INTRODUCTION

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General outline

The establishment of new communities and land reclamation projects in the Egyptian desert areas to overcome the growing population problem is a national target. In this respect, priorities are given to the desert fringes on both sides of the Nile Delta due to their accessibility, availability of surface water from the Nile and groundwater at relatively shallow depths and the existence of vast plains with deep sandy soils.

Ismailia canal conveys Nile water north east from Cairo to the eastern Delta and Suez canal areas. This canal is selected for study because it is being enlarged in stages to about three times its initial capacity. Three quarters of its course to Ismailia is through desert soil and so there exist and urgent need to study and define present and future seepage losses and its possible control.

In the area to the east of the Nile Delta, new desert settlements and land reclamation projects have been recently established, e.g. 10th of Ramadan city, Salhiya and Mullak reclamation projects. The present study deals with the hydrogeology and hydrogeochemistry of Ismailia canal environ between Abu Zaabal and Abbasa. The surface water system, the groundwater situation , the inter-relation between surface water and groundwater and the seepage from Ismailia canal are discussed.

1- Location

Ismailia canal is located at the south eastern fringes of the Nile Delta, reaches 120 km in length. After its intake at Shubra, the canal follows NE-SW and ENE-WSW trend till km 66 of its course. A great bend of the canal is exhibited at Abbasa, km 70, of its course. A general E-W trend is undertaken by the canal course until its terminus at km 120 located to the south west of Ismailia city. The area of study extends between longitudes 31° 20' - 31° 45' E and latitudes 30° 13' - 30° 32' N (Fig. 1)

2-Climatic Conditions

The area of study occupies a portion of the desert belt of Egypt. Its climate is characterized by a hot summer and a short rainy winter.

Meteorological data are collected and evaluated from three meteorologic stations located near the study area , Cairo in the west, Belbies in the east, and Salhia in the north.

It can be concluded that:

(1) The average minimum air temperature is recorded during January. It varies from 5.2 °C at Salhia station to 5.75 °C at Cairo station, while the maximum air temperature is recorded in July as 33. 75 °C at Salhia station and 35.75 °C at Cairo station. (Fig. 2).

(2) The area of study forms a portion of the semiarid belt of the Mediterranean sea. Its climate is characterized by an unstable rainy winter and stable warm summer, (nearly eight months). The evaporation influences the amount of recharge of groundwater aquifers as well as the ground water quality. The rate of evaporation increases from north to south and from west to east. It reaches its maximum value in June and July and its minimum value in January and December.

From the isofree surface evaporation contour map, (Fig.3), evaporation increases southward .This may be due to the increase of temperature and wind velocity in these directions.

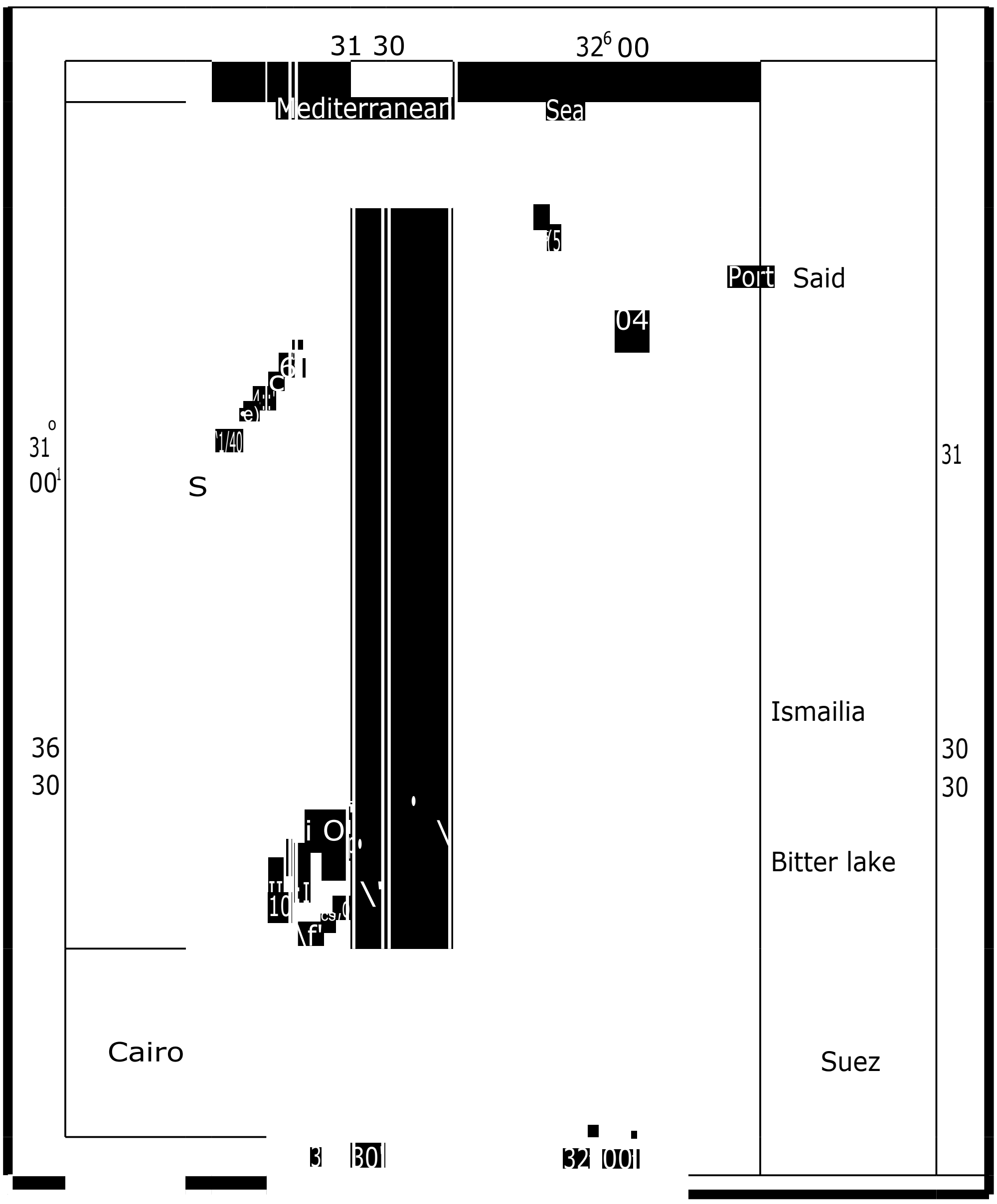
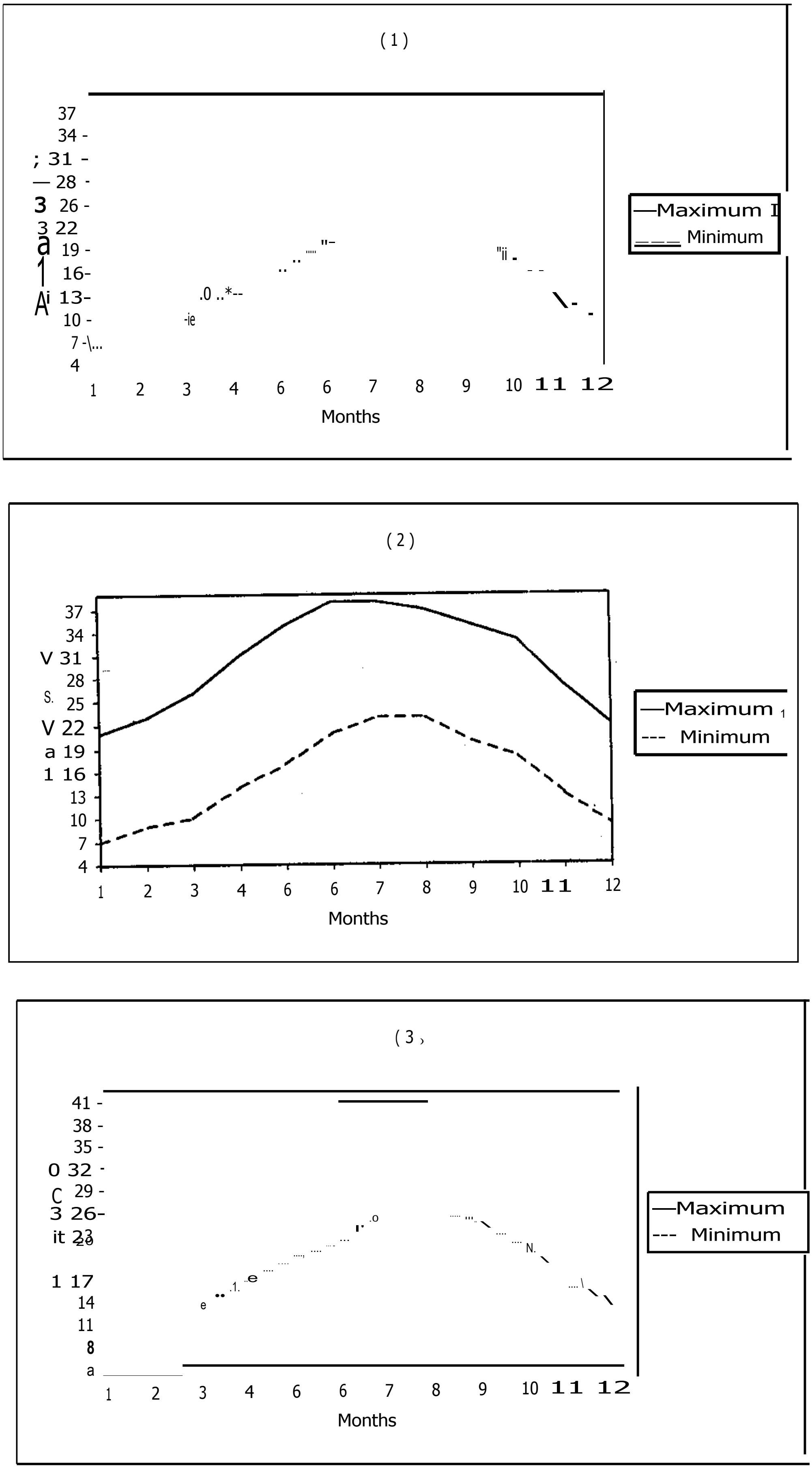


Figure (1) : Location map of the study area.

0 30 Km.

Area of study



Figure(2) :Average air temperature (c) at Salhia (1) , Belbies (2) and Cairo (3)

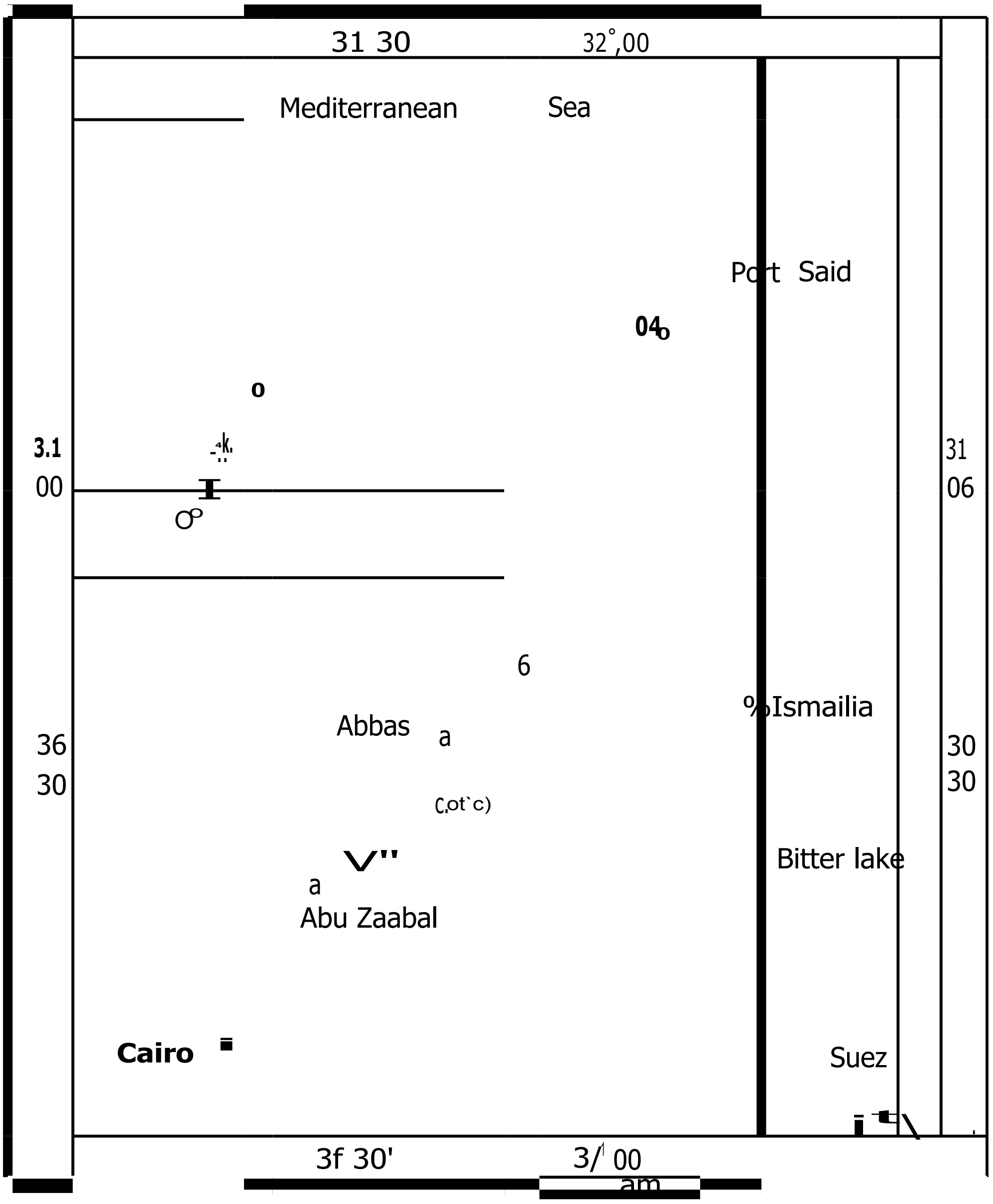


Figure (3) : Contour map of mean daily piche evaporation.

0 30 Km.

6 Contour level of equal piche evaporation (mm/day)

It is worth mentioning that due to the high intensity of evaporation in the study area, the greater part of the rainfall is lost by evaporation. This reflects a little replenishment by local rainfall to the ground water system.

In Abu Zaabal and Abbasa, the depth to ground water is very shallow (between 1 and 3m). Most of the soil in this area, is saturated by water forming at many parts a natural water pool .

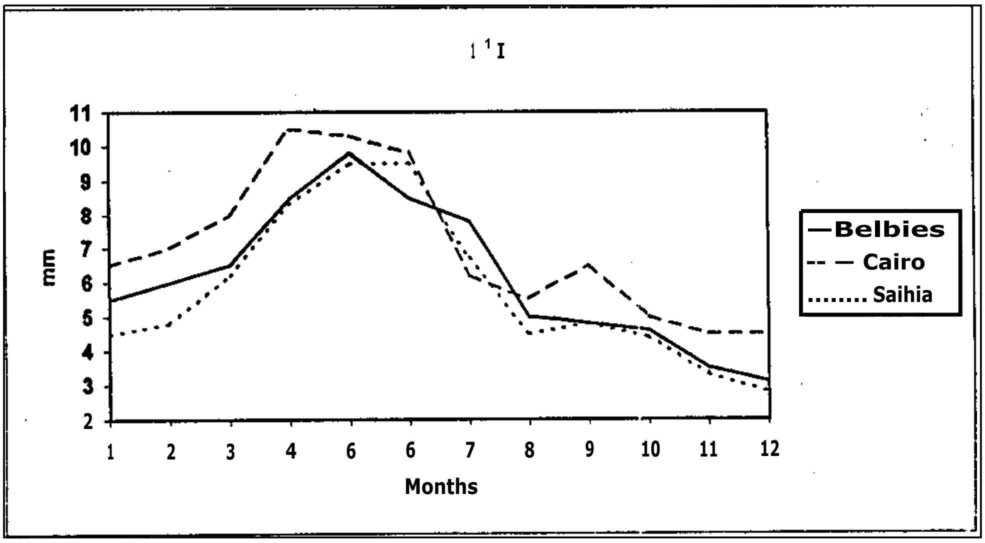
The evaporation intensity is generally higher in summer than that in winter. The maximum and the minimum values were recorded in June and December at Salhia (9.4 and 3.4 mm / day /month respectively). At Belbies the maximum and the minimum values were recorded 10.6 and 5.3 mm in April and December respectively, whereas at Cairo station they were 9.4 and 4 mm as recorded in May and December respectively (Fig.4 a).

(3) Statistical analysis of data given from meteorological Stations at Cairo, Belbies and Salhia showing that :

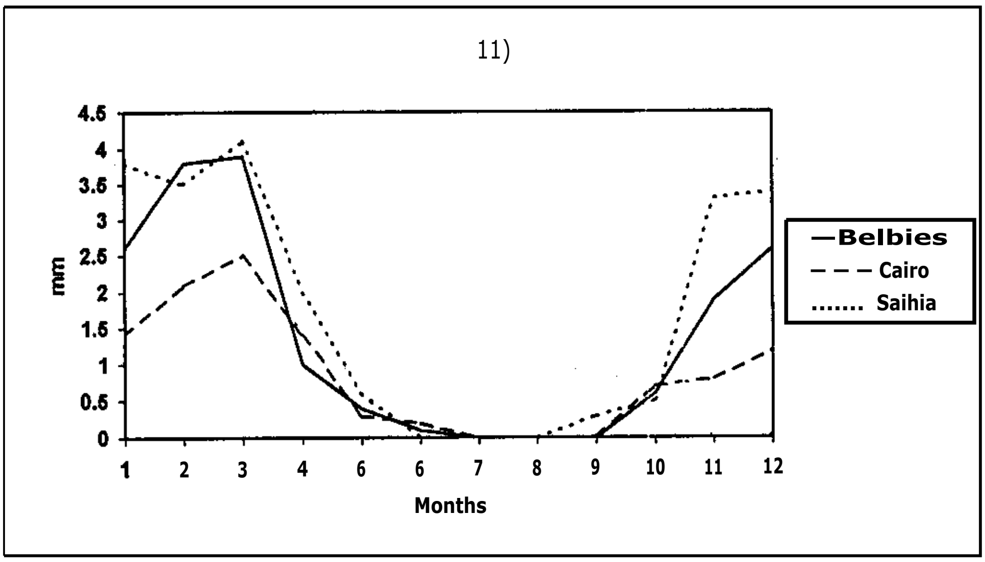
The minimum value of annual precipitation is recorded in Cairo while the maximum value is recorded in Salhia. The precipitation occurs in a period of 5 to 6 months per year (October, November, December, January, February and March) .

From isohyetal map, (Fig.5) it is clear that the difference in rainfall in the area of study is related mainly to the inland distance from the coast and probably to altitude. The rainfall increases from south to north

The total annual rainfall intensity ranges between 2.4 to 37 mm/ year at Salhia, 5 to 20 mm / year at Cairo and finally 5.5 mm /year to 28.5 at Belbies. (Fig.4 b). The maximum and the minimum values for rainfall were



Figure(4,a): The monthly evaporation at Salhia , Belbies and Cairo



•Figure(4,b): The monthly rainfall at Salhia , Belbies and Cairo

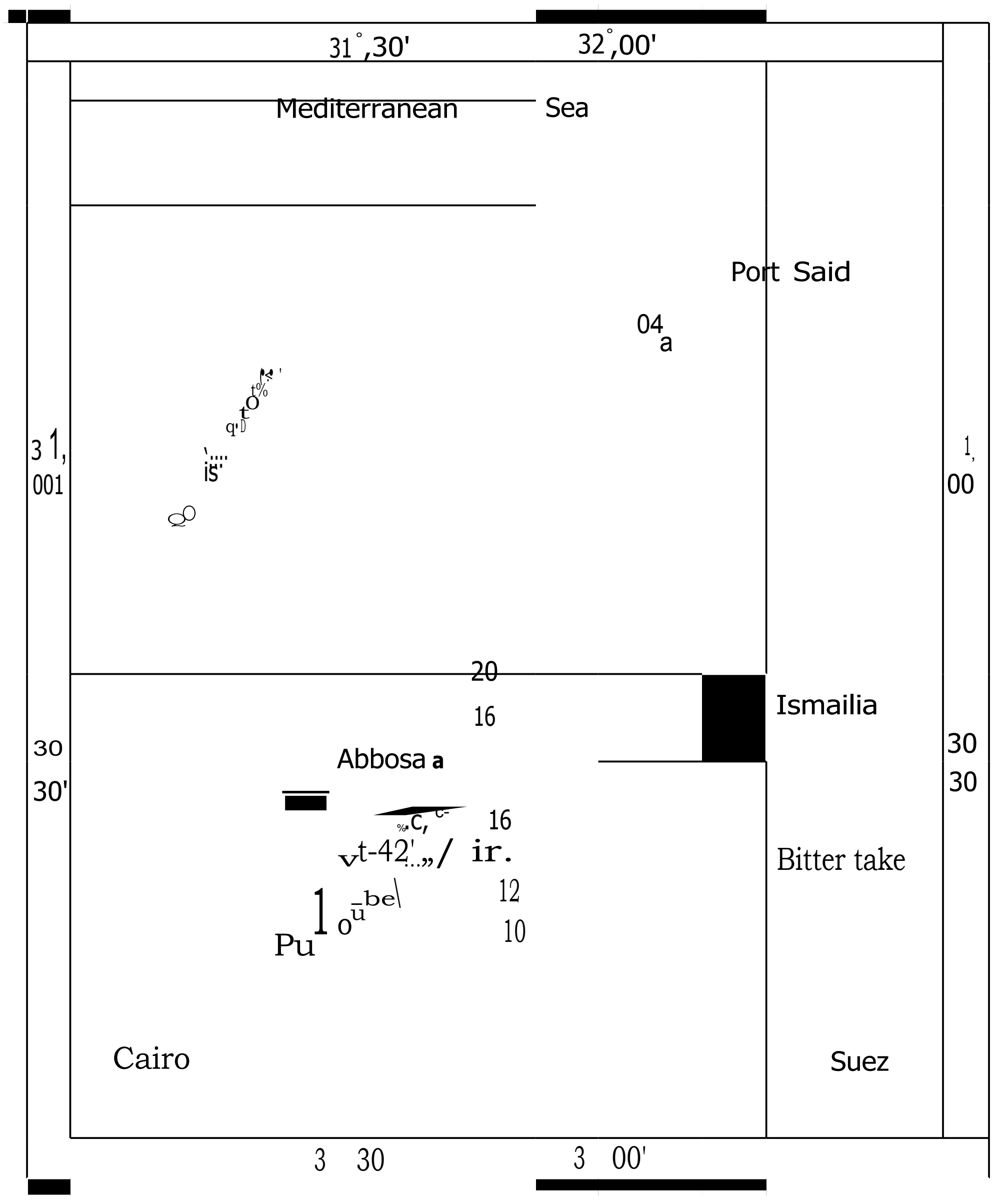


Figure (5) : Isohyetal map of the mean annual rainfall.

0 30 Km.

10 Contour level of equal mean annual rainfall (mm/year)

recorded in March and September at Salhia station (they were 4.2 and 0.6 mm respectively). At Belbies they were 3.8 and 0.15 mm in March and June respectively. At Cairo station they were 2.5 and 0.2 mm at March and June respectively.

(4) Using the above mentioned data and applying formula of Emberger (1955), it can be concluded that the investigated area exhibits desert climate.

$$Since Q = \frac{\underline{100}\ \underline{R}}{(M + m) \qquad - m)} \quad .-\ 1.392$$

Where :

Q is a quotient representing the dryness of the country (Table 1.2)

R is the normal total annual rainfall (mm)

NI is the maximum temperature of the hottest month (°C)

m is the minimum temperature of the coldest month (°C)

Table (1.2): prevailing climatic conditions corresponding to the different values of dryness quotient (Q).

Values of Q	Corresponding rainfall (mm)	Climatic conditions
0-20	0-200	Desert conditions
20-45	200-400	Arid conditions
45-65	400-800	Semi arid conditions

3- Previous works

Adequate information about the geology and geomorphology of the area east of Nile Delta are available in the works of Blanckenhom (1910 & 1921), Ball (1939), Hume (1905, 1910, 1925 & 1926), Attia (1954), Yallouze & Knetch (1954), Shukri (1953), Sigaeiv (1959), Said (1962), and Abu El Ezz (1971).

Many detailed works dealt with the geology and geomorphology of the area of study. Among them are; Barron (1907), Sadek (1926), Sandford & Arkell (1939), Thiebaud (1943), Abbas (1953), Shukri (1953), Shukri & Akmal (1953), Shukri & El Ayouty (1956), philip & Beheri (1961), Said & Beheri (1961), Faris & Abbas (1963), Soliman & Faris (1963), Shata (1965), Farage & Sadek (1966), Ismail & Selim (1968), Ismail & El Dakkak (1968), Metwally(1969), Shata & El Fayoumy (1970), Abuel Ella & Barakat (1970), Akaad & Abdallah (1971), El Nozahy (1972), and El-Shazly et al. (1975).

The most interesting works essentially related to the hydrology, hydrogeology and hydrogeochmistry of the area of study are available in modern literature. Among them are, Shotton (1946), Zaghloul (1959), Pavlov (1962), Hashim et al. (1963), Rofail (1963), Solit (1963), the Energeo project Company (1966), El Fayoumy (1968), Sorour (1968), Diab (1981), Youssef (1970), Shata & El Fayoumy (1970), Tadrous (1970) Abdel Daiem (1971), the Middle East Radioisotope Center (1971), El Shazly et al. (1975), the staff of the Ministry of Irrigation (1975), Hefny (1980), El Dairy (1980), Sallouma (1983), Diab et al. (1989), Khalil et al. (1985), Khalil and Atta (1985), Khalil et al. (1988), Kotb (1988), Kolkila et al. (1989), Geriesh (1989), El Fawal and Shendi (1991), El Shamy and Geriesh (1991& 1992), Abu Haiba (1993), and Ezz El Deen (1993).

Most of the previous works are regional and touch mostly the northern, western and eastern extremities of the investigated area.

Shata and El Fayoumy (1970) stated that the northern part of the investigated area belongs essentially to both the Quaternary and Tertiary deposits. It consists of deltaic deposits (200-500 m thick). These deposits are dominated by unconsolidated coarse sands and gravels (with occasional clay lenses). Their porosity varies between 25% and 40% .

Sallouma (1983) studied the geology, hydrogeology, hydrochemistry and potential of using surface water and groundwater in the area east of the Nile Delta. He concluded that the water-bearing formations are belonging to the Quaternary and Tertiary. These aquifers vary in porosity, hydraulic conductivity and mode of groundwater occurrences. The quality of water in the Quaternary aquifer is variable depending on the types of sediments and the source of recharge.

Khalil & Atta (1986), studied the area between Ismailia canal and Ismailia-Cairo road geophysically and hydrogeochemically respectively. They concluded that, the distribution of the groundwater salinity contents and ionic constituents are greatly affected by fresh water seepage from Ismailia canal and the saline water intrusion from Suez canal and its attached lakes. They concluded also, that the lithologic characteristics of the water bearing formation are of great influence on the change of chemical characteristics in the study area.

Diab et al. (1989) revealed that, the groundwater of the eastern part of the Nile Delta occurred in two groups of aquifers. The main one is a semiconfined Quaternary aquifer which is bounded by Damietta branch and Ismailia canal. The second group is of limited unconfined aquifers, which extends to the south of Ismailia canal and belongs to both Quaternary and Tertiary deposits. They believe that, the recharge of the last aquifer depends on the horizontal and vertical leakage from the main aquifer. They indicated also, that the invasion of salty water from the Mediterranean sea and Suez canal into the fresh water aquifer is of significant effect.

Geriesh (1989) studied the eastern part of the study area (west of Ismailia city). He concluded, on the basis of the electromagnetic and electric resistivity survey of the eastern part of Wadi El Tumilat that the upper horizon of the Wadi is occupied by brackish water of fluviomarine sediments and the hydraulic gradient is very low (P ' 3×10^{-4}

El Shamy & Geriesh (1991& 1992) concluded that Wadi El Tumilat aquifer can be divided into two distinct parts, the western one merges with the underlying main Quaternary aquifer where the only difference is in their hydraulic conductivities. The two aquifers form an unconfined groundwater reservoir.

4-Scope of the present study

The main target of this study is to define the hydrologic impacts of Ismailia canal on the area between Abu Zaabal and Abbasa. This study throws some light on the water seepage, the formation of ponds in some localities and water pollution.

In order to achieve the above purposes, the following subjects were studied.

4.1 Geomorphology and geology of the study area.

4.2 Hydrogeology of the Quaternary aquifer, surface hydrology and water seepage from Ismailia canal in the study area.

4.3 Hydrogeochemical characteristics of the Quaternary (Pleistocene) aquifer.

4.4 Groundwater pollution of the Quaternary (Pleistocene) aquifer.

4.5 Evaluation of surface and groundwater for different uses.

5- Method of study

5.1 Hydrogeological studies include;

5.1.1 Collection of records for surface water levels from ministry of irrigation.

5.1.2 Collection of well records from the research institute for groundwater.

5.1.3 Construction of water level maps using computer software.

5.1.4Construction of surface water hydrographs and ground-water hydrographs using computer software.

5.1.5 Studying the relationship between surface and groundwater.

5.2 Hydrogeochemical studies include :

5.2.1 Collection of water samples from canals, drains groundwater wells, both private wells (10-15 m deep) and municipal wells (60-70 m deep) and from water ponds.

The water samples were analyzed for major cations (IC, Na^+, m_g^{++} and Ca^{++}) and major anions (CL, SO4 - and HCO_3^-) expressed in part per million (ppm) using the following methods:

1- Sodium and potassium were determined with the use of the flame photometric technique described by Paech and Tracey, (1960).

2- Calcium and magnesium were determined with the use of the method described by Jackson (1958).

3- Chloride was determined using the method described by the American Public Health Association (1955).

4- Carbonate and bicarbonate were determined according to the methods presented by Jackson (1960).

5- Sulphate ions were determined according to the method described by Rossum and Villarrux (1961).

5.2.2 Studying the hydrochemical composition of the water samples.

5.2.3 Construction of distribution maps of both salinity and major ions.

5.2.4 Studying the hydrochemical relation of water samples taken from shallow and deep wells through hydrochemical profiles .

5.3. Water pollution studies include :

5.3.1 Collection of water samples from surface water (canals and ponds, and from groundwater (shallow and deep wells).

The collected water samples were analyzed for trace metals like iron, manganese, zinc, lead and copper using Atomic Absorption device at Faculty of Agricluture Zagazig University-Benha Branch .

5.3.2 Construction of distribution maps for the trace metals.

5.3.3 Studying the pollutants, pollution sources and quality assessment.

5.4 Evaluation of surface water and groundwater for different uses

5.4.1 Evaluation of both surface and groundwater for domestic uses.

5.4.2 Evaluation of both surface and groundwater for irrigation uses.

5.4.3 Evaluation of both surface and groundwater for industrial uses.

The thesis includes the following chapters.

- Introduction
- Chapter I includes geomorphology and geology of the study area.
- Chapter II includes the hydrogeology of the Quaternary (Pleistocene) aquifer and the surface hydrology in the study area.
- Chapter III includes hydrochemical characteristics of the Quaternary (Pleistocene) aquifer.
- Chapter IV includes groundwater pollution of the Quaternary (Pleistocene) aquifer.