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Monitoring and Characterization of ground water in Sadat City, Menoufia, Egypt.

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Abstract

The aim of the study was to describe water sources of Sadat city, Menoufia, Egypt. Monitoring support wells, artesian plants, and surface source which play an important rule in water quality as well as networks was run for 6 years from 2012 to 2017. The results showed the surface water source had fixed total dissolved solids (TDS) over the study years with an average of 272 ml/L. For the northern wells, TDS ranged from 397 mg/L to 546 mg/L with an average of 482 mg/L over a study period. For the southern wells, the TDS ranged from 703 mg/L to 1142 mg/L and had gradually increased due to overuse and uncontrolled water withdrawal from wells pumped into the reservoir, which supplies water to residential areas. The water of Sadat city especially in case of southern wells has no considerable potentials of groundwater resource. In addition, the water quality of distributed ones showed the most areas were supplied with water through the northern and surface stations had acceptable quality according to Egyptian guideline except the first and second residential areas.

Keywords: Iron; Manganese**.** Sadat City; total dissolved solids; water resources.

Introduction

Sadat City is considered the oldest of the first-generation cities affiliated to the New Urban Communities Authority. There are activities for the development of the city that include residential, industrial and agricultural activities that depend on ground water. The activities cause shortage of ground water as a result of its excessive, unsystematic withdrawal **(Fattah, 2012)**. Ground water is the most valuable water sources and is the basic element for the development of many sectors, such as the industrial, residential, tourism, agricultural and commercial sectors, as well as the livestock sector **(Ahmed and Ali, 2011).**

Ground waters are the world's most abundant freshwater resources providing about 50% of all drinking water, about 40% of water for agricultural irrigation, and 33% o e water necessary for industrial activities **(Swatuk, 2021).** In addition to this, it helps preserve the river's base flow and the local ecosystem (**Zhou and Cartwright, 2021**). In addition, groundwater is an important storage source for climate change adaptation because it reduces land subsidence's and ocean interferences (**Pramita Italic., 2021**). However, aquifers are frequently misunderstood and inadequately managed due to their invisibility **(De Fraiture, and Wichelns, 2010**).

Groundwater levels, abstraction rates, spring discharge and ground water quality are all measured around the world **(Lam Italic., 2021)**.An increased quantities and volumes of waste and pollutants in Sadat city have important environmental issues. Also the quantities of consumed water, which reaches double the quantities of consumption in the past years of the city's life led to increase water salinity **(Fattah, 2014).**

Regular monitoring program for ground water including levels, quality, extraction rates, rationalization of water uses and minimizing losses is mandatory issue. The chemical analyses of the collected water samples were carried out. To study the ground water contamination, the total dissolved solids, total hardness, electrical conductivity and pH value were monitored. The major anions (CO_3^{-2}, HCO_3^{-}, Cl^{-}, and SO_4^{-2}), and major cations (Ca^{+2} and Mg^{+2}) were analyzed. Also, the trace elements including Fe^{+2} and Mn^{+2} were determined.

Materials and methods

Sample's location: -

Samples from thirty-five ground water locations were collected through studying period from 2012 to 2017 as the productive water wells representing the study area of Sadat City (fig 1).Water samples were collected in refined plastic bottles. The sample bottles were rinsed with deionized water before sampling. Two groups of samples were collected from each sampling site, where the first group was used for major ions analyses. The second group was collected for heavy metals analyses and was acidified with nitric acid (HNO_3) to a pH less than 2**(APHA, 2005)**.

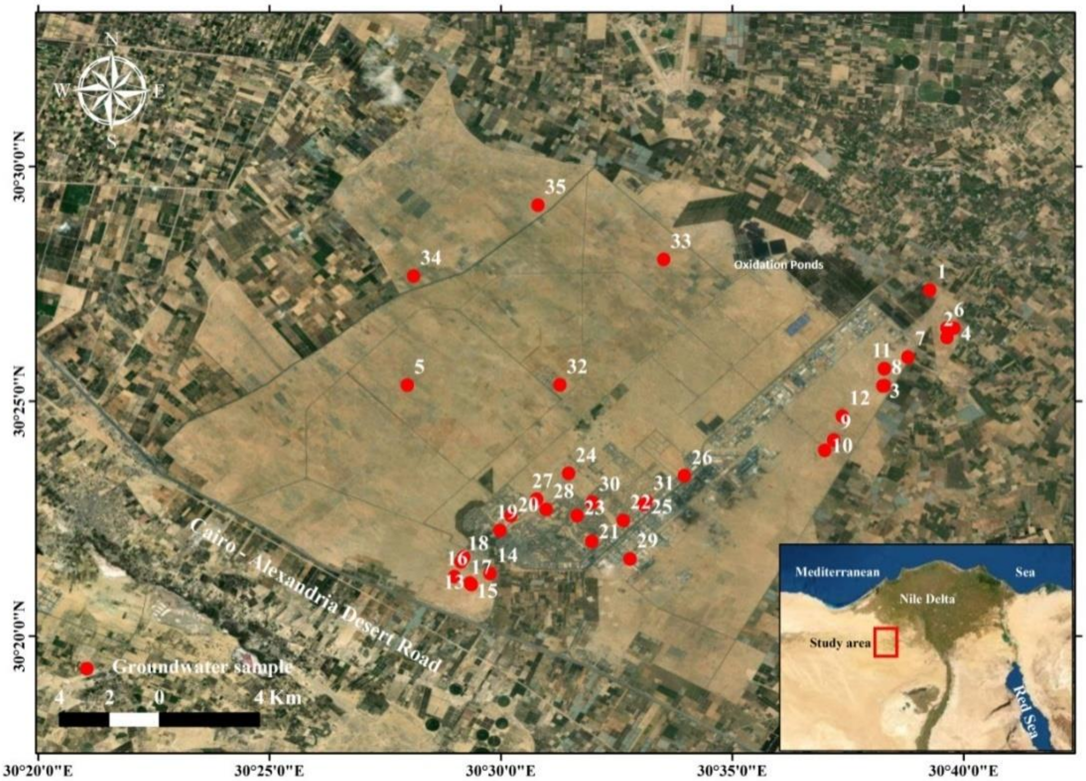

Fig. (1) Ground water samples location maps in the Sadat city, Menoufia, Egypt as studying area

Ground water samples were filtered through 0.45 mm polypropylene membranes, all samples were preserved at temperature less than 4 °C until analyzing processes as recommended by standard procedures. The chemical analyses were performed. All analyzes were carried out in the laboratories of Sadat City Authority. The temperature of the sample was maintained at ambient conditions prior to and during testing. The collected water was stored and refrigerated at 4 °C for subsequent testing. The temperature of the sample was adjusted to room temperature before initiating any test **(APHA, 2005)**.

Physical and chemical analyses of water samples

The quality of water samples was determined by measuring pH, electrical conductivity (EC), turbidity, chloride, total alkalinity, total hardness, Calcium hardness and Magnesium hardness. All the physical and chemical analyses were done in duplicates and determined following the procedures of Standard Methods done for the Examination of Water and Wastewater **(APHA, 2005)**.

Chemical analysis of trace elements (Iron, Manganese.) using spectrometer were tested and the results were expressed in mg/L. Spectrophotometer (HACH mod. DR 2000) was used to analyze (SO_4^{2-} , F^-, NH_3, NO_2^- ,NO_3^-). Major ions (Ca^{+2}, Mg^{2+}, Cl^-, HCO_3^-, and CO_3^{-2}) were analyzed by volumetric titration following the instruction of a standard analytical method (**APHA 2005**).

Data analysis

The data were analyzed using statistical software (SPSS Version 17, SPSS INC, Chicago, IL, USA). Initially, the descriptive statistics were computed. One-way ANOVA was used followed by Duncan's post hoc test (α0.05). In all tests, p values smaller than 5% were considered statistically.

Results and Discussion

In the present study, the hydrochemistry of the ground water is discussed in order to estimate the water quality variation, and to shed the light on the important indications about the history of various concentrations of major elements as well as ground water recharge, discharge, and movement of ground water in the studied area. Thirty-five groundwater samples were collected in 2017 from the productive water wells representing the study area (Fig 1). The chemical analyses of the collected water samples were carried out. The total dissolved solids (TDS), total hardness (TH), electrical conductivity (EC), pH value, the major anions (CO_3^{-2}, HCO_3^-, Cl^-, and SO_4^{-2}), and major cations (Ca^{+2} and Mg^{+2}) were analyzed. The minor and trace elements including Fe^{+2} and Mn^{+2} were also determined to study the groundwater contamination obtained chemical data are expressed in mg/L. The nature of water and it is an important parameter in drinking and irrigation usages of waters It has profound effects on water quality, affecting the solubility of metals, alkalinity and hardness of water **(Osibanjo Italic, 2011)**.

Total Dissolved Solids (TDS)

Total dissolved solids (TDS) typically comprise carbonates, bicarbonates, chlorides, sulfates, phosphates nitrates, calcium, magnesium, sodium, potassium iron, and a small amount of organic matter. Ground water of Quaternary aquifer belongs to good fresh water type in Sadat City, salinity contents range from 191 mg/L of well No.8 to 1578 mg/L of well No.14 in the west with a mean value of 484.6 mg/L, as a result of presence of impermeable clay and leaching processes of salts from clay present in the aquifer materials as shown in Fig. (2)

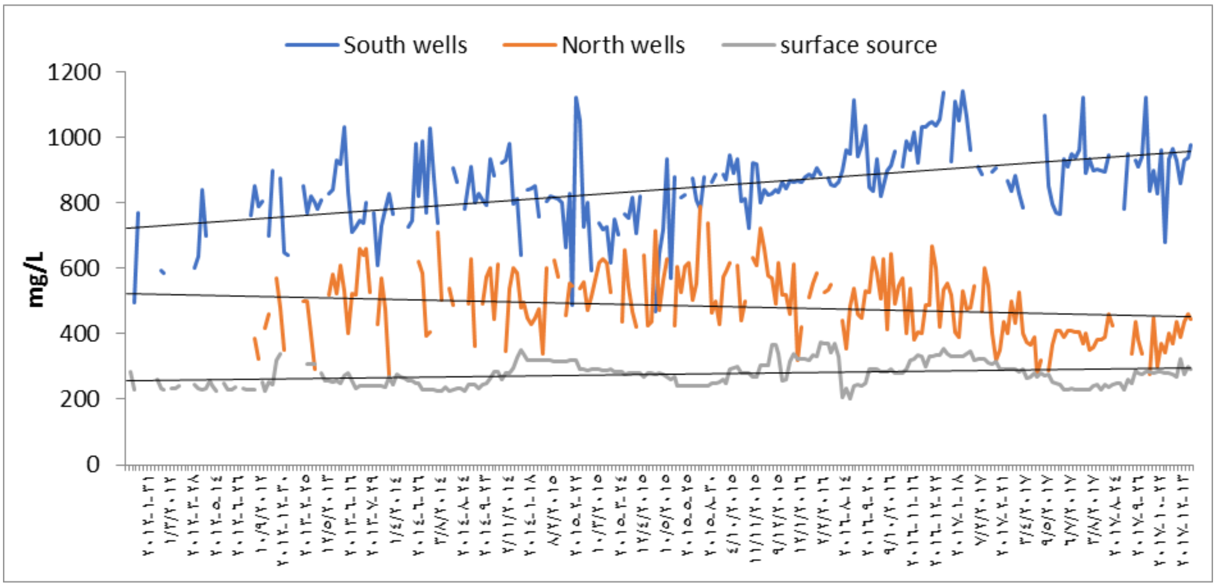

Fig. (2) Total dissolved solids distribution and trend lines of water resources in the Sadat City, Menoufia, Egypt through study period of 2012 to 2017.

Table (1) Statistical description of the measured physicochemical parameters in the ground water samples.

Parameter	pH	EC	TDS	Mg^{2+}	Ca^{+2}	Cl^-	$SO^2{}_4^-$	HCO_3^-	NO_3^-
Min	7.4	382	244.5	6.96	19.2	24	16	80	0.0
Max	8.1	2630	1683	69.16	160	320	300	162	3.7
Mean	7.53	809	485	17.95	54.4	112.5	76.9	121.8	0.52

All parameters are expressed in mg/L except pH, and EC (μs/cm)

Distribution of Minor elements in the ground water

This part is mainly devoted to shed light on the hydrochemistry and distribution of minor elements in the ground water of the area under study. Iron and Manganese are the most common elements which are determined in the collected ground water samples, according to Table (2).

Iron (Fe^{2+}) distribution

Iron is widely distributed in the earth's crust. Its main sources in ground water are the dissolution of iron bearing minerals commonly found in aquifer sediments as pyrite, siderite, magnetite, and iron silicate. The common form in the ground water is the soluble ferrous ion (Fe^{++}). When exposed to the atmosphere, Fe^{++} is oxidized to the insoluble ferric state (Fe^{+++}), which precipitated as ferric hydroxide causing a brown discoloration of the water. Corrosion of well casing and other pipes may also contribute iron to ground water. Moreover, bacterial activities can also increase or decrease iron concentration in ground water. The presence of iron in drinking water leads to a metallic taste. The maximum permissible concentration of iron in drinking water is 0.3 mg/L **(WHO, 2017)**, primarily for reasons of taste, and to avoid the kidney diseases staining of plumbing fixture and laundered clothes. It is clear that the studied samples are characterized by low concentration of iron ranging from 0.01 mg/L to 0.17 mg/L in the majority of ground water samples. And ranges between 0.28 ppm to 0.35 mg/L in large scale development areas (Wells No. 2, 3, and 5) (Table 2) reflecting effect of dissolution of iron bearing formation. Iron concentration increases gradually toward the southwestern portions.

Table (2) the values of heavy elements in the study area represented in mg/L.

Parameter	**Fe**	**Mn**
Min	0.00	0.00
Max	0.35	0.12
Average	0.07	0.03
SD	0.08	0.03
WHO limit	**0.30**	**0.10**
Egypt Limit	**0.30**	**0.40**

Manganese (Mn^{2+}) distribution

Some igneous and metamorphic minerals contain divalent manganese as a minor constituent. Small amount commonly occurs in dolomite and limestone, substituting for calcium. Manganese oxides and hydroxides are common sources of manganese in soil and sedimentary rocks. Manganese is an essential element in plant metabolism and its organic circulation can influence its occurrence in natural waters. The divalent ion (Mn^{++}) is soluble and found in most ground water at concentrations less than those of ferrous ion (Fe^{++}). When exposed to the atmosphere, manganese is oxidized to the much less soluble hydrated oxides **(Hem, J.D. 1980)**, which form black stains in plumbing fixtures and laundered textiles. It is clear that the water in the studied area is mainly characterized by low manganese concentrations ranging from 0.01 mg/L to 0.08 mg/L of the majority of the study area. Abnormal high values of manganese contents ranging from 0.1 to 0.12 mg/L were recorded at two places (Wells No. 14, and 17) reflecting effect of dissolution of manganese bearing deposits.

Conclusion

The purpose of the study was to describe Sadat city's water sources (support wells, artesian plants, surface stations) and to assess them and to know the extent of water quality in Sadat city as well as networks over the course of 6 years from 2012 to 2017.

For the surface source in Sadat city, the total dissolved solids trough the study period with an average of 272 ml/L. For the northern wells, TDS ranged from 397 mg/L to 546 mg/L with an average of 482 mg/L over a 6-year period. For the southern wells, TDS ranged from 703 mg/L to 1142 mg/L between 2012 and 2017 and has increased these days due to overuse and uncontrolled water withdrawal from wells pumped into the south station reservoir, which supplies water to residential areas (#1 and #2). All water samples had low to moderate concentration of Fe and Mn and below the Egyptian and WHO guidelines.

The water of Sadat City especially in case of southern wells has no considerable potentials of groundwater resource. In addition, the water quality of distributed ones showed the most areas were supplied with water through the northern and surface stations had acceptable quality according to Egyptian guideline except the first and second residential areas.

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