CHAPTER I

Introduction

General:

In the area under consideration north of the Gulf of Suez, the integrated development plan comprises many activities such as industrial zones, constructing harbors and tourist projects. Consequently, the demand for water is increasing to achieve the goals of the different development programs. Hence, finding new water resources, such as groundwater, is required. Definitely, Nile water will be infeasible to cover the expected increase of the water demands of Suez Gulf cities. Enhancements of both quantitative and qualitative aspects of the water supplies are important to assure their sustainability and adaptability to the different uses.

In the study area, groundwater is used mainly for tourist and industrial purposes. According to the rates of groundwater withdrawal with respect to water requirements, the studied province includes areas into which the groundwater represents 10-40% of the utilized water supplies. The daily discharge ranges from 260 to 3000 m^3/day at Wadi Araba and El Sukhna-Zafrana localities respectively *(Sewidan and Misak, 1992)*. The continuous use of such water potentially stresses its quantity and quality. Attention must be paid toward its protection and sustainability to cope with the excessive needs of the development programs. This work introduces a supplementary assessement of the availability of the water resources on the basis of identification and localization of recharging resources; as well as estimation of the rate and mechanism of groundwater salinization, pollution and eutrification.

The environmental isotopes techniques, along with the major and minor ions chemistry, were employed to carry out this study. This is supplemented with a survey of the gemorphological, geological and hydrogeological settings that help in processing the data in a proper way.

Objective and approach:

The objective of the present work is to identify the groundwater quality and evolution on the basis of different parameters. Among these are types of sediments, recharging sources, groundwater movements and its variation according to rock-water interaction. The study processing is based on geological and hydrogeological settings. In addition, hydrochemical and isotopic investigations of the groundwater samples will be discussed through the following:

1-Collection of all meteorological, geomorophological, geological and Hydrogeological data from previous studies.

2- Inventory of all water points in the area under consideration with depth to water and total depth, moreover, measuring the physical properties of water such as temperature, EC and pH.

3-Collecting all water points in the study area as well as collecting representing water samples from the Suez Gulf.

4- Performing chemical analyses for groundwater samples to determine the concentration of major and trace constituents.

5- Measuring the environmental isotopes (O-18, D) and radioactive (T, C-14) for water samples that represent different aquifers to identify the recharge, flow and salinization conditions.

6- Studying the salinity evolution of groundwater using chemical and isotopic mass balance models as Netpath.

7- Evaluation of the groundwater quality for different purposes.

8-Studying the possibility of removing salinity and the treatment of groundwater using co-polymers techniques

1.1-Location and climatic conditions:

The area selected for the present investigation (Fig. 1.1), lies within the northwestern part of the Gulf of Suez. It is located between Gebel El Galala El Qiblia due south and Gebel Ataqa due north. It is bounded by the Gulf of Suez to the east and by the water divide to the west. It lies between latitudes 28 45` & 30 00` N and longitudes 31 45` & 33 00` E. It comprises the harbor of El Sukhna, the new development projects extending along the Suez Gulf.

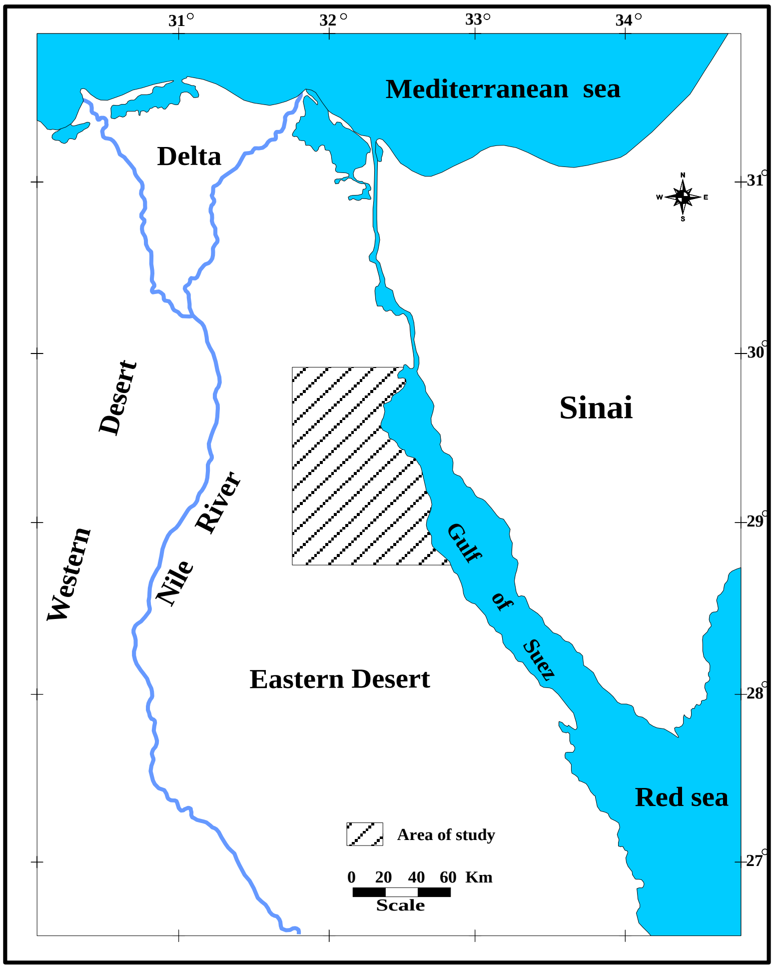

Fig.(1.1): Map showing the study area

Climate:

Climate factors as well as topography and geology play an important role on the groundwater system. Based on the available climatic data from 1978 to 1998 recorded at Suez and Qattamyia meteorological stations, the annual air temperatures are 22.94^{o}C, 21.6^{o}C at Suez and Qattamyia stations respectively. In the winter months, the range of temperature lies between 11.8 and 14.9^{o}C, while in the summer months, it ranges from 28.3^{o}C to 37.3^{o}C.

Rainfall is the main source of groundwater recharge in the study area. The rainy months begin in October and end in May with an average annual precipitation ranging from 15 to 20 mm at Suez station and from 5 to 15 mm at Qattamyia station.

The pitch evaporation ranges between 4.92 mm in Decenber and 12.2 mm in June at Suez station, while it varies between 5.6 mm in December and 13.9 mm in June at Qattamiya station.

According to *Nassim 1990*, the climatic conditions near Wadi Araba area are obtained from Korimate, Zafarna and Benisuef stations during 1980, 1983, 1986 and 1987 and summarized as follow:

At Korimate station, the temperature during winter ranges from 6.3^{o}C to 22.7^{o}C and from 19.9^{o}C to 35^{o}C during the summer. The total rainfall ranges between 0.1 and 18.7 mm during winter, while no rainfall was recorded during summer. At Benisuef station, the temperature during winter ranges between 5.1^{o}C and 23.2^{o}C and from 19.8^{o}C to 38.1^{o}C during the summer. The total amount of rainfall ranges between < 0.1 and 5.6 mm during winter and between 0.1 mm or less during summer. Evaporation at Benisuef station ranges between 5 to 18 mm and decreases gradually along the coastal zone toward the Suez area where the mean annual evaporation reaches 11.5mm at Suez. At Zafarana station, the temperature during winter ranges from 9.4^{o}C to 22.8^{o}C and varies during the summer from 22^{o}C to 37.1^{o}C. The total amount of rainfall ranges between 1.1 and 14.2 mm during winter with no rainfall observed during summer.

1.2-Previous work:

The area located within the northern part of the Suez Gulf was studied by several authors in the fields of geology, hydrology, hydrogeology and geophysics.

Renolds (1979) studied the geology of the northern part of the Gulf of Suez. He concluded that, the stratigraphic section is made up of a series of sediments ranging from Carboniferous to Eocene age. There is no evidence for the presence of Jurassic sequence in the southern part of the Gulf. After Oligocene rifting, thick marine sediments were deposited during Miocene time.

El Etr and Yousif (1981), visualized the region between Gebel Ataqa and north El Galala as a major graben which is complicated by several salient smaller horsts and subdivide grabens. The major graben is bounded by east northerly faults. Other faults are predominantly oriented west northwesterly to north northwesterly.

Tawfik (1988), studied the regional structure and geological settings of the northern Gulf of Suez. The Paleozoic rocks of the Gulf of Suez are composed of Lower Carboniferous to Permian sand and shale sequences. Jurassic sediments are exposed at the foothills of the northern plateau underlies Lower Cretaceous deposits. The Upper Cretaceous sediments are limitedly distributed at the northeast foot of Gebel Ataqa and coastally from El Ain El Sukhna to Abu El Darg. Tertiary deposits represent the large parts of table lands and main wadis.

El Kahwagy and Osman (1974), studied the groundwater at Wadi Badaa located to the south of Ataqa. The groundwater accumulation could be confined by the underlying impervious clayey beds. The receptivity of the whole thickness of the Middle Miocene Formation is much lower indicating the presence of water. At the depth of about 90 m from the surface, there are more possibilities for water existence.

REGWA (1977), estimated the quantity of fresh water within the Quaternary aquifer in Wadi Ghweiba as 1.28 x 10^8 m^3. The groundwater aquifer is mainly recharged from the precipitation that percolated into the aquifer. The water table in this locality is met at a depth of about one meter above sea level.

Yousef et al., (1978), concluded that the groundwater accumulations could exist in alluvium deposits and controlled mainly by the presence and configuration of underlying clays. A deeper aquifer could also exist and it is represented by sandstone or conglometric formations at unconformity between Miocene rocks and older formations. Probably faulting could have brought impervious formations down against previous rocks supporting this aquifer, thus cutting off groundwater discharge to the east.

REGWA(1979), studied the groundwater resources in Wadi Badaa and Wadi Hagoul. The Wadi deposits along the main stream retain groundwater only after a heavily rain season.

The wadi deposits which cover the low lands of the main stream of Wadi Badaa and Wadi Hagoul as going downstream and far from the sea shore can retain a good water quality. Near the sea shore the thickness of these deposits is very limited and it is not favorable to drill wells in these localities.

Khaled (1984), described the central part of Wadi Badaa besides Bir Badaa as the most suitable region for drilling wells with a reasonable good quality (TDS < 2600 ppm) at depths not exceeding 110 m. On the other hand, the rest of the area has more saline water (TDS > 2600 ppm).

Salem (1988), carried out geological and hydrogeological studies on the area between G.Ataqa and northern Galala. He concluded that the main groundwater aquifer is composed of Quaternary sands and gravels with some shale and limestone intercalations.

These sediments are believed to be deposited under marine conditions during the Pleistocene age. Perched groundwater occurs mainly in the alluvial deposits in the trunks of Wadi Badaa and Wadi Ghewiba on the upthrown sides of Badaa and Sukhna faults. The groundwater aquifer is structurally controlled by the Badaa and Sukhna faults from the north and west and by the major escarpment of the northern Galala and the Gulf of Suez shoreline from the south and east. The groundwater exists as a water table condition and the water table is generally slightly higher than sea level.

Aggour (1990), elucidated the hydrogeologic framework of Wadi Araba. He classified Wadi Araba as a high wadi according to its relative groundwater possibility. Rocks belonging to Carboniferous and Lower Cretaceous sandstone represent the main source of water in Wadi Araba Depression. The water is tapped from springs, shallow wells and occasionally deep wells. The Quaternary alluvium deposits constitute insignificant water bearing horizon.

Sallouma and Guindy (1992), studied the groundwater characteristics in some sandstone aquifers west of the Suez Gulf. The study revealed that the clastic sands and sandstone aquifers in the western side of the Gulf of Suez are represented by three main rock units; the Carboniferous, the Lower Miocene and the Lower Cretaceous.

The groundwater occurring in the sandstone is encountered in Wadi Araba. The exposed aquifer sediments are recharged directly through perculation of rainfall. The water is characterized by low salinity (1036-2597 mg/l), marine salt assemblages due to active circulation and leaching surrounding marine sediments.

Gomaa and Aggour (1999), studied the hydrogeological and hydrogeochemical conditions of carbonate aquifers in the Gulf of Suez region.

They considered that the carbonate rocks represent productive aquifers on both sides of the Gulf of Suez.

These rocks constitute extensive watershed areas (e.g. El Galala El Baharia, El Galala El Qiblia and Abu Sha’r plateau on the western side). Some recommendations are proposed in this study for the development of groundwater resources. Hand dug wells are suggested along the scraps of the plateaux at the favorable sites and more attention should be focused upon the utilization of the flowing water such as construction of surface reservoirs to control the discharge and use.

Abd Allatief et al., (1997), discussed the impact of structure and lithology on the groundwater occurrence along Wadi El Noqra-Wadi Badaa area. He used the electrical resistivity method for knowing the possibility of groundwater occurrence and recommending sites for drilling of water wells. The study revealed that the study area includes three units namely from top to bottom as “A”, “B” and “C” beside a surface cover of alluvial deposits. Unit “B” is the water bearing formation which is represented by gravels, gravely sand, clayey sand, clay and calcareous sandstone faces. Some clay intercalations present within the water bearing formation affect the priority of the recommended sites for drilling water wells. Faults play an important role to increase the aquifer thickness toward south and southeast.

Mohamed (2001), evaluated the groundwater potentiality in Wadi Hagoul-Wadi Badaa area based on geophysical techniques. He concluded that the hydrogeological zones below the dry alluvial veneer covering the surface of the area include the following:

1) Zone “A”: Dry Quaternary alluvium that slopes toward the Gulf of Suez. This zone percolates rain water downward.

2) Zone "B": Saturated Quaternary alluvium that represents the main Quaternary aquifer in the study area. Its bottom surface is irregular due to structural dislocations that affected the Late Tertiary rocks.
3) Zone "C": Tertiary limestone zone which contains groundwater within the joints and fractured upper horizon. However, at greater depth the carbonate rocks are massive dry.

Nasr (2004), studied the groundwater aquifers in Wadi Ghweiba area using geoelectrical and GIS techniques. He concluded that the groundwater aquifers are occurred in Wadi Ghweiba and downstream portions of Wadi Badaa while they are absent in the upper part of Wadi Badaa. Such formations belong to Quaternary and Pliocene-Miocene deposits with thickness ranging from 16 to 235 m. the faults and lineaments such as sukhna, Badaa and south Ataqa play dual roles in the distribution of groundwater potentiality in Wadi Ghweiba is more promising than in case of Wadi Badaa due to the extension and promising saturated.