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RESEARCH ARTICLE

Monitoring the changes in the quality of drinking water through nine years in Assiut governorate, Egypt

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Abstract

The main aim of this study was to monitor the quality of surface and groundwater used for municipal and drinking purposes in Assiut governorate, Egypt over nine years (2009-2017). Therefore, the available data were collected from all official resources in the governorate. The data of 37789 drinking water samples from eleven districts plus East and west of Assiut governorate were summarized and compared with national and international drinking water standards of Arab Republic of Egypt A.R.E law no-458/2007 and WHO (World Health Organization) guidelines 2004. The initial high level of turbidity in 2009 and subsequent propensity to fall over time were mostly caused by the installation of new surface water pumping filtration stations as well as new Fe and Mn removal stations. The records for ammonia, Fe and Mn concentrations increased in the Northern part of Assiut (Dairut, ElQusiya and Manfalut), and in the Eastern part (Sahel Selim and ElBadari) of Assiut governorate. This trend may be due to infiltration of the excessive application of fertilizers and wastes derived from human and animal activities. Some parameters such as (turbidity, TDS, alkalinity, hardness, Fe, Mn and NH3 showed increases in groundwater sources than those in municipal water. Some parameters (Alkalinity, Cl-ion, NH_3, Fe and Mn) were temporally at the lowest concentration in winter for the same source compared to summer. Furthermore, research showed that the Assiut Governorate's drinking water has excellent (54%), good (38.5%), and acceptable (7.5%) TDS levels. The overall hardness values were 38.5% hard and 61.5% very hard.

Key words: Quality of drinking water; Nile water; Groundwater; Alkalinity; Assiut.

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Introduction

Water is becoming more and more important as a component of life on Earth with each passing day. Due to widespread environmental degradation, it is crucial to monitor the water quality, especially when it comes to sources of drinking water. The drinking water sources in Assiut governorate are surface Nile or its irrigation canals and groundwater from a quaternary aquifer which generally is semi-unconfined in the area. It is assumed that natural and unpolluted water taken from deep wells is clean and healthy (Reimann et al, 2003). Groundwater quality can be affected by the composition and solubility of rock materials in the aquifer, partial pressure of carbon dioxide, water temperature, acid-base reactions, oxidation-reduction reactions, loss or gain of constituents as water percolates through clay layers and mixing of groundwater from adjacent strata. The extent of each effect is determined in part by the residence time of the water within the different subsurface environments (El-Otefy et al. 2017).

The main sources of pollution of groundwater are the discharge of urban and industrial wastewater to the environment without any treatment, excess drafting, agriculture pesticides which have recently gained importance as a main factor, and the water leaking from septic tanks that are commonly used in places where there is no sewer system may be carried to groundwater. Furthermore, unregulated constructions, a lack of sewage network capacity, and a high incidence of vertical leakage all contribute to an increase in the volume of polluted water that seeps downwards to affect the aquifer. (Awad and Abdel-Baki, 1993).

Physical changes in the taste and color and odor of drinking water are the biggest problem in drinking water especially with increasing turbidity, and the chemical properties such as total dissolved solids (TDS), iron (Fe), manganese (Mn), ammonia (NH_3) and nitrate (NO_3) (HCWW, 2017). Figure 1 shows the sampling location of drinking water pumping stations.

Fig. 1. Map of Assiut governorate showing the sampling location of drinking water pumping stations.

Water sampling

Water sampling from Assiut governorate was carried out according to standard methods for water analysis (APHA, 2005; 2012). In order to track changes in water quality, samples were taken from tap water along the governorate's distribution network as well as groundwater pumping stations (which include 238 tanks and groundwater wells with outlets for drinking water and 222 pumping stations). During the investigation period, water samples were collected in capped polyethylene clean bottles.

To study and assess the quality of drinking water in Assiut governorate for the study period between 2009 to 2017, water samples were collected from more than 700 wells located in 222 groundwater pumping stations present in Assiut governorate, as shown in Fig.1 and 9 large drinking water filtration stations, 1slow surface water filtration station, 11 Compact filtration stations and 3 Zalateya stations (as) surface water. In addition to municipal water samples in all districts in area during period from January 2009 to December 2017. The collected data were summarized and compared with the standard limits of the Egyptian Standard Limits, No-458/2007) according to the Egyptian Ministry of Health and the guidelines recommended by the World Health Organization (WHO, 2004).

Analytical Techniques

The analytical methods used by all laboratories were based on the standard methods for water examination according to the American Public Health Association (APHA 2005; 2012). To assure data accuracy, all field parameters were measured in the field and then double-checked in the lab. The pH, and total dissolved solids (TDS) of water samples were measured by using pH meter and EC meter (HANNA combined electrode, HI991301). The turbidity of water samples was measured using a turbidimeter (HI-88703– HANNA INSTRUMENT). The concentration of ammonia was measured calorimetrically Phenate method according to 4500-NH_3 F. The concentrations of Fe and Mn were measured calorimetrically using a visible spectrophotometer (HACH, DR-5000) according to 3500-Mn B. persulfate method, and 3500-Fe B. O. Phenanthorline method, respectively.

Results and Discussion

Physical properties of drinking water Turbidity

Turbidity makes water appears cloudy or muddy, which is caused by the presence of suspended and dissolved matter, such as clay, silt, fine particles of organic and inorganic matter, soluble colored organic compounds, plankton and other microscopic organisms, organic acids, and dyes (ASTM, 2003; USEPA, 1999). The main sources of drinking water turbidity include clay, poor well development, waste discharges, excessive discharge, runoff from watersheds especially those that are disturbed or eroding, Algae or aquatic weeds and products of Algae or aquatic weeds breakdown in water reservoirs (Thomas and Camp, 1963). The color of water, whether resulting from dissolved compounds or suspended particles, can affect a turbidity measurement. Generally, the average turbidity values in Assiut governorate ranging from 0.47 to 4.99 NTU with an overall average of 1.96 NTU (Table 1). The surface water turbidity value ranging from 0.47 NTU in ElBadari to 3.67 NTU in Sahel Selim (Table 2). Meanwhile, in the groundwater ranging from 1.15 NTU at Abu Tij to 4.99 NTU in ElFateh (Table 2). The overall average of turbidity from all resources of Assiut governorate is shown in (Table 1) showed increasing turbidity in 2012 and 2013 especially in areas that totally depend on groundwater as a main source of drinking water (Dairut, ElQusiya, Sahel Selim, ElBadari, ElFateh and Abnub), where there was no surface water filtration station. These values in the groundwater were high especially in Dairut, ElQusiya, Sahel Selim and ElFateh, mainly due to the Fe ions in the groundwater. The high turbidity value also may be attributed to discharge from agricultural, industrial, and anthropogenic wastewater and the effect of the recharge from the surface water. The local effects of the high soluble iron concentration of the aquifer, which oxidized when exposed to air, provide another explanation. The normal drinking water turbidity rating in Assiut is higher than what is allowed in Egypt. Despite having a 5 NTU limit, it complies with WHO requirements.

Total Dissolved Solids (TDS)

The total dissolved solids are a measure of the total amount of minerals dissolved in water. It is a very useful parameter for the evaluation of water quality (USGE, 1998). Different guidelines are used for water

classification according to its TDS content. Chebotatarev (1955) classified water according to TDS value into three classes: fresh (TDS is less than 1500 mg/l), brackish (TDS ranging from 1500 to 3000 m/L) and saline water (TDS is more than 5000 mg/L). The drinking water in Assiut governorate according to TDS value is typically freshwater including all industrial zone in the study area. In Assiut governorate, TDS average values ranging between 104 mg/l in 2015 to 904 mg/l in 2017 in Sahel Selim with an overall average of 382 mg/l (Table 1). Surface water TDS values ranging between 104 mg/l (ElQusiya) to 682 mg/l in Sahel Selim (Table 2). While TDS values in groundwater ranging between 190 mg/l in Abu Tij to 904 mg/l in Sahel Selim (Table 2). Generally, Sahel Selim and ElBadari have the highest value of TDS. Additionally, ElGhanyem, which depends totally on groundwater, showed high TDS.

Our results showed that TDS values increase away from the river Nile and decrease in wells near to river Nile (Data not shown). Additionally, TDS tended to show a higher increase during winter than summer, mainly due to the infiltration of surface water during the high-recharge period at winter. Generally, the TDS average value of water according to WHO (1992) in Assiut. The average value in Assiut governorate was acceptable according to Egyptian Standard Limit (1000mg/l), and WHO 2004 limit (600 mg/l).

Table 1. Turbidity and TDS of drinking water in Assiut governorate districts (2009-2017).

Year	Turbidity			TDS		
	Min	Max	Av./year	Min	Max	Av./year
2009	1.13	3	1.9	250	700	456
2010	1.1	4.6	2.43	217	650	400
2011	1.27	3.02	1.99	171	714	370
2012	0.63	4.99	2.08	206	848	380
2013	0.47	4.68	2.29	126	866	366
2014	0.54	3.33	1.67	196	850	379
2015	0.74	2.7	1.64	152	904	398
2016	0.55	3.56	1.8	163	841	356
2017	0.82	4.62	1.85	104	781	328
Total average	0.80	3.83	1.96	176	795	382
WHO guideline		5			600	
Egyptian standard		1			1000	

Table 2. The range of chemical characteristics of drinking water at each district from Assiut Governorate overall 2009-2017.

	City	Turbidity		TDS		pH		T. Alkalinity		T. Hardness	
		Net	C. Station	Net	C. Station	Net	C. Station	Net	C. Station	Net	C. Station
1	Dairut	1.3-4.62	1.9-4.68	243-393	341-482	7.5-7.75	7.5-7.65	170-307	190-363	270-323	280-342
2	ElQusiya	1.25-3	2-4.63	104-393	231-429	7.4-7.68	7.5-7.81	120-208	140-295	149-242	250-311
3	Manfalut	0.95-2.8	1.73-2.7	152-577	262-458	7.4-7.89	7.4-8.04	151-278	181-321	174-238	224-348
4	Eastern Assiut	1-1.7	ND	197-377	ND	7.37-7.9	ND	140-210	ND	174-192	ND
5	Western Assiut	0.96-2	ND	236-317	ND	7.5-7.8	ND	153-222	ND	160-231	ND
6	Centeral Assiut	1-2.65	ND	406-491	ND	7.5-7.9	ND	211-323	ND	281-325	ND
7	Abnub	0.74-2.1	1.21-2.63	230-540	406-640	7.4-7.8	7.4-7.7	153-298	239-336	168-340	305-346
8	ElFateh	0.78-3	1.41-4.99	126-450	253-542	7.5-7.89	7.6-8.04	130-342	290-323	253-384	264-337
9	Sahel Selim	0.55-3.67	1.83-3.7	351-682	650-904	7.4-7.97	7.5-8.05	211-366	251-347	315-438	330-488
10	ElBadari	0.47-2.82	1.2-4.5	208-292	543-665	7.5-7.92	7.38-7.82	121-402	202-403	133-361	254-385
11	Abu Tij	0.85-1.8	1.15-2.4	171-386	190-431	7.4-7.8	7.6-7.77	150-310	190-333	159-225	211-283
12	Sedfa	0.82-3	1.72-3	173-401	270-439	7.5-7.8	7.6-7.8	145-326	217-329	155-331	225-337
13	ElGhanyem	2.35-0.8	1.6-2.82	363-490	342-421	7.4-7.75	7.5-7.73	314-392	329-403	310-346	321-357

Net: average analysis of the drinking water distribution net of the district.
c. Station: average analysis of the drinking water stations of the districts.
ND: Not Detected

Table 2 continued. The range of chemical characteristics of drinking water at each district from Assiut Governorate overall 2009-2017

	City	Cl^-		Fe		Mn		NH_3	
		Net	C. Station	Net	C. Station	Net	C. Station	Net	C. Station
1	Dairut	33-71	42-74	0.09-0.59	0.14-0.5	0.15-0.55	0.21-0.55	0.1-0.7	0.2-0.86
2	ElQusiya	27-53	38-69	0.05-0.5	0.16-0.5	0.11-0.33	0.16-0.35	0.1-0.6	0.38-0.8
3	Manfalut	28-107	44-71	0.1-0.29	0.15-0.34	0.06-0.25	0.1-0.33	0.03-0.4	0.05-0.6
4	EAST	28-35	32-37	0.12-0.32	ND	0.08-0.22	ND	0.07-0.5	ND
5	West	32-37	ND	0.05-0.28	ND	0.01-0.16	ND	0.01-0.5	ND
6	Center	58-90	ND	0.16-0.33	ND	0.05-0.28	ND	0.11-0.3	ND
7	Abnub	31-79	64-86	0.05-0.3	0.12-0.43	0.01-0.25	0.09-0.4	0.06-0.5	0.05-0.8
8	ElFateh	36-157	67-122	0.03-0.43	0.15-0.5	0.04-0.43	0.03-0.49	0.02-0.7	0.1-0.7
9	Sahel Selim	75-158	121-190	0.1-0.77	0.16-0.45	0.06-0.45	0.14-0.38	0.1-0.45	0.14-0.7
10	ElBadari	33-49	104-148	0.02-0.43	0.12-0.56	0.2-0.35	0.06-0.4	0.01-0.35	0.03-0.32
11	Abu Tij	21-48	28-49	0.03-0.29	0.06-0.29	0.04-0.29	0.1-0.54	0.02-0.04	0.01-0.06
12	Sedfa	28-61	50-69	0.03-0.23	0.09-0.25	0.01-0.56	0.14-0.39	0.02-0.12	0.02-0.21
13	ElGhanyem	27-80	35-64	0.02-0.34	0.12-0.27	0.06-0.4	0.23-0.39	0.01-0.1	0.02-0.1

Net: average analysis of the drinking water distribution net of the district.
c. Station: average analysis of the drinking water stations of the districts.
ND: Not Detected

Chemical properties

Hydrogen ion activity (pH)

The pH values are presented in (Table 3). The lower the pH is the more acidic the water. pH is used as a measure of the solvent power of water. At the typical temperature of groundwater, a pH of 7 is considered neutral (APHA, 2005). In most types of surface and groundwaters, which are in direct contact with the atmosphere, the pH value ranges from 7 to slightly more than 8. However, the pH value is a function of CO2-, CO3--, and HCO3-, an equilibrium which is easily disturbed by carbon dioxide content changes (Saleh, 1993). The data showed that the drinking water pH values in the studied area slightly varied through the months of the year, ranging between 7.37 (East Assiut) and 8.05 (ElFateh) with an overall average of 7.64 (Table 3), which means that the drinking water was neutral to slightly alkaline water. Generally, surface drinking pH water ranging between 7.37 at Eastern Assiut and 7.92 Sahel (Table 2), While, in groundwater, it ranging between 7.38 at ElBadari to 8.05 at Sahel Selim, Manfalut and ElFateh which are neutral to slightly alkaline (Table 2). The increase in the pH in the southern part of Assiut may refer to the influence of the limestone rocks in that area. The pH value variations are related to local geological and geographical variations (Timothy and Colin, 1997). All results in Assiut governorate were acceptable according to Egyptian Standards limits (6.5-8.5) and according to

WHO guidelines (6.5-8). Therefore, the pH value of drinking water was recorded (8.04) in 2017 in ElFateh and in 2016 at Manfalut, while Sahel Selim was (8.05) in 2015which were not accept according to WHO 2004.

Table 3. Chemical characteristics of drinking water at Assiut governorate districts (2009-2017).

Year	pH			T. Alkalinity			T. Hardness		
	Min	Max	Average of all samples in year	Min	Max	Average	min	max	Average of all samples in year
2009	7.37	7.8	7.53	120	403	258	192	370	283
2010	7.39	7.8	7.54	123	402	267	177	385	282
2011	7.4	7.77	7.61	147	392	261	174	385	283
2012	7.37	7.9	7.67	138	392	265	149	411	281
2013	7.43	7.97	7.67	118	403	250	167	488	288
2014	7.5	7.89	7.68	120	380	260	151	439	278
2015	7.5	8.05	7.72	150	356	239	140	415	270
2016	7.48	8.05	7.66	139	355	247	165	445	270
2017	7.38	8.04	7.6	126.	384	248	133	400	266
Overall average	7.42	7.9	7.64	133	385	255	161	415	278
WHO Guideline	6.5	8			*			200	
Egyptian standard	6.5	8.5			*			500	

*= did not have a limit in the standard method

Table 3 continued. Chemical characteristics of drinking water at Assiut governorate districts (2009-2017).

Year	Cl^-			Fe			Mn		
2009	31	121	60.5	0.15	0.77	0.323	0.12	0.4	0.25
2010	30	175	69.5	0.15	0.77	0.317	0.13	0.46	0.26
2011	21	158	59.1	0.12	0.3	0.202	0.06	0.54	0.24
2012	21	166	63.3	0.05	0.5	0.248	0.1	0.39	0.26
2013	22	175	59.8	0.03	0.37	0.154	0.11	0.43	0.25
2014	30	158	62.1	0.02	0.45	0.188	0.05	0.49	0.27
2015	21	170	61.5	0.03	0.55	0.187	0.01	0.56	0.2
2016	24	190	62.1	0.04	0.59	0.171	0.01	0.55	0.2
2017	28	164	62.4	0.02	0.49	0.178	0.01	0.41	0.14
Overall average	25	164	62	0.07	0.53	0.22	0.07	0.47	0.23
WHO Guideline		250			0.3			0.4	
Egyptian		250			0.3			0.4	

Table 3 continued. Chemical characteristics of drinking water at Assiut governorate districts (2009-2017).

Year	Min	Max	Average of all samples
2009	0.04	0.54	0.24
2010	0.01	0.57	0.22
2011	0.02	0.82	0.24
2012	0.01	0.84	0.3
2013	0.01	0.74	0.32
2014	0	0.88	0.25
2015	0.01	0.56	0.2
2016	0.03	0.7	0.16
2017	0	0.57	0.1
Overall average	0.01	0.69	0.23
WHO Guideline		1.5	
Egyptian standard		0.5	

Total Alkalinity (T. Alkalinity)

Alkalinity is commonly used to indicate a buffer capacity of the system against acid impact. Buffering capacity is the ability of a body of water to adjust the changes in pH and phosphates. Titrated alkalinity is expressed as the equivalent concentration of $CaCO_3$ in mg/1. Bicarbonate is the major form of alkalinity. Carbonates and hydroxide may be significant when algae activity is high. Alkalinity is significant in the treatment processes for potable water and wastewater (Hem, 1970). The range of T. Alkalinity in Assiut governorate is 118 to 403 mg/l with an overall average of 255 mg/l (Table 3). The range of T. Alkalinity in surface drinking water in Assiut governorate ranging from 120 mg/l in ElQusiya to 402 mg/l in ElBadari (Table 2), while, in groundwater, it ranging from 140 mg/l In ElQusiya to 392 mg/l in ElGhanyem (Table 2), Also the highest T. Alkalinity value was in ElGhanyem (314-403mg/l) in the distribution net and at the pumping station respectively (Table 2), these may be because ElGhanyem is depending only on groundwater for drinking water source. Generally, the highest T. Alkalinity value was in ElGhanyem and Sahel Selim followed by ElBadari and ElFateh which depended totally on groundwater until 2013. Then after 2013 At Twabeyah surface water filtration station in ElFateh affected the Total Alkalinity. Alkalinity values were high at ElGhanyem during all months of the year. Generally, T. Alkalinity is higher in groundwater than in surface Nile water.

The high levels of alkalinity detected in the southern part of Assiut could be explained by the high bicarbonate content, the addition of soap, and the detergent used by the residents for washing and bathing. (Mokhtar, 2017)

Total Hardness (T.H)

Water hardness is defined as the sum of the concentrations of Ca and Mg ions expressed as mg/l of $CaCO_3$. If the hardness as $CaCO_3$ (total hardness) exceeds the alkalinity of the water as $CaCO_3$ (equivalents to the bicarbonate and carbonate), the difference between the two values is called noncarbonated hardness, or permanent hardness. If the total hardness is less than or equal to the alkalinity the permanent hardness = 0. The temporary hardness can be removed by heating where $CaCO_3$ precipitates, but the permanent hardness can be removed by adding sodium carbonate react with Calcium and calcium carbonate precipitates (Dojlido and Gerald, 1993). In Assiut governorate The Total Hardness values (as $CaCO_3$) average values ranging between 133 mg/l in 2017 to 488 mg/l in 2013 in with an overall average of 278 mg/l (Table 3).

According to Durfor and Becker (1964) and WHO (2008), water is classified according to its hardness into soft, moderately hard, hard and very hard water. According to Durfor and Becker (1964), WHO (2008), 61.5% of Total Hardness values are Hard to Very Hard, while only 38.5% of samples are very hard (data not shown). It was observed that T.H values increase during winter and decrease during summer (2009-2017). Generally, T. hardness is higher in groundwater than in surface Nile water.

The accepted limit of Total Hardness in drinking water according to the Egyptian Standards Limits (law No. 458/2007) is 500 mg/l. This means that the average drinking water Total Hardness value in all Assiut governorate was acceptable however according to WHO guideline 2004 the limit is 200 mg/l. Therefor all Assiut districts are acceptable except for Dairut, Assiut center, Sahel Selim, ElFateh and ElGhanyem districts (Table 2).

The Chloride ion (Cl^-)

Evaporation, salty water, and marine water are the main sources of chloride in groundwater, sedimentary rock particularly when it evaporates, is a major natural source of chloride ions; insoluble igneous rocks are a minor source. Generally, the chlorides in drinking water concentrations value in Assiut governorate ranging from 21 to 190 mg/l with overall average 62 mg/l (Table 3). The chloride values in surface drinking water values ranging from 21 mg/l in Abu Tij distribution net to 158 mg/l in Sahel Selim (Table 2). Meanwhile, in groundwater sources, it ranging from 28 mg/l in Abu Tij to 190 mg/l in Sahel Selim (Table 2). The chloride is high in the western part of Manfalut and Assiut. However, the average values were within the acceptable limit. The distribution of the chloride ion concentration all over Assiut showed a slight increase in value from year to year to support the fact that the concentration of some chemical elements is encountered with the high recharge seasons of the river Nile. Sahel Selim has the greatest concentration of chlorides in drinking water, while Abu Tij has the lowest, which may be related to the groundwater source. During the winter, particularly in January and February, the chloride readings drop. increases in July and August (summer), though. The impact of the high recharge seasons of the river Nile may be to blame for the drop in chloride content throughout the winter months of January to March. According to both Egyptian Standard and WHO 2004 with a limit of 250 mg/l, the average drinking water chlorides value in Assiut governorate was accepted.

Iron (Fe)

Iron is the fourth most abundant element in the Earth's crust. It accounts for 5% of the earth's crust. Its main source in groundwater is the dissolution of iron-bearing minerals commonly found in sedimentary aquifers such as pyrite, siderite, magnetite, and iron silica. The common form of iron in groundwater is the soluble ferrous ion Fe^{2+}. When exposed to the atmosphere, Fe^{2+} is oxidized to the insoluble ferric state Fe^{3+}, which precipitates ferric hydroxide causing a brown discoloration of the water. Corrosion of well casing and other pipes may also contribute iron to soluble iron in groundwater. Bacterial activity can also change the amount of iron in groundwater. substantial natural iron sources Sandstone rocks contain oxides, carbonates, and sulfides, or iron clay minerals, which are sources of iron in groundwater. Igneous rocks contain amphiboles, ferromagnesian micas, ferrous sulfide (FeS), ferric sulfide or iron pyrite (FeS_2), and magnetite (Fe_3O_4.). Generally, the Iron in drinking water concentrations in Assiut governorate ranging from 0.02 to 0.77 mg/l l with an overall average of 0.22 mg/l (Table 3). Data in (Table 2) revealed that Fe in surface drinking water range from 0.02 mg/l in Abu Tij to 0.77 mg/l in Sahel Selim. Meanwhile, in groundwater, it ranges from 0.06 mg/l in Abu Tij to 0.56 mg/l in ElBadari. It increases at the northern part of Assiut area in Dairut, and southwestern parts at ElGhanyem along southeastern in Sahel Selim o.77 (the highest value). Fe changes seasonally in groundwater sources. The increase of the Fe^{+2} concentration may be related to the waste sources and the excessive application of fertilizers and manure in agriculture activities, while the decrease in Fe^{+2} concentration in the winter period may be related to seasonal recharge and the decreased effect of domestic wastewater discharge into groundwater and soil. Fe in groundwater is higher than in the municipal water. This may be due to the fact that all groundwater wells of high Fe concentration are usually equipped with facilities for Fe removal. The accepted limit of iron value in drinking water according to Egyptian Standards Limits and WHO guidelines is 0.3 mg/l, which means that the average drinking water iron value in Assiut governorate was accepted except in some areas in Dairut, Sahel Selim and ElBadari.

Manganese (Mn)

Manganese resembles iron in its chemical behavior and its occurrence in natural water. It arises from soil and sediments. Metamorphic and sedimentary rocks and mica biotite and amphibole hornblende minerals contain large quantities of manganese. In natural water, manganese concentration is usually under 0.2 mg/l. The divalent ion Mn^{2+} is soluble and present in most groundwater at concentrations less than those of $Fe^{2+.}$ When exposed to the atmosphere, Mn_2+ is oxidized to the much less soluble hydrated oxides (Hem, 1985). Black stains from Mn appear on cleaned clothing and plumbing fittings. Manganese affects water's usability where more than 0.2 mg/1 precipitates upon oxidation causing unpleasant tastes, deposits on foods during cooking, stains plumbing fixtures and laundry, and promotes growths in reservoirs, filters, and distribution systems, so the majority of industrial users object to water with more than 0.2 mg/1.Generally, manganese in drinking water in Assiut governorate ranging from 0.01 mg/l to 0.56 mg/l with an overall average of 0.22 mg/l (Table 3). The concentration of Mn in surface drinking water concentrations ranging from 0.01- 0.56 mg/l in Sedfa (Table 2). While in groundwater Mn concentrations value ranging from 0.03 mg/l in ElFateh to 0.55 mg/l in Dairut (Table 2). The data showed that Mn increases in the northern area of Assiut governorate in Dairut, at the southwestern parts of the study are in Sedfa and ElGhanyem along the eastern south in Sahel Selim, observed that Mn contents slightly increase during winter especially January and February. Meanwhile, it decreased during summer July and August. The accepted limit of manganese value in drinking water according to Egyptian Standards and WHO 2004 is 0.4 mg/l, which means that the average drinking water Mn value in Assiut governorate was accepted. Except for some areas in Dairut, Sedfa and Sahel Selim.

Ammonia (NH^{+}_3)

Generally, most ammonia in water is present as NH_4 rather than as NH_3. Ammonia is considered a component of municipal or community wastes, it is excreted by animals and produced during decomposition of plants and animals waste, thus returning nitrogen to the aquatic system. It also may come from fertilized agricultural fields. The drinking water ammonia values in Assiut governorate ranging from 0.0 mg/l to 0.88 mg/l, as shown in Table 3. High ammonia content is registered in Dairut and ElQusiya in the northern part of Assiut government, Sahel Selim and ElBadari in the eastern part of Assiut which is mainly due to the increase in the groundwater level and the effect of agricultural fertilizers, such as NH_{+4} NO_3 or $CO(NH_2)_2$. Agricultural pesticides and sewage runoff are potential diffuse sources of water contamination (Karnath, 1987). Ammonia values decrease during winter, especially January and February, while increases during summer (July and August), and its value in groundwater was greater than it in the surface water. The accepted limit of ammonia values of drinking water according to Egyptian Standards Limits (law no. 458/2007) is 0.5 mg/l. it means that the average drinking water Ammonia value in Assiut governorate was accepted except in the north at Dairut and ElQusiya, the northeastern area at Abnub along ElFateh more south at Sahel Selim. Meanwhile according to WHO guidelines 2004 with its limit of 1.5 mg/l ammonia values of drinking water were accepted.

Conclusions

The results of the current monitoring study showed that the surface water of Assiut governorate is a great drinking water since it is produced from the Nile River. However, in some areas, the concentration of some criteria exceeds WHO regulations. Generally, the TDS in drinking water in Assiut governorate were excellent 54%, good 38.5% and acceptable7.5%. Meanwhile, total hardness values were 61.5% hard and 38.5% very hard. The values for NH3, Fe and Mn concentrations increased in some locations of Assiut governorate. Therefore, Monitoring water quality standards and their importance for human health in drinking water distribution networks is essential. It is necessary to conduct more research while taking into account elements like nitrate and dangerous heavy metals.

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