Hydrogeochemical studies for toshka area,western desrst-egypt

The present thesis is mainly dealing with the hydrogeochemistry of Toshka area; it lies on the western side of Lake Nasser where it is delineated by latitudes 22° 15` and 23° 6`N and longitudes 31° 18` and 32° 00` E. It should be noted that groundwater in the investigated area is used mainly for agricultural purposes.The collected data and the obtained results were edited and represented within five chapters under the following titles:- CHAPTER I: Introduction.-CHAPTER II: Geomorphology, Geology and Hydrogeology.-CHAPTER III: Hydrogeochemical aspects.-CHAPTER IV: Hydrogeochemical modeling and statistical analysis-CHAPTER V: Evaluation of groundwater quality for different purposes.1-Introduction:This chapter contains general outlines, location of the study area, aim and scope of the present work and previous related studies.2- Geomorphology, Geology and Hydrogeology:The area under consideration can be geomorpholgically subdivided into the following units:-a- Aswan High Dam Lake.b- The Nile Valley.c- Wadi Kurkur pediplaind- Tushka depression.e- West Dungul plainGeologically, the sedimentary succession are described in the following from older to younger1- Abu Simbel Formation (Upper Jurassic-Lower Cretaceous).2- Lake Nasser Formation and Sabaya Formation (Lower Cretaceous).3- Kiseiba Formation (Upper Cretaceous).4- Kurkur Formation (Paleocene).5- Dungul Formation (Lower Eocene).6- Fluvial and Alluvial deposits, Lake deposits and Eolian deposits (Quaternary).Hydrogeologically, the water resources in the study area include two systems namely:a- Surface water systemThe surface water system includes both the High Dam Lake and El Sheikh Zayed canal.b- Groundwater systemThe Nubian sandstone facies constitute the main rock unit in the subsurface and they are composed of course to medium sandstone with intercalations of siltstone, clay and occasional conglomerate that rest unconformably on the Precambrian basement rocks at different depths. The groundwater exists under unconfined and semiconfind conditions. The thickness of the Nubian sandstone varies between 170 -320m, generally this thickness almostly increases toward southeastern directions, i.e. towards Aswan High Dam Lake, and decreases in the northwestern and northeastern.The depth to water table in this aquifer is ranging between 20 and 147m. Recharge of the Nubian aquifer is from three sources: a) Seepage of the Nile water, Lake Nasser. b) Regional groundwater influx from areas with modern groundwater recharge and c) Local infiltration through the precipitation during wet periods in past.the main groundwater flow direction is detected from the direction from Lake Nasser at the southeast towards the middle part of the study aquifer surrounding Toshka depression. The main trends of groundwater flow lines indicate that the Nubian aquifer is recharged at present from Lake Nasser.III- Hydrogeochemical aspectsIn the study area, majority of groundwater samples of the Nubian sandstone aquifer (81%) lie in the fresh zone, while the brackish water representing by 19 % of the total samples. The total dissolved solids range from 230 (well, 26) to 1875 mg/l (well, 54). The water salinity increases markedly from southeast to northwest and from east to west towards the middle of Toshka area, which matches, or follows the general direction of the groundwater flow, toward the middle of Toshka depression.The total hardness of groundwater, the mean value of total hardness reached 243 mg/l as $CaCO_3$, respectively.A- Frequency distribution of major ions.The concentration of calcium constituent is ranging from 6.12 to 93.92mg/l, with an average value of 80.37mg/l. Magnesium content groundwater ranges from 1.24 to 36.81mg/l, with an average value of 13.92mg/l. The concentration of sodium constituent ranges from 68 to 423mg/l, with an average value of 157mg/l. While the concentration of chloride constituent ranges from 53.1 to 433.8mg/l. with an average value of 180.6mg/l . With regard to, the concentration of sulfate constituent ranges from 13 to 711mg/l, with an average value of 216mg/l, while bicarbonate constituent ranges from 36 to 208mg/l, with an average value of 129mg/l.B-Ionic ratiosi) Sodium/chloride ratio (rNa^+/rCl^-).The value of rNa^+/rCl^- ranges from 0.54 to 1.94, with a mean value of 1.37. for water samples, 98% of the total samples have a mean value of rNa^+/rCl^-more than that of seawater (0.83) which indicates the continental deposition.ii) Sulfate/chloride ratio (rSO_4^{2-}/rCl^-).Value of rSO_4^{2-}/rCl^- ratio ranges from 0.05 to 1.95 with a mean value of 0.9, which is more than that of sea water (0.1). This reflects the dissolution of local terrestrial salts rich in sulfate.iii) Calcium/magnesium ratio (rCa^{2+}/rMg^{2+}).The range and mean values of this ratio are 1.0-14.98 and 3.9, respectively. This means that, the mean value is more than that of sea water (0.18) and less than that of rain water (7). All the investigated groundwater samples have rCa^{2+}/rMg^{2+} more than unity.iv) Calcium/sulfate ratio (rCa^{2+}/rSO_4^{2-}).The value of this ratio ranges from 0.19 to 9.68 with a mean value of 1.09, which is less than the value of rain water (2.63) and more than sea water (0.39).v) Calcium/chloride ratio (rCa^{2+}/rCl^-).All water samples have values of rCa^{2+}/ rCl^- that range from 0.09 to 2.29, with a mean value of 0.85 which is higher than the recorded value of sea water (0.04).C- Assemblages of hypothetical salts.Most groundwater samples (83%) of are characterized by the assemblage of hypothetical salts II and III which contain two and one bicarbonate salts, respectively, reflect the effect of leaching and dissolution of terrestrial salts by local infiltration of rain water during pluvial and post pluvial times as well as from the surface water system (Lake Nasser). Furthermore, 15% of groundwater samples are characterized by hypothetical salt assemblage (I) which is similar to that of Nile water. This confirms that the recharge is mainly from Lake Nasser. On the other hand, few groundwater samples of the Nubian Sandstone aquifer (2%) have the assemblages (VI) which contain $MgCl_2$ salt.Two profiles, AA` and BB` were performed to show the spatial variations of hypothetical salts combinations.C- Geochemical classification of groundwater1- Geochemical classification based on ionic relationships (Schoeller, s diagram, 1962):The plotting of hydrochemical data on Schoellar’s diagram shows that the majority of groundwater samples have nearly similar pattern, where the sodium ion (meq) is more than the chloride ion (meq) in 98% of samples, such pattern reflects fresh water of meteoric origin2- Geochemical classification based on trilinear diagram (Piper,s, 1953):most of groundwater samples (62%) are plotted within sub-area 7, which is dominated by alkalis and strong acids (primary salinity), are shown to be influenced by marine more than continental conditions. 38% of total samples are located within sub-area 9, where no one cation-anion pair exceeds 50 percent. These samples reflect different recharge sources to the Nubian sandstone aquifer (Lake Nasser and paleo-water).3- Geochemical classification based on modified Durov’s diagram (1948):Most groundwater samples (38% and 31%) of the Nubian sandstone aquifer are distributed between the sub-squares representing the glauberite (sodium-sulphate) water and (magnesium-sulphate) water.29% of groundwater samples are related to the sub-square of halite (sodium-chloride) and only one groundwater sample (2%) is related to the sub area of bischofite (magnesium chloride). So, this means that some of the investigated samples display chemically more developed stage of mineralization,4- Geochemical classification based on Solin`s diagram (1948):98% of of groundwater samples are located at the lower quadrant in the fields of (SO4-Na) and (HCO3-Na) types, indicating meteoric origin of groundwater as a result of leaching and dissolution of the terrestrial salts, while 2% of groundwater samples are located at the upper quadrant in the field of (Cl-Mg) and (Cl-Ca) types. This indicates the effect of traces of old sea water on the chemical composition of groundwater.IV- Hydrochemical Modelling and Statistical Analysis.Netpathxl modeling has been used to quantify the mass transfer that accompanies the rock / water interaction processes. The contribution of recent recharge from Lake Nasser to the Nubian aquifer in the study area varies largely (0.0% to 94%, avg. 46.8%) and a really controlled by the lithological and structural elements which either facilitate the recharge or act as a barrier against it.The saturation indices of calcite, dolomite, gypsum, anhydrite, silica, Goethite and hematite were calculated and spatially represented on figures.SPSS program were used to estimate bivariate correlation, factor analysis and cluster analysis. The result of factor analysis showed two factors (F1 and F2). F1 has positive loadings for TDS, Ca, Mg, Na, HCO3, Cl, SO4 and NO3 ($> +0.5$). This factor refers to leaching and dissolution processes. F2 is composed of HCO3 it should be an indicator of the hydrochemical effect of leakage from lake Nasser to groundwater.The scores of these factors were spatially distributed which showed that, the high values of F1 are found in the middle part of Tushka area. On the other hand F2 implies that, the high values of F2 are found at the eastern part of the study area, near to Lake Nasser.Cluster analysis of 49 sampling sites fell into 6 major clusters. These clusters were also represented spatially. Cluster 2 represents the most affected samples by recharge from Lake Nasser.V- Evaluation of surface and groundwater quality.All surface water is suitable for different purposes. Majority of groundwater samples (81%) in the study area are suitable for drinking. 79% of groundwater samples are unsuitable for domestic and laundry uses because they range from hard to very hard water. 83% of groundwater samples are excellent for all classes of livestock and poultry, while 17% are very satisfactory for all classes of livestock and poultry.Evaluation of surface and groundwater for irrigation purposes.According to Doneen`s classification, regardless of soil types, majority of groundwater samples in the study area can be classified as water of the second grade (class II) of irrigation water. While the rest of groundwater samples can be classified a water of the first grade (class I) and third grade (class III) of irrigation water.According to Wilcox’s classification, the majority of the Nubian sandstone aquifer groundwater samples (98%) are suitable for irrigation purpose, while the rest of samples (2%) are unsuitable.According to Richard`s, Most of the groundwater samples(58%) are considered as good water for irrigation which are located at classes (C1-S1 and C3-S1), while 42% of groundwater samples are considered as moderate water for irrigation as they are located at classes (C2-S2, C3-S2 and C4-S2).RecommendationsIn order to develop the groundwater in the Toshka area, the following bases should be taken into account:1- It is recommended that a number of hydrometeorological stations should be established as soon as possible along the High Dam Lake.2- Many other tools must be used to estimate the net recharge from Lake Nasser to the Nubian aquifer, especially isotopic analysis.3- The interval distance in the future between each two successive wells should not be less than 1km in order to minimize the interference between wells and the existed wells should not be operating simultaneously if the distance between them is less than 1km.4-Monitoring of the changes in water level and salinity with time in such area will be necessary.5- The corrosion effect of the groundwater on the well casing must be taken into consideration.6- A special treatment to remove iron and manganese from groundwater must be taken into consideration which may cause health damage and corrosion for well casing.