# SUMMARY
# AND
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This thesis describes the hydrogeology and hydrochemistry of water resources in the Ismailia canal environs and its impact on the groundwater and defines the present and future seepage losses and their possible control. The area of study extends between longitudes 31° 20' - 31° 45' E and latitudes 30° 13' - 30° 32' N.

## I. Geomorphologic and geological studies:

The area of study contains the following geomorphologic units:

-Shubrawit ridges.

-Ankabia - Iweibid structural plain.

-Gebal umm ragm - Gebel umm katib ridges.

-Belbies - El Tell El Kabier - Salhia old deltaic plains .

-Wadi El Tumilat stretch.

-Umm gidam gravelly slopes.

-The hydrographic basins.

The study area belongs to the Tertiary and Quaternary ages. The sedimentary succession has a thickness that exceeds 5000 m from the geologic point of view. The deposits of hydrologic importance belong to the Quaternary and essentially to the Pleistocene.

The Quaternary deposits consist of fluviatile successive fining upward sequences dominated by unconsolidated gravels, coarse to fine sands and terminated by mud and clay lenses.

The Tertiary rocks consist of sandy marly fossiliferous limestone, shale and sandstone (marine sediments).

From the structural point of view, the faults are the most structural element affecting the area of study. Nearly all the faults are of the normal types. The fault phenomenon accounts for the formation of morphotectonic basins, which are suitable place for groundwater accumulation.

The fault may be also prevent the free movement of water from one aquifer to the other as in Abu Zaabal areas due to the sealing of the fault planes by basalt.

II. Hydrogeological studies

The surface water system in the study area comprises Ismailia canal essentially which was dug more than century ago. It is planning to enlarge Ismailia canal through two stages after year 1964 and finishing the enlargement at year 2017. The main irrigation canal in the area of study are El Wadi El Sharqi canal and Saidya canal while the main drain is Belbies drain.

Surface water level of Ismailia canal from 1950 to 1965 ( first stage of enlargement) and from 1970 to 1999 ( second stage of enlargement ) increases in summer and decreases in winter. At the first stage of enlargement they reached 14.32 m at Sereakus barrage, 10.49 m at Belbies barrage and 9.58 m at Abbasa barrage during the summer, while they decreased to 12.86 m, 9.41 m and 8.60 m at the same locations during winter. At the second stage of enlargement they reached 14.37 m at Sereakus barrage, 10.57 m at Belbies barrage and 9.61 m at Abbasa barrage during the summer, while they decreased to 13.61 m , 9.55 m and 8.68 m at the same locations during winter. Surface water quantities entered Ismailia canal were increased from 2204.69 Mm3 /y at first stage of enlargement to 3482.70 Mm3 /y at the second stage of enlargement

Surface water level of El Wadi El Sharqi canal increases in summer and decreases in winter, they reached 8.53 m during summer and decreased to 7.64 m during winter. Surface water level of Saidya canal reached 8.40 m during summer and decreased to 7.52 m during winter.

The Quaternary sediments are discriminated into two hydrogeological units; the Holocene aquitard capping the main aquifer which belongs to the Quaternary ( Pleistoncene) aquifer.

The Holocene aquitard is composed of sand, silt and clay, its average thickness in the study area is 9 m. The lithofacies and thickness variations affected, to a high degree, the hydraulic connection between surface water and groundwater and also define the degree of confinement of the Quaternary (Pleistocene) aquifer. The Quaternary (Pleistocene) aquifer is composed of unconsolidated sand and gravel with clay lenses. Its thickness varies from 200 m at south to 250 m at northern portion of the study area.

The hydraulic parameter of the Quaternary ( Pleistocene) aquifer revealed that the effective porosity is 18 % in the study area. The hydraulic conductivity ranges from 50 m / day to 150 m / day. The transitivity varies from 1400 m2/day to 1600 m2/day. The storage coefficient ranges between 1 x 10-3 to 1 x 10-3.

The records of 11 observation water wells from year 1975 to 1999 are selected to represent the change in groundwater level in the Quaternary (Pleistocene) aquifer within the study area.

The studying of well hydrographs and potentiometric surface maps indicates that the variation in groundwater level are attributed to change in surface water level which increases gradually in summer than in winter.

There is gradual decrease in groundwater level from 1985 to 1990 attributed to gradual decrease in surface water quantities entered the study area during these periods.

The groundwater flow direction in the study area is interpreted from water level maps. The groundwater flow is directed mainly from north to south in the area lying south of Ismailia canal and from south to north in the area northern of Ismailia canal.

The hydrogeological relationship between surface and groundwater can be studied from correlation between the hydrograph of Ismailia canal and the nearby wells. Generally Ismailia canal cuts its course without any lining so that permit the seepage from canal to surrounding ground water system. The annual seepage rate (m3/y/k) of Ismailia canal is estimated during the first and second stages of enlargement. At Abu Zaabal area, It was found that the seepage rate (m3/y) ranges between 13365.05 and 137345.85 during the first stage and varies from 161450.45 to 168845.35 during the second stage while it ranges between 164874.15 and 168962.15 during the first stage and varies from 195472.10 to 203644.45 during the second stage at Abbasa area .

The Tertiary strata of hydrogeological importance are the Miocene carbonate and Oligocene sandstone as water bearing formation, while the Pliocene clay acts as an aquiclude.

## III. Hydrochemical studies

The hydrochemical study of water samples given from the area of study reveals that, the salinity of surface water (Ismailia canal, irrigation canals and drains) varies between 194.28 ppm to 820.50 ppm. The surface water of Ismailia canal, irrigation canals and drains are classified as fresh water (TDS < 2000 ppm) and suitable for drinking (TDS < 500 ppm) except the drains which collect the sewage water (TDS > 500 ppm) as Belbies and Sandanhour drains.

The surface water samples represent Ismailia canal and main irrigation canals ( Saidya canal, Mullak canal, Bahr El Shibini canal, Menaiyer canal) and drains ( Ghafaria drain, Wadi drain ) are dominated by alkaline earth and weak acids. The main hypothetical salts of these samples are calcium and magnesium bicarbonate. The hypothetical salts of El Wadi El Sharqi are sodium and potassium bicarbonates while it becomes soudium, potassium chloride and sodium, potassium sulphate for Belbies and Sandanhour drains. Gausag and El Kasser drains are calcium, magnesium chlorides and calcium, magnesium sulphates.

## HU Salinity content in the groundwater of the Quaternary ( Pleistocene) aquifer:

The salinity content of groundwater in both shallow and deep wells of the Quaternary ( Pleistocene) aquifer ranges between 167.90 and 877.50 ppm and between 156.70 and 1015.17 ppm, respectively. The salinity distribution in both shallow and deep wells indicates that the salinity increases to the west.

At Abu Zaabal and Belbies coincident in both shallow and deep wells and confirm the good hydrochemical connection between shallow and deep groundwater and advocate the existance of local pollution sources resulted from the infiltration of domestic, agricultural and industrial wastes.

## 111.2 Chloride content in the groundwater of the Quaternary (Pleistocene) aquifer:

In groundwater of the Quaternary (Pleistocene) aquifer, the chloride content varies from 22 to 612 ppm in shallow wells and from 24 to 320 ppm in deep wells. The chloride content distribution in groundwater shows the presence of local zones of high concentrations at Abu Zaabal and Belbies. The local variations in the chloride concentrations are concident in both shallow and deep wells and are attributed to local pollution sources.

## 111.3 Sulphate content in the groundwater of the Quaternary (Pleistocene) aquifer:

The sulphate content in groundwater of the Quaternary (Pleistocene) aquifer varies from 0.835 to 742.38 ppm in shallow wells and from 1.3 to 43669 ppm in deep wells. The distribution of sulphates in shallow wells indicates the presence of local zones of high concentrations at Abu Zaabal and Belbies. These local zones have a great effect on its content in deep wells at the same sites. This also confirms the existence of local pollution sources.

### 111.4 Bicarbonate content in the groundwater of the Quaternary (Pleistocene) aquifer:

Bicarbonate concentration in groundwater of the Quaternary (Pleistocene) aquifer varies from 131.76 to 596.58 ppm in shallow wells and from 29.28 to 414.80 ppm in deep wells. The bicarbonate distribution in groundwater indicates that high content exists in shallow wells, and the presence of local variations advocates the existance of local pollution sources. The presence of bicarbonate in water in combination with calcium and magnesium causes water hardness

### 111.5 Potassium content in the groundwater of the Quaternary (Pleistocene) aquifer:

Potassium content in groundwater of the Quaternary (Pleistocene) aquifer varies from 3.60 to 30 ppm and from 3.30 to 20 ppm in shallow and deep wells, respectively. The distribution of potassium in groundwater shows a good similarity in its content in both shallow and deep wells.

### 111.6 Sodium content in the groundwater of the Quaternary (Pleistocene) aquifer:

Sodium content in groundwater of the Quaternary ( Pleistocene) aquifer varies from 7 to 540 ppm in shallow wells and from 5.50 to 200 ppm in deep wells. The distribution of sodium ions in shallow wells in the study area indicates the presence of local polluted zones at Abu Zaabal and Belbies (sodium concentrations > 250 ppm), the groundwater in the polluted zones is considered unsuitable for drinking.

## 111.7 Magnesium content in the groundwater of the Quaternary (Pleistocene) aquifer:

Magnesium content in groundwater of the Quaternary (Pleistocene) aquifer vareis from 9.60 to 112.32 ppm in shallow wells and from 13.44 to 47.52 ppm in deep wells. The magnesium distribution in groundwater shows the presence of local zones of high concentrations but the magnesium contents still below the excessive limits for drinking.

## 111.8 Calcium content in the groundwater of the Quaternary (Pleistocene) aquifer:

The calcium content in groundwater of the Quaternary (Pleistoncene) aquifer varies from 12 to 105.60 ppm in shallow wells and from 28.80 to 139.20 ppm in deep wells. The calcium distribution in groundwater shows a correlation between its content in shallow and deep wells and confirm the presence of local zones of high concentrations occurred at Abu Zaabal. Hardness of water is attributed to the presence of calcium and magnesium ions, the water in the study area varies from moderate to very hard.

## IV Groundwater pollution studies

The quality of water was affected by human activities. The greatest sources of groundwater pollution are animals farms, sewer, polluted streams and refuse disposal sites. Therefore, the shallow wells are more polluted than the deep wells.

## IV.1 Contamination of groundwater of Quaternary (Pleistocene) aquifer

### IV.1.1 Trace Metals contaminates in the groundwater of the Quaternary (Pleistocene) aquifer:

Trace metals can be toxic and even health hazard to human beings even at relatively low concentrations because of their tendency to accumulate in the body.

Iron content in the groundwater of the Quaternary ( Pleistocene) aquifer shows low concentration due to the oxidation of ferrous ions to ferric oxides with a consequent precipitation. Its content varies from ferric oxides with a consequent precipitation. Its content varies from 0.05 ppm to 1.26 ppm in both shallow and deep wells. Iron content in deep wells shows a slight decrease than in shallow wells and still within the limit of WHO 1984, except the shallow wells in Abu Zaabal, Belbies and Abbasa.

Manganese content in groundwater of the groundwater of the Quaternary (Pleistocene) aquifer ranges from 0.01 ppm to 1.76 ppm in both shallow and deep wells. The distribution of manganese in groundwater indicates that its content in shallow wells is higher than that in deep wells.

The manganese concentration in the study area is within the limit of WHO 1984 where the maximum acceptable concentration is 0.5 ppm. Only exception encountered in polluted zones at Abu Zaabal, Belbies and

Abbasa where the concentration of manganese concentration of shallow groundwater wells exceeds 0.5 ppm.

Lead concentrations in the groundwater of the Quaternary (Pleistocene) aquifer ranges between 0.01 ppm and 0.045 ppm in both shallow and deep wells. The distribution of lead in groundwater shows that both shallow and deep wells are within the limit of WHO 1984 where the concentration not more than 0.1 ppm.

Copper content in groundwater of the study area in both shallow and deep wells varies from 0.01 ppm to 0.35 ppm . Based on the WHO 1984, the groundwater is within the limit where its not exceeds 1.5 ppm.

Zinc content ranges between 0.01 ppm and 0.35 ppm in both shallow and deep. The majority of the study area has zinc concentration ranges from 0.1 ppm to 0.2 ppm, the exception at Abu Zaabal, Belbies and Abbasa which have concentration more than 0.2 ppm but within the limit of WHO (1984).

### IV.1.2 Microbiological contaminants in the groundwater of the Quaternary (Pleistocene) aquifer:

The source of microbiological contamination is human and animal sewage or waste water. The Coliform group of bacteria and Escherichia Coli (E. Coli) in particular are the most frequently used indicators of bacterial contamination. The shallow wells in the study area are polluted, because it contain E.Coli and are poorly constructed.

### IV.1.3 Organic contaminants in the groundwater of the Quaternary (Pleistocene) aquifer:

The intensive use of pesticides and herpicides for agricultural purposes gives rise to water pollution, because these compounds are persistent and strongly adsorbed by materials and often accumulated in micro-organisms to concentrations several times as high as that in water.

There are more than one type of pesticides used in the study area, among them, Malation, Gammexane, Toxaphene and Lannate. These chemicals reach surface water and infiltrate, causing groundwater pollution.

## IV.2 Evaluation of groundwater of the Quaternary (Pleistocene) aquifer on the basis of potential uses:

### IV.2.1 Evaluation of groundwater of the Quaternary (Pleistocene) aquifer for drinking

According to the international standards for drinking water by WHO (1984), the groundwater of the Quaternary ( Pleistocene ) aquifer, in the study area, is acceptable for drinking except some shallow wells at Arab Gehina ( Abu Zaabal ) and Zefitat Mashtol ( Belbies ) .

### IV.2.2 Evaluation of groundwater of the Quaternary (Pleistocene) aquifer for irrigation

The investigation of groundwater of the Quaternary (Pleistocene) aquifer for irrigation by Ayers ( 1977 ), U.S. lab .( 1954 ) and Wilcox (1948 ) indicates that; the shallow groundwater, in the study area, is classified as good to permissible water for irrigation while the deep groundwater are classified as excellent to good except at Abu Zaabal and Belbies which are good to permissible water for irrigation.