CHAPTER (1)

INTRODUCTION

1.1 General outlines:-

Water is a vital resource for further socio-economic development of arid and semi-arid countries. The increase in demands for water by communities, industries, and agriculture resulting from population growth makes it essential to develop and manage the very limited water resources to meet our needs.

Groundwater plays, and will continue to play a critical role in satisfying water requirements for most of arid and semi-arid countries. Thus sustainable groundwater development and presentation of groundwater quality should receive priority of attention.

Egypt is mainly covered by desert and only 4% of its land is arable, mainly the alluvial plain of the Nile and its delta. In order to cope with the increasing population, the government of Egypt has been pressed into the development of Sinai Peninsula which has high potentials in mineral resources, tourism, and agriculture development.

The over growing development activities in the coastal areas of South Sinai specially at Sudr area on the Gulf of Suez, necessitate an increasing demand for urban water supply at present. Groundwater is considered as the only source of drinking and irrigation, and this requires the evaluation of the groundwater resources quantitatively and qualitatively for sustainable development in this important area.

1.2 Aims of the present work:-

To face the over growing development activities in the area under consideration and their urgent needs for water we have to evaluate the groundwater which considered the main source of water for sustainable development. This includes:

a) Defining the recharge sources and its renewability.
b) Investigating the flow regimes and the impact of lithofacies and structural elements on the hydrological system
c) Highlighting the mechanism of Salinization and water quality parameters

d) Evaluating the groundwater quality for different uses (drinking, irrigation, industry…).

1.3 Location and description of the study area:-

The area of study is situated on the eastern side of the Gulf of Suez. Wadi Sudr catchment's area is an elongated area lies in the southwestern part of Sinai Peninsula. It is bounded between latitude 29º 30/ and 29º 50/ and longitudes 32º 40/ and 33º 20/, as shown in figure (1-1), Ahmed 1992. This basin covers an area of about 670 km2.

In Sudr area groundwater extracted from shallow aquifers which represents the main source of water for irrigation and domestic purposes. It is mostly extracted from shallow wells (maximum 38m depth).

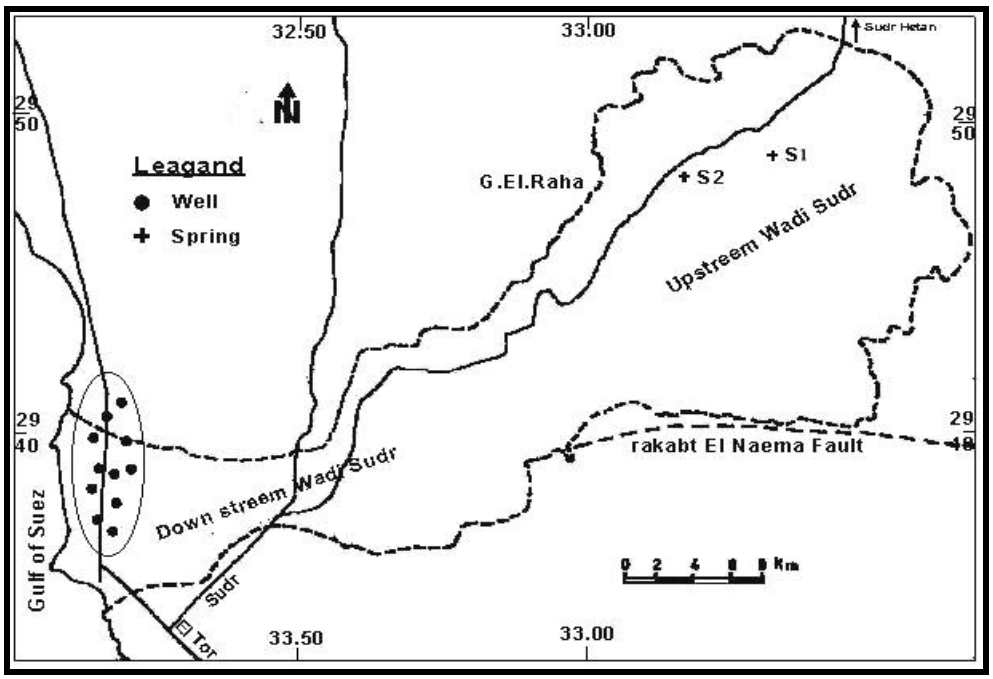

Fig. (1-1): Location map of the study area (Ahmed 1992).

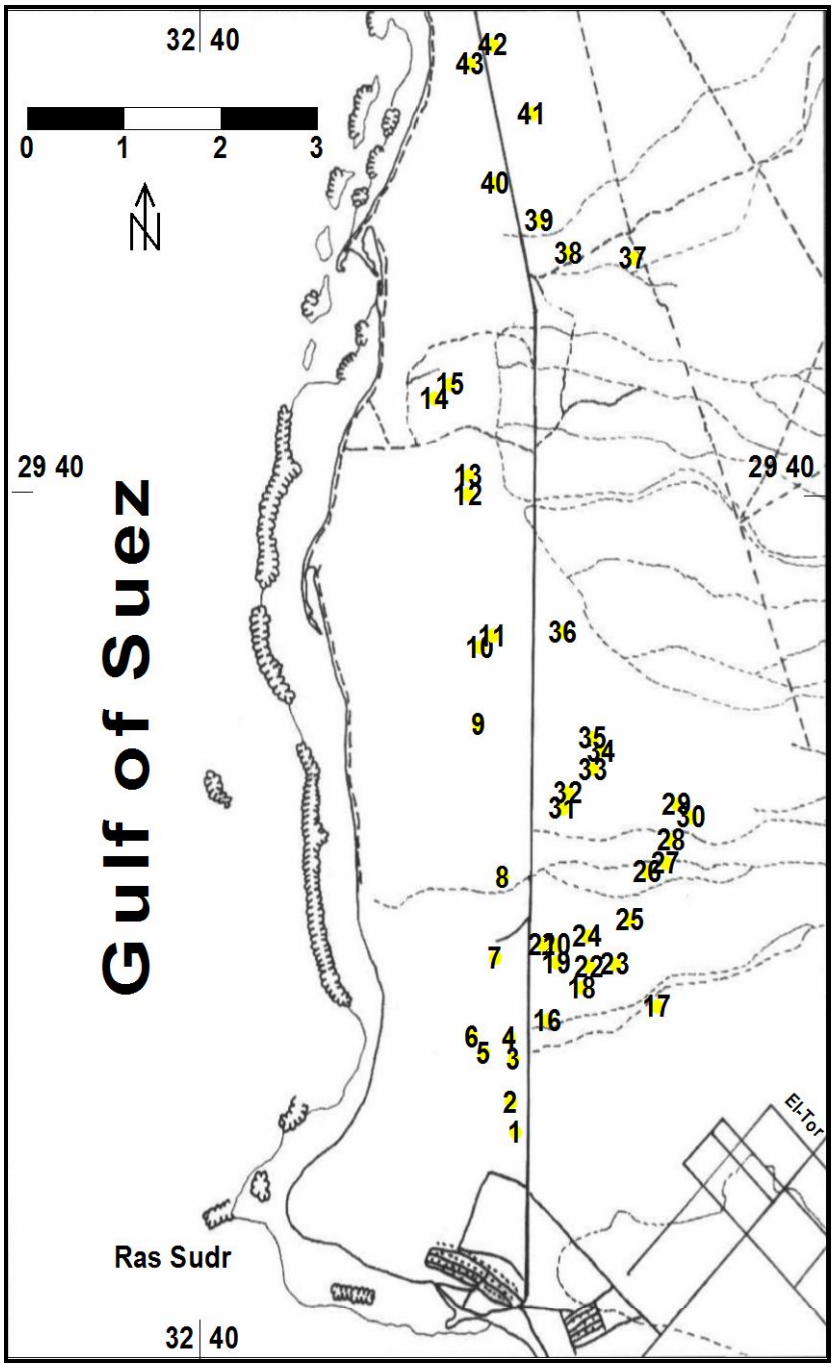

Fig. (1-2): Location map of the Delta of Wadi Sudr showing the collected samples.

1.3.1 Climate conditions:

In Sudr area as well as in other localities along the Gulf of Suez, the climate is characterized by extreme aridity with low and erratic rainfall, high evaporation rates and low relative humidity, high summer temperature and generally vigorous winds. According to the available meteorlogic information from Ras Sudr stations , the monthly mean maximum temperature ranges from 19.2°C in January to 34.9°C in August, with a yearly average of 27.9°C. While the monthly mean minimum temperature ranges from 8.4°C to 22.3°C, with a yearly average of 13.4°C. The relative humidity ranges between 48.2% and 63.5% and the mean evaporation ranges from 5.8 mm/day to 13.9 mm/day.

Table (1-1) The climatological data at Ras Sudr stations (Average for the period 1985 -1998). **(Abdel-lattif and Abdel-sabour, 2004).**

Month	Temperature (°C)			Mean precipitation (mm)	Mean evaporation (mm)/day	Relative Humidity %
	Max.	Min.	Aver.			
January	19.2	8.4	12.2	26	7.2	51.9
February	20.2	9.2	13.3	14	8.4	49.7
March	22.8	10.8	15.2	61	9.6	51.3
April	26.9	13.9	18.4	61	11.5	48.2
May	30.8	17.1	23.6	0	12.9	52.4
June	33.9	20.1	26.7	0	13.9	53.1
July	34.8	21.7	28.1	0	13.7	55.5
August	34.9	22.3	28.3	0	12.7	58.7
September	32.1	20.3	26.1	0	11.4	61.5
October	29.0	17.7	23.4	0	8.8	63.5
November	24.1	13.1	18.3	43	6.9	61.9
December	20.3	9.7	13.2	47	5.8	55.9
Mean	27.5	13.4	20.6		10.2	55.4

According to **Morad (2000)**, the following elements of the rainfall data are of particular importance:

1. Intensity of rainfall data; expressed as depth of water per unite time.
2. Duration of rainfall; it is the time elapsed from start to end the rainfall event.
3. Depth of rainfall; expressed as the thickness of the water layer on the ground surface.
4. Geographic extent of the area subjected to rainfall.
5. Frequency of rainfall; which refers to the average time elapsed between occurrences of two rainfall events of the same depth and duration. The reciprocal of rainfall frequency is referred, as return period.

1.3.2 Spatial variation of rainfall:-

Naturally, the same amount of rain does not fall uniformally over the entire catchment. Table (1-2) show the variation of storm rainfall depth in the upstream, midstream and downstream parts of Wadi Sudr during the years 1990-1999. From this table the following are noticed:-

1. The storm rainfall depth gets its highest value in the upstream and midstream portions of Wadi Sudr having almost the same amount.
2. The records of the downstream, in most cases, do not follow the rainfall depth that fall on the upstream and midstream parts, due to the mountainous nature of the latters.
3. Only storms that on the upstream and midstream parts of the catchment area are responsible for the runoff in the wadi catchment
4. The maximum records of daily storms among the years of the last decade occurred between January and March, i.e. winter-spring season.

Table (1-2) Distribution of storm rainfall depths among the stream gradient (1990-2000), (Abdel-lattif and Abdel-sabour, 2004).

Date of storm	Rainfall Depth (mm)		
	Upstream	Midstream	Downstream
26/01/90	15.5	10.8	5.6
8/2/1990	1.36	2.5	0.3
11/3/1990	1.76	0	0
2/4/1990	9.14	4.7	3.1
26/01/91	2.5	1.8	0.4
22-23/03/91	30.5	47	34
3/11/1991	2.2	1.5	0
24/12/91	6.43	6.5	0
11/3/1994	20.67	20.67	-
3/3/1997	-	7.7	0.5
11/12/1998	4.7	4.7	2.29
14/01/99	1.1	1.1	
7/2/1999	14.6	14.6	1.02
20/02/99	0.7	0.7	
26/01/2000	8.16	-	-

1.3.3 Rainfall frequency analysis:-

Considerable difference in rainfall quantities and the pattern of their occurrence are experienced in the area of study (Ras Sudr and Nekhil stations) where rainfall is irregular and unreliable.

With a record of only 22 years (1976-1997) in the study area, the determination of a representative frequency pattern for both monthly and annual rainfall is probably satisfactory. In constructing the frequency graphs Figure (1-3) shows 12 classes for monthly distribution and Figure (1-4) shows the annual distribution, **(Abdel-lattif and Abdel-sabour, 2004)**.

Rainfall depth (mm)	No. of rainy months
0	181
>0<1	36
>1<2	15
>2<3	9
>3<4	4
>4<5	5
>5<6	3
>6<7	3
>7<8	2
>8<9	3
>9<10	0
>10	3

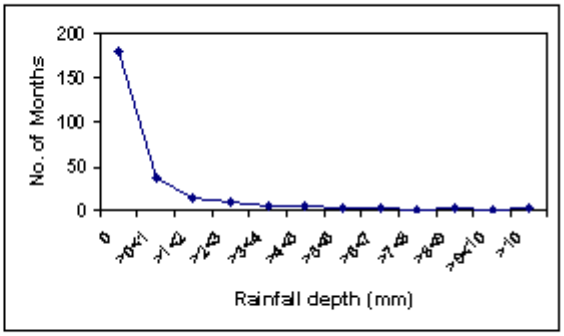

Figure (1-3): Average monthly rainfall frequency Ras Sudr (1978-1997).

Rainfall depth (mm)	No. of rainy years
<5	5
>5<10	6
>10<15	3
>15<20	2
>20<25	1
>25<30	1
>30<35	1
>35<40	1
>40	1

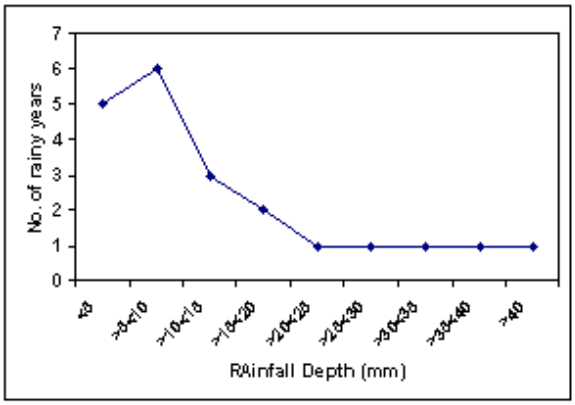

Figure (1-4): Average annual rainfall frequency Ras Sudr (1978-1997), (Abdel-lattif and Abdel-sabour, 2004).

1.4 Review of previous works:-

Several Studies were carried out on Sudr-Gharandal area. Most of these studies were concerned on geology, hydrogeology, geomorphology, and hydrochemistry of this area. The majority of these studies were concentrated on the deltas of the major basins. Among these studies only a few were contributed significantly to the use of isotope hydrology as a new tool.

The following is a summary of these studies relevant to the present work.

.*Abdel Mogheeth et al. (1985) performed* chemical analysis of water bodies in the alluvial deposits aquifer of the downstream of Wadi Ghrandal. They concluded that dominate water type sodium chloride and calcium sulfate with salinity of 2300 mg/l.

Dames and Moore (1985) investigated the hydrology of wadi Sudr as a part of document about Sinai. They proved that the total dissolved salts in groundwater of delta wadi Sudr ranges between 2500 to 3000 mg/l.

Garamoon (1987) performed hydrological study on the delta of wadi Sudr. He concluded that the alluvial deposits constitute potential water bearing formation in the valley, also he showed that the dominate water type are sodium chloride and sodium sulfate with a total salinity ranging from 2967 to 4961 mg/l.

Hasanein (1989) performed a study on the geology of water resources in wadi Sudr –wadi Gharandal area. He concluded that the alluvial deposits aquifer constitute the main source of the groundwater in the wadi ,with a salinity ranging from 2000 mg/l in the east and northeast to 5400 mg/l in the west and southwest i.e. in accordance with the general direction of the groundwater flow. This increase is due to leaching and dissolution processes. The chemical water type is sodium chloride.

AlGamal et al (1998) performed an isotopic and hydrochemical investigation on the groundwater of Sudr area to explore its genesis. They indicated the combination of two types of water composing the studied groundwater , one of the two types is of depleted O18 and TDS and the other is of more enriched in both.

JICA (1999) studied the groundwater resources in wadi Sudr and found that the salinity ranging from 2450 to 7624 mg/l with Sodium chloride water type and the static water level in the delta is generally less than 4 m above sea level.

Morad (2000) concluded that the dominate water type in Sudr area is sodium chloride or sodium sulfate, which may be an indication for sea water intrusion or evaporite leaching phenomena. It can be deduced that the groundwater in the delta of wadi Surd is considerably affected by two main sources, the runoff through the main wadi channel and the sea water intrusion from the Gulf of Suez. He also found the salinity ranging from 2148 to 8960 mg/l.

El Sayed and Said (2000) studies reveal that there are two water salinity zones, one is the brackish water which occupies the eastern parts of the deltas and the second is the saline water which dominates the coastal plain. The main source of different ions in the brackish and the saline zones of the alluvial aquifer is the water bearing formation itself and the pollution resulting from seawater. The groundwater samples of alluvial aquifer are affected by the mixing cation exchange processes and the dissolution of terrestrial and marine salts which lead to considerable change in water chemistry.