APPLICATION OF ENVIRONMENTAL ISOTOPES TO THE STUDY OF WATER AND SALINITY BUDGETS OF THE IRRIGATION NETWORK OF THE NILE DELTA

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CHAPTER 1.

GENERAL INTRODUCTION

I.1. Introduction :

All forms of life on earth depend on water. Humans use water for many purposes, drinking, irrigation fisheries, industrial processes, transporation and waste disposal. In recent years however, the enormous impacts of humans on natural systems have been recognized. It has been further established that any program to regulate human activities involving water must be based on an understanding of natural processes affecting the water cycle.

In many areas of the world especially in the arid zones, water is and has been a scarce commodity. World water resources are being increasingly strained to meet requirements from the growth of population, increasing industrialization and intensified, agriculture. The exploitation of more water resources is essential and therefore great efforts have to be made to develop the available water resources.

The Nile is usually considered the longest river in the world. It represents the only major renewable source of water in an extremely arid zone. More water for irrgiation became available with the building of the old Aswan Dam in 1902. When enlarged in 1912 and again 1933, it reached a total capacity of $6x10^9$ m^3 of water. The construction of the Aswan High Dam (1960-1967) eliminated the Nile's seasonal floods and allowed all agricultural land to be brought under pernnial irrigation.

Egypt has a total land area of about one million Km^2. It belongs to arid and semi arid regions, of which 3.75×10^6 Feddans of Agricultural land are concentrated in the Delta (Ministry of Irrigation 1981). The water of the River Nile is not sufficient for the purposes of significant expansion of the cultivated areas outside of the Nile Delta and also valley and increasing the existing cropping intensity. Thus, agricultrual development plans depend mainly upon better use of existing water sources, and development of new water resources. One of the main technical problems in water to optimite crop growth is, therefore, to establish of the quantity of water to be applied for irrigation of a particular area and the quantity of drainage water and salinity that may be removed from the soil in order to meet the optimal growth situation of the crops.

About half of Egypt's population is involved in agricultural. The silty clay layers used for crop growth average 10 m in depth and overlie thicker layers of sand and gravel. Lighter textured soils occur along the fringes of the Delta and in the Nile Valley.

At present approximately 2-3 billion m^3 of drainage water is being reused for irrigation purposes yearly. Land development projects are planned that will require another 4 billion m^3 of drainage water in order to supply part of envisaged extension of the agricultural acreage in the future.

Under the present conditions about 15% of drainage waters with suitable quality is reused (Rijtema and Roest 1982) but an enormous quantity of potentially useable drainage water is flowing to the sea. A portion of this water that has a low salinity could be reused or saved making irrigation water available for additional areas to be reclaimed.

The ultimate goal with respect to the use of the drainage water resource is 10 billion m^3 yearly to be reached by 1990.

The acceptance of the reuse of drainage water as an official policy in water management requires a careful and detailed understanding of the processes controlling the salinity of drainage water, groundwaters and the quantities of water represented by each of the major loss terms :

1. Evaporation
2. Transpiration
3. Seepage.

Variations in the stable isotope composition of water (ratios of heavy isotopes to light isotopes O^{18}/O^{16} and H^2/H^1) are extremely sensitive to evaporation in drainage water and these variations could provide a potentially precise indicator of the total amount of evaporation which has occurred. Since transpiration produces very little change in the stable isotopic composition of water paning through irrigated fields. Gaging information combined with the stable isotope data can indicate directly the efficiency of water use in the entire irrigated crop system.

Calibration of the stable isotopic composition data to the amount of evaporation loss can be accomplished by sequantital sampling of water from an open pan filled with irrigation water and allowed to evaporate to small fraction of initial volume. Thus samples from experimental evaporation pan and from drainage water can be provide new information on the efficiency of irrigated water use.

The stable isotope data combined with chemical data can be used to indicate the sources of salinity in the drainage waters. These data can help in resolving the relative contribution of salts from :

1. evaporative concentration,
2. soil leaching,
3. possible upward mixing of marine salts in areas with potential input from intrusion of sea water into deeper groundwaters.

Salinity increases derived from soil leaching should produce no change of the isotope composition of drainage water, while those resulting from either evaporation concentration or mixing of marine water would be accompanied by large stable isotopic changes. The changes of stable isotope composition induced by these latter two processes are very different and should be possible to be largely resolved in combination with chemical data.

Together with hydrological and hydrochemical investigations of water resources, radiometric investigation are also important. The determination of tritium content present in undergroundwaters is a useful tool for the determination of the age of recharge of these waters. It gives an idea about whether groundwater are "old" or rapidly recharged from modern sources. Applying tritium dating technique, the recharge rate of groundwater bodies can be computed in selected areas. This tracer has been present in high concentrations in irrigation water only since the mid 1950's with the highest concentrations present in the middle 1960's. Thus groundwaters from the Nile Delta having amount of this isotope comparable to those present during peak years, have been recharged to a significant extent from the irrigation network and annual flooding of the Nile River between the late 1950's and the late 1960's while groundwater free of tritium have not been recharged within the last 30 years.

The combination of evaporation pan stable isotopes data and chemical data in drainage waters from the Nile Delta and tritium data from selected groundwaters, should provide important new information for management of the