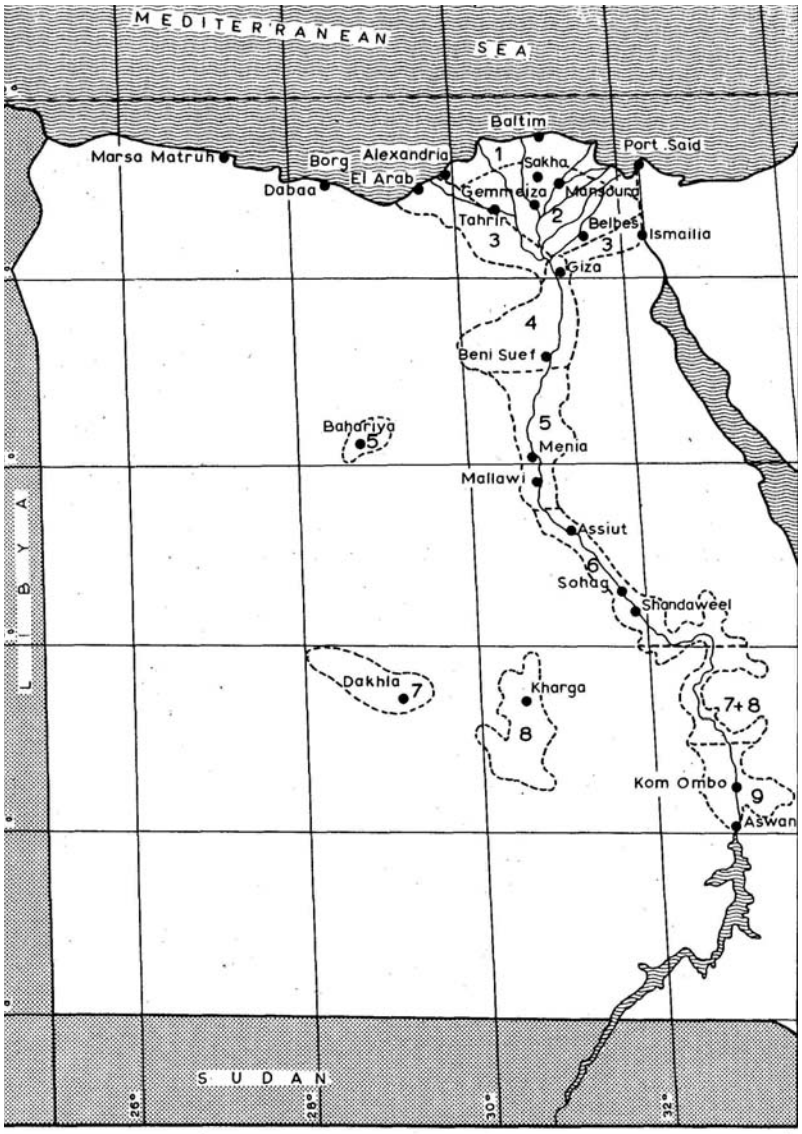
Egypt occupies the north-eastern corner of Africa at the crossroads linking the near and far east. It is located between latitudes 22 and 32 north and longitudes 24 and 37 east, and is bordered by Mediterranean Sea to the north and Sudan to the south, the Red Sea, Israel and Palestine to the east and Libya to the west. This latitudinal location means that the most of Egypt falls within Africa's dry desert region, excepting a narrow strip of land for north which experiences a Mediterranean type of climate. The total area is about 1,000,000 square kilometers.

B. CLIMATE

The climate is sub-tropical arid climate. Agriculturally speaking, Egypt is practically rainless country, depending on irrigation for its agriculture.

Climatologically Egypt is too much differentiated to expect uniform agro-meteorological conditions, Aboukhaled et. al. (1975), based on the analysis of a combination of temperature, vapour pressure and wind velocity concluded that the Delta area is to be subdivided in a Costal Area, a Central Area and a Desert Border Area. On the other hand, Middle and Upper Egypt agro-climatologically can be subdivided on basis of latitude. The following 9 agro-climatological areas are therefore distinguished (see map):

1. Coastal Area
2. Central Delta Area
3. Desert Delta Area
4. Giza area
5. Area latitude 29^o - 27.5^o N
6. Area latitude 27.5^o - 26^o N
7. Dakhla area 26^o - 25^o N
8. Kharga area 26^o - 25^o N
9. Aswan area 25^o - 24^o N



1.	Coastal area	5.	Area latitude 29^o - 27.5^o N
2.	Central Delta area	6.	Area latitude 27.5^o - 26^o N
3.	Desert Border area	7.	Dakhla area 26^o - 25^o N
4.	Giza area	8.	Kharga area 26^o - 25^o N
		9.	Aswan area 25^o - 24^o N

Agro-climatological areas of Egypt (from Aboukhaled et al., 1975).

C. LAND RESOURCES

The cultivated Soils are estimated now by about 8.2 million feddans. Out of this area 5.5 million feddans are old alluvial soils while the rest (2.7 million feddans) is old and newly reclaimed land. This newly reclaimed land are basically of sandy and calcareous nature.

The agricultural alluvial soils of Egypt are about 3% of its total area. The majority of the cultivated soils are recent alluvial soils formed from the sedimentation of the flood suspended materials during the different flood seasons in the recent geological era. These soils are heterogeneous in their textures and calcium carbonate content depending on the conditions at the time of sedimentation. These conditions are

Nile flood water velocity, distance from the main stream of the River Nile, differences in the soil surface (topography), overlapping of the flood streams of the old Nile branches in the Delta, and the influence of both eastern and western type of soils especially the mountains in the valley.

Pedologically the alluvial soils of Egypt belong to Azonal, the Entisols, Aridisols and Vertisols. They are young soils with no generalized pedogenic characteristics. The difference between them is a matter of texture, with its associated properties, as well as the influence of management practice. In general, the soil profile shows an almost uniform content of clay where **the fine clay is dominated by well-crystallized montmorillonite, abnormal dioctahedral iron-rich smectite.** ***Serious soil degradation of these soils is mainly through rising ground water and increasing salinity.***

The alluvial soils cultivated were surveyed. Regarding soil productivity the soils they were classified into six classes. The soils of classes 1 and 2 are considered as productive soils while the soils of classes 3 and 4 are considered moderate to poor productive ones. On the other hand, soils of classes 5 and 6 are bare soils, houses utilities.

The following is the description of the cultivated soil productivity classes:

Class 1:

These soils are high productive soils. The crop production of these soils is much higher than the general average of the country. The costs of the agricultural practices in these soils are relatively low. They are characterized by natural drainage where they drain in the River Nile, availability of irrigation water, non-**saline through the soil profile, non-sodic (non-alkaline) through the soil profile.** These soils are clay loam or loam, have moderate to rapid water permeability and have no water table to the depth of 150 cm.

Class 2:

These soils are good productive soils. The crop production of these soils is higher than the general average of the country. The costs of the agricultural practices in these soils are normal. They are characterized the availability of irrigation water, **non-saline through the soil profile except in small scattered areas where medium salinity appeared in the sub-surface layers or along the soil profile, non-sodic (non-alkaline) through the soil profile except in small scattered areas where sodicity (alkalinity) appeared only in the sub-surface layers of the soil profile.** These soils are clay have no water table to the depth of 150 cm.

Class 3:

These soils give the general average of the crop production of the country. The costs of the agricultural practices in these soils are relatively within the average. **They are characterized by poor drainage in most of these soils and the poor leveling of some of them, which resulted in the appearance of the water table at depths less than 150 cm from the soil surface. They are characterized also by the appearance of medium or high salinity along the soil profile or in some of its layers and this criterion is in the majority of the soils of this class. Other characteristics are that in some of these soils sodicity (alkalinity) appear either along the soil profile or in some of its layers;** in some other soils the soil texture is coarse sandy or calcareous especially those immediately next to the borders of the valley and delta.

Class 4:

These soils give a poor production far below the general average of the crop production of the country. The reasons for their poor production are the same as in class 3.

This classification shows that texture, water table, salinity and sodicity are the main factors controlling soil productivity in such soils

D. WATER RESOURCES

The Nile is the major source of water in Egypt. The Nile's Water Agreement between Egypt and Sudan in 1959 gave about 55.5 billion cubic meters. This amount is almost more than 90% of the country's developed water resources. The following is the available water in Egypt from different resources.

Rainfall is scarce and very limited except for the northern parts close to the Mediterranean Sea particularly in Sinai and Northwestern Coast. The rainfall water is used locally in these areas either for growing some pastures for animal grazing or cultivating some other crops, e.g. barely and figs. These areas are considered the dry land farming areas in Egypt.

The deep groundwater in Sinai and western Desert represents another water resource in Egypt but non-renewable in addition to its high mining cost. Therefore, its utilization still very limited and the future expansion of its use will not exceed small fraction of Egypt’s share of the Nile water.

On the other hand, there are some other non-conventional resources, i.e**. agricultural drainage water, the treated sewage water and groundwater of Nile aquifer (floodplain and Nile fringes).** The estimated amount of the drainage water to be reused either directly or after blinding with fresh water is about 4.5 BCM/y (Abdel Azim, 1999). This reuse is expected to reach about 8.5 BCM/y in future. Currently, about 0.5 BCM/y of treated sewage is used and it is expected to reach about 2.0 BCM/y by year 2017. current groundwater use of Nile aquifer (floodplain and Nile fringes) is estimated at 5.2 BCM/y and planned to reach 7.5 BCM/y in the future (Attia, 1996).

This means that by the year 2017 the non-conventional water, i.e. agricultural drainage water, the treated sewage water and groundwater of Nile aquifer (floodplain and Nile fringes, will be about 30 % of the water resources used in agriculture. The salinity levels of this water vary but these levels are higher than those of conventional primary irrigation water sources and consequently could easily contribute to the salinization problem by the miss-use and the absence of proper on-farm water management as well as monitoring water and soil quality (salinity).

E. IRRIGATION METHODS

Regarding the irrigation methods used surface and improved surface irrigation are the main methods used in the old alluvial soils. On the other hand, there are some areas where sprinkler and drip irrigation are practiced, i.e. some of those cultivated by fruit trees and vegetables. In the newly reclaimed land (sandy and calcareous soils) the use of sprinkler and drip are a must by law.

F. Cropping Activities

Since water is available all year round and agriculture is fully under irrigation, with some exceptions in very small areas in the northwest coastal zone, continuous cropping is the general rule all over the country.

1. Cropping Pattern and Crop Rotations

Crop rotations refer to the particular sequence of crops during the cropping seasons of the year, as well as during a definite numbers of successive years, depending on the area occupied by the main crop in the rotation.

There are a number of different crop rotations followed throughout the country, depending on the crops involved and the fertility of the soil. Rotations are usually named after the main cash crop in the rotation and the proportion of the land it occupies (hence the number of years it take to o be planted again in the same block of land). The commonest rotations are the 2-year and 3-year rotations while the 1-year rotation is forbidden because of its negative impacts on the soil characteristics and crop productivity. Including of a leguminous crop in the rotations (mainly berseem) is highly recommended to conserve the soil fertility as well as improving its physical properties.

As a perennial crop, alfalfa is not grown in the Nile Delta and Valley, and is restricted to the newly reclaimed lands. Other than the permanent orchards planted to fruit trees and sugarcane areas, there no place for permanent or perennial crops in the Egyptian cropping system.

Areas specialized in vegetable crop production usually have three or four crops a year. On the other hand, there are many different rotations introduced now in the cropping system of Egypt as a result on the introducing of new high yielding and short-duration growing-season varieties as well as new crops.

2. Cropping Intensity

The ultimate result of the double and multiple cropping patterns, commonly followed, is a very high cropping intensity. The cropping index in the 2-year and 3-year rotation is 2.0 as a result of growing two crops per year. The vegetables crop area with three to four crops a year will has a cropping index of 3.0 – 4.0. This means that the cropping area is almost more than double the cultivated land area (Cropping Area = Cultivated Area × Cropping Index).

G. Salt Affected Soils In Egypt

The salt affected soils in Egypt, in spite of their occurrence in a scattered pattern over the country, On the other hand, saline soils are scattered over the whole Delta but mainly predominate in the northern part.

1. Reasons of soil salinity:

- Sea water intrusion
- Inadequacy of field drainage network (inefficient drainage)
- High water table
- Waterlogged condition
- Use of low quality water “marginal water’ (drainage water, treated waste water, underground water)

The impact of these reasons is aggravated by the high evaporative demand of the atmosphere.

2. Measures to avoid soil degradation (deterioration):

- Egypt has the most intensive network of field drainage in the world especially in the River Nile Delta region. This is mainly to keep the surface water table at the needed reasonable depth for crop production. This is a must to clear the root zone from excess water, after irrigation within a short time and prevent the capillary action from moving the soluble salts to the root zone or soil surface.
- An intensive network of monitoring the quality of the drainage water is established to cover the Delta region (Figure 2). This is to collect the data of drainage water quality (salinity as well as other parameters) as the use of drainage water is practiced on a relatively large scale in crop irrigation in the Delta region.
- Cultivating rice (rice rotation) in almost 1 Million feddans concentrated in the northern part of the Delta. This has to impacts; one to stabilize the front of the Mediterranean Water intrusion and the other is to help in leashing any accumulated soluble salts in the soil profile during cultivating the other crops in the rotation

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II. USE OF AGRICULTURAL DRAINAGE WATER IN IRRIGATION (A CASE STUDY)

The amount of **Drainage Water** in Egypt is considered as 30% of the Irrigation Water. It is estimated by about 13 – 14 BCM/year.

The Drainage Water is considered now, in Egypt, as an important resource for irrigation in the water resource budget.

The policy of the government of Egypt is to use **the Drainage Water** in **irrigation** as follows:

- **Directly** for irrigation if its salinity is less than 700 mg/l;
- **After mixing** it 1:1 with Nile water (around 250 mg/l) if the concentration of salts is 700 to 1500 mg/l.
- **After mixing** it 1:2 or 1:3 with Nile water (around 250 mg/l) if the concentration of salts is 1500 to 3000 mg/l.

This is in addition to:

- The amounts Discharged to the Nile in Upper Egypt (about 4.07 BCM)
- The amounts Discharged to the Nile Branches and some Main Canals (about 1.5 BCM)

A. HISTORICAL

It can be stated that the **official** use (or reuse) of the Drainage Water in irrigation in Egypt is dated back to the thirties of the last Century. The mixing pump station of El-Serw El-Aaly was established in 1928 in northeast Delta to lift drainage water from El-Serw drain and mix it with the water from Rosetta branch. Since that time more than 20 mixing pump stations were established.

The estimated amounts of the Drainage water used in irrigation was 2.6 BCM during 1984 and increased to 3.6 BCM in 1994 to reach 4.1 in 1998 aiming to 8.4 by the complete operation of El-Salam (Eastern part of the Delta) canal and finalizing El-Ummum Drain project (Western part of the Delta and North Sinai).

There is also an **unofficial use** of Drainage Water in irrigation estimated at 2.0 BCM.

B. ACTIONS FOR IMPLEMENTATION

In order to implement the policy of using (or reusing) in a safe way the Ministry of Water Resources and Irrigation has an intensive network to monitor the quality of the water either in the main open drains, pumping station and mixed water. This network covers the **Nile Delta** as well as **Fayoum Governorate** with more than **90 measuring points.**

One of the very serious actions to be considered is to keep the drainage water away of contamination by the different pollutants; mainly sewage and industrial effluents.

C. RESEARCH

To cope with the policy of the government to use the Drainage Water as one of the main sources of irrigation water an extensive research program is carried out in the research institutions in Egypt. The research areas can be summarized in the following:

- Study the negative impact of using drainage water on soils and methods of mitigation.
- Establishing local guidelines to use drainage water in irrigation.
- Recommending an optimum crop-soil-water management for using the Drainage Water in irrigation.
- Producing crop salt tolerant varieties to be cultivated where relatively saline drainage water to be used.

D. EXTENSION

There are many ways to advise farmers and disseminate the information regarding the use of drainage water in agriculture (irrigation). The following are some of the organizations that lead the work in this area:

- In the Ministry of Agriculture and land Reclamation there are the Sector of Agricultural Extension (village extension workers and subject matter specialists), Experimental Research Stations working as research and extension organizations (satellites of the Research Institutes of the Agricultural Research Center) and National campaigns.
- In the Ministry of Water Resources and Irrigation there are the Institutes of the National Water Research Center, Irrigation Advisory Service division, Water users Associations organizations and Water Boards organizations

E. NEW APPROACH

Recently there is a new approach in using the drainage water in irrigation named intermediate use. This new approach is depending on using the drainage water within the location it is collected and not to leave it to be collected in the main drains and then use it. The advantage of this approach is it will conserve the drainage water quality by not mixing it with other lower drainage water qualities from other areas served by the main drain. Also it will save the drainage water from pollutants that may be carried out by drainage water of some drains in the same network.