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Assessment of selected physicochemical parameters to investigate the groundwater quality of El-Bheira Governorate, Egypt

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Abstract:

The present study investigates the ground water quality for drinking and irrigation purposes in Beheira Governorate, Egypt. Physico-chemical parameters of different wells at different zones were analyzed. The results were compared with the standard guideline values for drinking and irrigation purposes. The parameters studied were pH, temperature, turbidity, color, taste, odder, electrical conductivity, total dissolved salts, total hardness, calcium hardness, magnesium hardness, calcium, magnessium, sodium, potasium, bicarbonate, carbonate, chloride and sulphate. The results showed that the total hardness (measured as $CaCO_3$) varied from 310 to 490 mg L^{-1} indicating relatively high hard water. According to World Health Organization, magnesium value is deviated from the suggested permissible limits for well (1) and well (14); while all other studied parameters are agree within World Health Organization. All studied parameters for all studied wells, were within Egyption Drinking Water Standards and suitable for drinking purposes. Magnesium hazard values indicate that all wells under consideration are suitable for irrigation except wells (7, 9 and 15); which have magnesium hazard values large than 50 %. According to salinity classes, all wells under

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consideration are considered to have good to doubtful salinity. The other chemical indices like sodium percentage, sodium adsorption ratio, and residual sodium carbonate showed that the water quality is good and suitable for agricultural purpose and can be utilized for irrigation purpose. . To protect the water quality from deterioration and maintain it usable quality, certain precautionary measures should be adopted such as: domestic wastes and agricultural run offs should be treated before disposing off and waste materials should be dumped to suitable sites.

Key words: Groundwater, Drinking, Physico-Chemical Parameters, Standard, Irrigation purposes, Beheira, Egypt.

1-INTRODUCTION

In most parts of the world, ground water consider as a major natural resource for drinking, irrigation and industrial purposes and all other human activities (Sirajudeen et. al., 2014 ; Prasad and Narayana, 2014). Approximately one third of the worlds, population are using ground water sources for drinking purpose (Nickson et. al., 2005). The ground water is considered as a secondary source to irrigate some agricultural areas in the delta region (Ali, 1987 and Radi, 1984); and as an essential source for some cultivated lands to which the Nile water is not reachable. In many parts of Egypt, the ground water is widely used for drinking and other domestic purposes. Egypt's water demands are increasing largely because of the staggering population growth, one million people every nine month (Masoud et. al., 2003). The modern civilization, industrialization, urbanization and increase in population have led to fast degradation of our ground water quality. Ground water contains various types of pollutants and several other substances are dissolved in it; and it can be useful for human body but in a specific limit (Agrawal 2009). Ground water varies widely depending on hydrological conditions, pumping period, depth of aquifer, types of soil, and human activities (Masoud et. al., 2003). The suitability of ground water for irrigation is contingent on the effects of the mineral constituents of the water on the plants and the soil as well as the salts (Nweke et. al., 2013). Poor quality irrigation water (with high salt concentration) may affect plant growth physically by limiting the uptake of water. The modification of osmotic processes effects of salts on soils and result in alterations in soil structure, permeability and aeration; which indirectly affect plant growth (Nweke et. al., 2013).

The chemical parameters such as Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, CO_3^{2-}, Cl^{-} and SO_4^{2-} play a significant role in classifying and assessing water quality for irrigation (Nweke et. al., 2013). Most of the people in our studied area (Beheira governorate, Egypt) used ground water for drinking and irrigation purposes. Similarly research has also been carried out on various zones of Egypt but no updated data appears concerning ground water quality of El-Bheira Governorate, Egypt. Therefore the current work was carried out in order to assess ground water quality in the area under consideration for drinking and irrigation purposes. Fifteen wells have been chosen for this study. The water quality is generally assessed by comparing its physico-chemical parameters against the suggested permissible limits (Sana et. al., 2014; Burston et. al., 1993). The parameters studied were pH, turbidity, temperature, color, odor, taste, total hardness (TH), calcium hardness (CaH), magnesium hardness (MgH), electrical conductivity (EC), total dissolved solids (TDS), Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, CO_3^{2-}, Cl^{-} and SO_4^{2-} .

The results of these parameters were compared with the suggested permissible ranges of World Health Organization (WHO, 2011) and Egyptian Ministry Health Water Quality Standards (EMH, 2007) for human consumption.

2- METHODS AND MATERIALS

2-1. Studied area

This paper is concerned with the wells of ground water in Beheira governorate, Egypt. Beheira governorate is a costal governorate in Egypt, it is located in northern part of the country in the Nile Delta, and its capital is Damanhur.

Beheira governorate enjoys an important strategically place in west of the Rosetta branch of the Nile. It is bounded by Mediterranean (north), by Alexandria Governorate (north western), by Matrouh Governorate (west), by Giza (south Western), by Menoufia (east) and by Kafr Al Sheikh governorate (north eastern) ; two main Roads runs through the Beheira Governorate are Cairo-Alexandria desert Road and agricultural Road (**Fig. 1**). Beheira contains important industries such as cotton, chemicals, carpets, electricity and fishing. The locations of different wells under investigation are shown in **Table 1** and in map (**Fig. 2**)

Fig. 1: the geographical location of Al- Beheira governorate

Table 1 Locations of wells under consideration

Well number	Location	Well number	Location
1	Zawyat El-Bahr	9	Waqid
2	Zawyat El-Bahr	10	Khunayzah
3	Moghanaien	11	Khunayzah

4	Moghanaien	12	Khunayzah
5	Moghanaien	13	Khunayzah
6	Waqid	14	El Haddayn
7	Waqid	15	El Haddayn
8	Waqid		

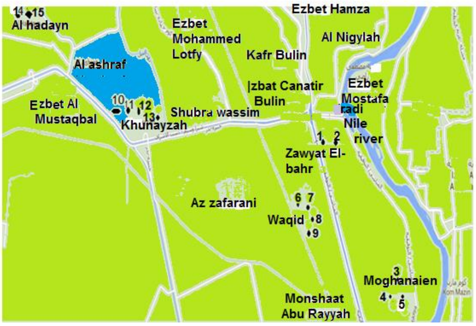

Fig. 2: Map of different wells locations in El- Beheira Governorate, Egypt.

2.2. Collection and analysis of water samples

Fifteen wells of different villages in Beheira governorate were selected for the studies, **(Table 1)**. **Fig.2** shows sites of wells under study. Water samples were collected using poly ethylene bottles which were washed with tap water at the first and then were rinsed using double deionizes water. The water samples were collected from varies places at the studied area. Temperature, pH, EC, and TDS were measured immediately. Then the samples were transported to the laboratory for further analysis after its treatment with 0.5 % chloroform as a preservative material (APHA, 1998). For analysis, all the instruments were calibrated appropriately according to the commercial grade calibration standard prior to the measurements. The samples were analyzed for pH, total hardness (TH), calcium hardness (CaH), magnesium hardness (MgH), electrical conductivity (EC), total dissolved solids (TDS), Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Sodium (Na^{+}), Potasium (K^{+}), Bicarbonate (HCO_3^{-}), Carbonate (CO_3^{2-}), Chloride (Cl^{-}) and Sulphate (SO_4^{2-}) using the standard methods by the American

Puplic Health Association (APHA,1998) . The Taste, color, odor, and turbidity were observed organolaptically.

2.3 Statistical Calculations

Pearson Correlation Coefficient and percentages were found out using Microsoft Excel 2010.

The Agricultural indices, Sodium Absorption Ratio, Sodium Percentage and Residual Sodium Carbonate were calculated following the methodology of Kaur and Singh [2011] The percent sodium was determined using Eq. (1):

$$Na\% = \frac{Na^{+}\ x\ 100}{Ca^{2+} + Mg^{2+} + Na^{+} + K^{+}} \qquad (1)$$

The sodium adsorption ratio (ASR) is a good measure of the sodium hazard (Wilcox, 1995) which can be used as expression of the reaction with the soil. It was determined by using Eq. (2):

$$\mathrm{SAR} = \frac{Na^{+}}{\sqrt{\left(\frac{Ca^{2+} + Mg^{2+}}{2}\right)}} \qquad (2)$$

The relative proportion of sodium in the water in the form of sodium Carbonate was also determined using Eq. (3):

$$\mathrm{RSC} = (HCO_3^{-} + CO_3^{2-}) - (Ca^{2+} + Mg^{2+}) \qquad (3)$$

The magnesium can be used to specify the magnesium hazard (Szabolcs and Darab, 1964) for assessing irrigation water. the magnesium hazard can be determined by the following equation:

$$MH = \frac{Mg^{2+}\ x\ 100}{Ca^{2+} + Mg^{2+}} \qquad (4)$$

All ionic concentrations in the above equations are expressed in meq L^{-1}.

3- RESULTS AND DISCUSSION

3.1 validity of water under study for drinking

Tables 2a and 2b show the results of analysis for the studied water samples. Temperature was ranging from 26^{o}C to 27^{o}C. These values of the temperatures are considered as advantage for industrial purposes (Nweke, et. al., 2013). The turbidity was ranged from 1.00 (NTU) for well number 7 to 3 (NTU) for well number 1. According to World Health Organization (WHO, 2011) and Egyptian Ministry Health Water Quality Standards (EMH, 2007), the values of turbidity for all wells under consideration are lower than the prescribed limits, therefore the water of all wells under study are acceptable to consumers. The results showed that all water samples of all wells in all zones were colorless, odorless, and tasteless. The pH values was ranged between 7.2 in well number 9 and 8.00 in well number 11, thus the water in all wells under study is alkaline water, and falling within the suggested permissible limits of World Health Organization (WHO, 2011) and Egyptian Ministry Health Water Quality Standards (EMH, 2007), consequently it fit for drinking. The deviations in the pH value from 7 are primarily the result of the hydrolysis of salts not originated from strong bases and strong acids (Masoud et. al., 2003). The pH values may be largely due to the influence of the soils and organic matters (Orajaka, 1972).

Table 2a shows that the electrical conductivity (EC) was ranging from 543 for well number 12 to 1270 µs cm^{-1} for well number 10. The increase of EC value mainly related to the effect of pollution; which increases the concentrations of Ca^{2+}, Mg^{2+}, HCO_3^{2-} and Cl^- (Masoud et. al., 2003). The WHO and EMH did not list any recommendation for the permissible or maximum level of electrical conductivity in drinking water. Total dissolved salts (TDS) values were ranging from 417 to 812 mg L^{-1} for wells numbers 13 and 10 respectively. According to maximum permissible limit of total dissolved salts (1000 mg L^{-1}) set by World Health Organization (WHO, 2011) and Egyptian Ministry of Health Water Quality Standard (EMH, 2007), all the water wells under consideration are safe for drinking purposes. An increase in the total dissolved solids (TDS) of the ground waters is subjected to fertilizer input which result in presence of many components, such as potassium, sulfates and phosphorous in water (Masoud et. al., 2003). Hardness of water is the property of water; which prevents the leather formation with soap and increase the boiling point of water (Sirajudeen et. al., 2014). Water hardness mainly depends upon the amount of calcium or magnesium salts or both (Sirajudeen et. al., 2014). The high hard water would lead to heart disease and kidney stone formation (Sirajudeen et. al., 2014). In the present study the total hardness (TH) values varied from 310 for well number 9 to 490 mg L^{-1} for well number 11 indicating relatively high hard water, but these total hardness values of all studied wells lower than the prescribed limit (500 mg L^{-1}) (WHO, 2011 and EMH, 2007). Calcium hardness (CaH) values were ranging from 150 for well number 9 to 310 mg L^{-1} for well number 11. Also magnesium hardness (MgH) in all wells under consideration was ranging from 140 for well number 12 to 220 mg L^{-1} for well number 14.

As shown in **Table 2b**, the bicarbonate concentration in the ground water under consideration was ranging between 260 for well number 9 to 480 mg L^{-1} for well number 11. The source of the bicarbonate in the water wells can be attributed to the carbon dioxide gas which renders the ground water slightly acidic by the formation of carbonic acid, which dissociate to produce H^+ and HCO_3^- (Masoud et. al., 2003). The WHO and EMH did not list any recommendation for the permissible or maximum level of Bicarbonate in drinking water. The values of chloride concentrations were observed in the range between 70 mg L^{-1} for well number 13 and 130 mg L^{-1} for well number 1. No health based guideline value is proposed for chloride ion in drinking water. However, chloride concentration in excess of about 250 mg L^{-1} can give rise to detectable taste in water (WHO, 1993). The values of chloride concentration in all wells under consideration are lower than the recommended guideline (250 mg L^{-1}) of World Health Organization (WHO, 2011) standards and Egyptian Ministry of Health (EMH, 2007) Water Quality Standards, therefore the water of all wells under study are tasteless and suitable for drinking purposes. The presence of sulfate in drinking water may cause noticeable taste and contributes to the corrosion of distribution system (WHO, 1993). **Table 2b** shows the values of sulfate concentration as a range from 20 to 130 mg L^{-1} in wells numbers 12 and 11 respectively. The higher value of sulfate in water can be attributed to the salt water intrusion to the aquifer (Masoud et. al., 2003). However, the sulfate value for all wells under investigation are below the listed recommendation of (WHO, 2011) standards (250 mg L^{-1}) and below the EMH standards (250) mg L^{-1} (EMH, 2007). The values of carbonate ion concentration are low for all wells under study. The distribution of calcium in aquatic habitats has attracted the attention of several investigators as it is the major constituent of mineral deposits as well as the shells and skeletons of organisms (Abdel Moati, 1985). Calcium is the form of calcium carbonate or sulfate resulting from organic activity or inorganic precipitation. Due to its involvement with the biosphere and carbonate system, this element has relatively high variability (Abdel Moati, 1985). According to **Table 2b**, the values of calcium concentration were ranging from 60 for well number 9 to 116 mg L^{-1} for well number 6. The relatively high values of calcium concentrations were observed in wells numbers 1, 2, 4, 5, 10, 11, 14, and 16, the high values of calcium concentrations, probably due to: i) the discharge of calcium rich effluents, ii) domestic, agricultural and industrial wastes, iii) microorganisms may favor the precipitation of calcium carbonate, iv) bacteria may decompose organic compounds containing calcium, as a result calcium carbonate produced by carbon dioxide formed during its decomposition (El-Hadad, 2006). The calcium concentration values for all wells in our study zones are below the recommended guideline (200 mg L^{-1}) of Egyptian Ministry of Health (EMH, 2007) Water Quality Standards. While, the World Health Organization (WHO, 2011) does not list guideline for this element in drinking water.

The concentration values of magnesium of the wells at the studied zones are in the range between 30.38 mg L^{-1} in well number11 and 53.9 mg $L^{-1}$for well number 14. According to the listed recommendation of (WHO, 2011) , the maximum acceptable level of magnesium in drinking water is 50 mg L^{-1}, therefore all water wells under consideration are suitable for drinking purposes except well number 1, and well number 14, while according to (EMH, 2007), the maximum acceptable level of magnesium in drinking water is 150 mg L^{-1}, therefore, all wells at our study zones are suitable for drinking purposes.

The values of sodium concentrations were ranging between 80 for well number 12 and 150 mg L^{-1} for well number 14. The high values of sodium concentration are 150 mg L^{-1} in well number 14 and 140 mg L^{-1} for well number 6. The high values of sodium concentration may be due to excess of bicarbonate ion which cause a release of the alkali ions (usually sodium Na^+) into the water by exchanger such as clay materials and other related minerals that form part of the aquifer minerals (Custodio, 1983). The values of sodium concentration in all wells under consideration are below the listed recommendation of (WHO, 2011) standards (200 mg L^{-1}) and (EMH, 2007) standards (200 mg L^{-1}).

Table 2a Physical and chemical parameters of different wells

Source	C^0	Color	Odor	Turb. (NTU)	pH	TDS (mg L^{-1})	EC (µs cm^{-1})	TH (mg L^{-1})	CaH (mg L^{-1})	MgH (mg L^{-1})
W(1)	27	Colorless	Odorless	3.00	7.3	680	1050	460	250	210
W(2)	26	Colorless	Odorless	1.50	7.5	692	1070	430	280	150
W(3)	26	Colorless	Odorless	1.20	7.4	441	652.0	340	210	130
W(4)	27	Colorless	Odorless	2.00	7.8	597	911.0	440	260	180
W(5)	26	Colorless	Odorless	1.50	7.3	468	696.0	426	240	186
W(6)	28	Colorless	Odorless	1.90	7.9	728	1130	450	290	160
W(7)	28	Colorless	Odorless	1.00	7.3	560	850.0	350	160	190
W(8)	26	Colorless	Odorless	1.70	7.4	548	830.0	385	215	170
W(9)	27	Colorless	Odorless	1.30	7.2	380	550.0	310	150	160
W(10)	26	Colorless	Odorless	1.70	7.7	812	1270	480	280	200
W(11)	28	Colorless	Odorless	1.80	8.0	770	1200	490	310	180
W(12)	27	Colorless	Odorless	1.20	7.3	375	543.0	320	180	140
W(13)	27	Colorless	Odorless	1.50	7.5	417	611.0	360	200	160
W(14)	27	Colorless	Odorless	1.30	7.5	657	1011	450	230	220
W(15)	27	Colorless	Odorless	1.40	7.3	453	672.0	360	160	200

Turb. = Turbidity NTU = Natural Turbidity Unit
EC = Electrical Conductivity TH = Total Hardness
MgH = Magnesium Hardness CaH = Calcium Hardness

Table 2b Concentration (mg L^{-1}) of various ions in different wells

	Concentration of ions (mg L^{-1})							
Source	Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	HCO_3^{-}	CO_3^{2-}	SO_4^{2-}	Cl^{-}
W(1)	100	51.50	110	16.0	420	0.394	60.0	130
W(2)	112	36.75	118	20.0	460	0.432	52.0	110
W(3)	84.0	31.85	80.0	10.0	330	0.310	30.0	100
W(4)	104	44.10	100	16.0	420	3.940	80.0	110
W(5)	96.0	45.57	86.0	8.00	324	0.304	60.0	90.0
W(6)	116	39.20	140	30.0	440	4.130	110	120
W(7)	64.0	46.55	118	20.0	300	0.282	40.0	110
W(8)	86.0	41.65	112	20.0	390	0.366	60.0	100
W(9)	60.0	39.20	96.0	16.0	260	0.244	27.0	80.0
W(10)	112	49.00	100	24.0	460	4.320	110	100
W(11)	124	30.38	90.0	20.0	480	4.510	130	110
W(12)	72.0	34.30	80.0	16.0	290	0.270	20.0	80.0
W(13)	80.0	39.20	88.0	18.0	360	0.338	30.0	70.0
W(14)	92.0	53.90	150	20.0	440	0.413	80.0	100
W(15)	64.0	49.00	130	10.0	300	0.282	48.0	80.0

Also **Table 2b** shows that the values of potassium concentrations in the wells under consideration were ranged between 8 mg L^{-1} for well number 5, and 30 mg L^{-1} for well number 6. Potassium in the wells under consideration may be attributed to the ground water contaminated by potassium fertilizers (El-Hadad, 2006). The World Health Organization (WHO, 2011) and Egyptian Ministry Health (EMH, 2007) Water Quality Standards do not list a guideline for potassium in drinking water.

Table 2c the standards for drinking water according to According to World Health Organization (WHO, 2011) and Egyptian Ministry Health (EMH, 2007) Water Quality Standards.

Parameters	EMH	WHO
Temp.	NS	NS
Taste	NS	NS
Color	NS	NS
Odor	NS	NS
Turbidity	10	NS
pH	6.5-8.5	6.5-8.5
EC(μs ⁄cm)	NS	NS
TDS($mg\ L^{-1}$)	1000	1000
TH($mg\ L^{-1}$)	500	500
CaH($mg\ L^{-1}$)	NS	NS
MgH($mg\ L^{-1}$)	NS	NS
$HCO_3^-(mg\ L^{-1})$	NS	NS
$CO_3^{2-}(mg\ L^{-1})$	NS	NS
$Cl^-(mg\ L^{-1})$	250	250
$SO_4^{2-}(mg\ L^{-1})$	250	250
$Ca^{2+}(mg\ L^{-1})$	200	NS
$Mg^{2+}(mg\ L^{-1})$	150	50
$Na^+(mg\ L^{-1})$	200	200
$K^+(mg\ L^{-1})$	NS	NS

NS = Not stated

3.2 correlation coefficients (r) for chemical and physical parameters

Table 3 gives the following correlation coefficients (r) for chemical and physical parameters of the wells under consideration: high significant strong positive correlation (r =1.00) between the electrical conductivity and total dissolved salts, is due to the increase of the cations and anions contents in water, alternatively to increase the electrical conductivity values (Masoud et. al., 2003). High significant strong positive correlations, are obtained between electrical conductivity and each of HCO_3^- (r = 0.900), SO_4^{2-} (r = 0.868), Ca^{2+} (r = 0.834) and Cl^- (r = 0.749). This indicates that bicarbonate, sulfate, calcium and chloride are major ions in the ground water under consideration. The large amount of calcium may be presented as calcium bicarbonate, calcium sulfate, and calcium chloride. Also, high significant positive correlations are obtained between total dissolved salts and each of HCO_3^- (r = 0.900), SO_4^{2-} (r = 0.868), Ca^{2+} (r = 0.834) and Cl^- (r = 0.749). This is attributed to the major ions in the ground water under consideration which are bicarbonate, sulfate, calcium, and chloride ions. Weaker correlations are obtained between potassium and both of Cl^- (r = 0.42), Ca^{2+} (r = 0.46), Mg^{2+} (r = 0.013) and Na^+ (r = 0.46).

Table 3 Correlation coefficients (r) matrix for chemical and physical parameters of the wells under consideration

Parameter	pH	EC	TDS	TH	Cl^-	SO_4^{2-}	HCO_3^{2-}	CO_3^{2-}	Ca^{2+}	Mg^{2+}	Na^+	K^+
pH	1.00											
EC	0.70	1.00										
TDS	0.70	1.00	1.00									
TH	0.70	0.902	0.902	1.00								
Cl^-	0.416	0.749	074	0.649	1.00							
SO_4^{2-}	0.850	0.868	0.868	0.886	0.550	1.00						
HCO_3^-	0.770	0.900	0.900	0.904	0.630	0.80	1.00					
CO_3^{2-}	0.910	0.690	0.690	0.670	0.400	0.86	0.60	1.00				
Ca^{2+}	0.800	0.834	0.834	0.901	0.620	0.825	0.91	0.726	1.00			
Mg^{2+}	0.260	0.200	0.200	0.270	0.150	0.096	0.05	0.130	0.12	1.00		
Na^+	0.120	0.410	0.410	0.30	0.358	0.30	0.31	0.020	0.08	0.56	1.00	
K^+	0.596	0660	0.66	0.423	0.420	0.56	0.59	0.556	0.46	0.013	0.46	1.00

While there are moderate correlations between K^+ and each of EC (r = o.66), TDS (r = 0.66), SO_4^{2-} (r = 0.560) , HCO_3^- (r = 0.590), and CO_3^{2-} (r = 556) this may be due to the formation of double salts between potassium and both of SO_4^{2-} and CO_3^{2-} ions.

The double salts are mainly as 1: 2 Na^+ to SO_4^{2-} or CO_3^{2-} ratio. Also mono salt may be formed between Na^+ and HCO_3^-. The mono salt is mainly as 1:1 K^+ to HCO_3^-. Weak correlations are obtained between Na^+ concentration and all given parameters as shown in **Table 3**, except magnesium ion, where there is a moderate correlation between Na^+ and Mg^{2+}.

Strong correlations are obtained between total hardness and both of Ca^{2+}(r = 0.901), HCO_3^-(r = 0.904), and SO_4^{2-}(r = 0.886), however moderate correlations are given between the total hardness, concentrations of Cl^-(r = 694), CO_3^{2-}(r = 0.62). Moderate very weaker correlations are observed between the total hardness, concentrations of Mg^{2+}(r = 0.27), Na^+(r = 0.300) and K^+(r = 0.423). This means that Ca^{2+}, HCO_3^- and SO_4^{2-} are the main contributors to the total hardness than Mg^{2+}, Na^+ and K^+. The strong positive correlations are observed between concentrations of Ca^{2+}, HCO_3^- and SO_4^{2-} where r = 0.91 and r = 0.825, respectively, assign that large fraction of Ca^{2+} present as $Ca(HCO_3)_2$, and $CaSO_4$, and calcium is a great contributor to the total hardness. The moderate positive correlations are deduced between the concentration Cl^- and the concentrations of SO_4^{2-} and HCO_3^- , where r = 0.55 and 0.63 respectively. Also there is moderate positive correlation between Ca^{2+} and CO_3^{2-} concentration where r = 0.726, indicating that there is a large amount of Ca^{2+} may be present as $CaCO_3$. Poor correlations are obtained between Mg^{2+} and all parameters; this indicates that the contribution of Mg^{2+} to EC, TDS, and TH is weak. Also only small amount of Mg^{2+} is present as salts with each of Cl^-, SO_4^{2-} , HCO_3^- and CO_3^{2-}. There is a weak positive correlations between i) pH and Cl^-(r = 0.416) ii) pH and Mg^{2+}(r = 0.26) ii) pH and Na^+(r = 0.12); therefore there is no dependence of Cl^- or Na^+ or Mg^{2+} on pH of the ground water. While the data gives strong correlations between pH and CO_3^{2-}(r = 0.910) b) SO_4^{2-}(r = 0.85), indicating a large dependence of CO_3^{2-} and SO_4^{2-} ions on pH of the ground water under consideration. Also moderate positive correlations are observed between pH and each of HCO_3^-(r = 0.77), TH (r = 0.7), TDS (r = o.7), EC (r = 0.7), and K^+(r = 0.596); which indicate that there is moderate dependence of HCO_3^-, TH, TDS, EC, and K^+ on pH.

3.3 Validity of water under study for irrigation purposes

The suitability of ground water for irrigation purposes depends on its mineral constituents (Sadashivaiah et. al., 2008). Total salts, electrical conductivity, relative proportion of sodium to other principle cation as expressed by SAR, sodium percent, and residual sodium carbonate (RSC) are some of the techniques adopted by Salinity Laboratory of the department of agricultural (Wilcox, 1995) in evaluating the suitability of water for irrigation purposes. **Table 4** shows the classification of wells under consideration according to salinity hazard classes (using electrical conductivity values for all studied wells). According to Wilcox, 1995 all wells under consideration are considered to have good to doubtful salinity, Where the wells numbers 3 and 5, 9, 12, 13, and 15 are good suitable for irrigation purposes; while the remaining wells are doubtful for irrigation purposes.

Table 4 Salinity hazard class, sodium hazard classes based on sodium adsorption ratio (SAR), water class based on sodium percent (Na%), and water quality based on residual sodium carbonate (RSC) (Wilcox, 1995).

EC (μ moh Cm^{-1})	Water Class	Remark on quality
100 – 250	C_1	Excellent
250 – 750	C_2	Good
750 – 2250	C_3	Doubtful
>2250	$C_4 – C_5$	Unsuitable
SAR	Sodium Hazard Class	Remark On Quality
10	S_1	Excellent
10 – 18	S_2	Good
18 – 26	S_3	Doubtful
>26	$S_4 – S_5$	Unsuitable
Na%	Water Class	
< 20	Excellent	
20 – 40	Good	
40 – 60	Permissible	
60 – 80	Doubtful	
>80	Unsuitable	
RSC (meq L^{-1})	Remark on Quality	
< 1.25	Excellent	
1.25 – 2.5	Doubtful	
>2.5	Unsuitable	

The results of SAR, Na%, RSC and magnesium hazard (MH) class for wells under consideration are given in **Table 5**. The wells under consideration are classified with respect to percent sodium (as shown in **Table 4)**, and the results indicates that; the wells numbers 1, 3, 4, 5, 10, 11, 12, and 13 have percent sodium (Na%) large than 20 but less than 40, therefor the wells numbers 1, 3, 4, 5, 10, 11, 12, and 13 are considered as good suitable for irrigation ; whereas the other remaining wells have values of percent sodium (Na%) large than 40 and less than 60 and are classified as permissible if used for irrigation purposes. The Salinity Laboratory of the United State Department of agriculture established the sodium adsorption ratio as a direct method of assessing the suitability of water for irrigation (Nweke, et. al., 2013). The classification of the wells in our study, with respect to SAR as shown in **Table 4** indicates that; the SAR values of all wells under consideration are ranged between 1.8 and 3.06 meq L^{-1}, showing excellent irrigation water.

Table 5 Sodium percent Na^+ %, residual sodium carbonate (RSC), sodium adsorption ratio (SAR), and magnesium hazard (MH) of wells under consideration

Source	Na^+ %	RSC (meq L^{-1})	SAR	MH (%)	Source	Na^+ %	RSC (meq L^{-1})	SAR	MH (%)
W(1)	39.63	-2.40	2.50	46.23	W(8)	43.13	1.40	2.50	49.57
W(2)	41.15	-1.14	2.48	35.58	W(9)	45.45	-2.10	2.37	52.58
W(3)	38.86	-1.45	1.88	38.40	W(10)	35.08	-2.80	1.98	42.50
W(4)	37.86	-1.86	2.07	41.23	W(11)	34.04	-0.70	1.88	28.73
W(5)	36.50	-3.20	1.80	44.06	W(12)	39.60	-1.70	1.90	44.61
W(6)	43.o5	-1.76	2.87	36.22	W(13)	39.10	-1.36	2.02	45.27
W(7)	47.47	-2.17	2.74	55.28	W(14)	47.46	-1.90	3.06	50.00
					W(15)	51.38	-2.38	2.99	56.66

The classification of the water samples of the wells under consideration based on residual sodium carbonate are indicated in **Table 4**. According to United States Salinity Laboratory (USSL) Department of Agricultural, water having more than 2.5 meq L^{-1} of RSC is not suitable for irrigation purposes. As shown in the **Table (4)** including RSC values; all the water wells under consideration have residual sodium carbonate less than 1.25 meq L^{-1}; therefore safe for irrigation purposes.

Another indicator can be used to specify the magnesium hazard (MH) for irrigation water (Szabolcs and Darab, 1964).

Szabolcs and Darab (1964) proposed that if the magnesium hazard percent (MH %) was greater than 50 (**Table 6**), the water will be unsuitable for irrigation purposes. According to **Table 5**, the values of magnesium hazard percent (MH %) of the wells under consideration range between 28.73 for well number 11 and 56.66 for well number 15. All the water wells under consideration have MH% value less than 50 except wells numbers 7, 9, 14, and 15, therefore all wells under consideration are suitable for irrigation except wells numbers 7, 9, 14, and 15.

Table 6 Water quality based on magnesium hazard (Szabolcs and Darab, 1964)

MH(%)	Remark on quality
< 50	Suitable
>50	Unsuitable

4- CONCLUSION

From this study it can be concluded that; according to **Egyptian Ministry Health (EMH) Water Quality Standards** all the water wells under consideration are suitable for drinking purposes. According to the **World Health Organization** (WHO) suggested permissible limit only two wells are deviating for magnesium parameter. Na%, SAR, RSC, and MH analysis showed that the water quality is good and suitable for agricultural purpose and can be utilized for irrigation purpose. To protect the water quality from deterioration and maintain its quality, certain precautionary measures should be adopted such as: domestic wastes and agricultural run offs should be properly treated. Waste materials should be disposed of at proper places. Proper attention should be given to sanitation pipes and these should be carefully installed. Soil tests should be carried out before installing a water well. Awareness campaign and seminars should be carried out in order to educate the peoples about safety measures and importance of save water quality.

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REFERENCES

1. Abdel Moati, M.A.R. 1985." Study on the chemistry of lake Manzalh waters" Ph.D. Thesis, Faculty of Science, Alexandria Univ., Egypt, 433P.
2. Agrawal, R., 2009. Study of Physico-Chemical Parameters of Ground Water Quality of Dudu Towyn in Rajana Sthan, Rasayana, J. Chem. 2(4), 969-971.
3. Ali, A.S., 1987. The procession system of lands and economic use of land and water resources in some cultivated, new land in A.R.E, Ph.D. Thesis, Facility of Agricultural, El-Menia University, Egypt.
4. APHA/AWWA. 1998. Standard Methods for the examination of water, and waste water, 20th edition. American Public Health Association, Washington DC, USA.
5. Burston, M.W., Nazaari, M.M., Bishop, K.P. and Lerner, D.N. 1993."Population of ground water in the coventry region (UK) by chlorinated hydrocarbon solvents." J. Hydrol. 149: 137-161.

6. Custodio, E., 1983. Man's Important on the hydrological environments, International Conference on Ground water and Man, Ausralian water resources Concil, Proceeding: Canberra, Australian Governooment Publishing Service, 2, 43.
7. Egyptian Ministry of Health and Population, 2007. Standards and specifications of water Quality for drinking and domestic uses. Internal report: 8
8. El Hdad, A. M. A., 2006. Study on physico chemical changes and water treatment for Kom Hamada Sector – El – Beheira Governorate, Egypt, Ph.D. Thesis, Faculty of Scince, Alexandria University, Egypt.
9. Kaur, R. and Singh, R.V. 2011. "Assessment for different groundwater quality parameters for irrigation purposes in Bikarner city, Rajastan." Journal of Applied Sciences and Environmental Sanitation 6(3): 385-392.
10. Masoud, M. S., Zayed, M. A. and El Hdad, A. M. A. 2003. Study of ground water quality in Kom Hamada area, Behira Governorate, Egypt" Journal of Bulletin of the Chemists and Technology of Macedonia, 22, PP. 143-154 .
11. Nickson, R.T., McArthur, J.M., Sherstha, B., Kyaw-Nyint, Y.O. and Lowry. D., 2005."Arsenic and other drinking water quality issues, Muzaffargarh district, Pakistan."Appl. Geochem. 20:55-68.
12. Nweke, O.M., Aghamelu, O.P. and Obasi, l.A, 2013. Hydrogeochemical analysis and quality evaluation of groundwater from Onicha-Uburu, Southeastern Nigeria for irrigation purposes, Afr. J. Environ. Sci. Technol., 7(5), PP. 222-228.
13. Orajaka, S., 1972. Salt water resource of East Central State of Nigeria journal Min. Geol. In Geology of Neigeria, C.A. Kogbe (ed). Eliz Pub. Co. PP. 455-477.
14. Prasad, B.G. and Narayana, T.S., 2014."Subsurface water quality of different sampling stations with some selected

parameters at Machilipation town." Nat. Env. Pollut. Tech. 3(1): 47-50

15. Radi, M.A.H. 1984. Scientific Research Conference in field of Irrigation and water resource, Ministry of Irrigation, Cairo.
16. Sadashivaiah , C., Ramakrishn-aih, C.R. and Ranganna, G. 2008. Hydrochemical analysis at evolution of ground water quality in Tumkur Taluk, Karnataka State, Ind. Int. J. Environ. Res. Public Health 5(3): 159-164.
17. Sana, U., Akmal, M., Aziz, F. and Khana, K. J. 2014."Hand Pumps Water Quality Analysis for Drinking Water and Irrigation Purposes at District Dir Lower, Khyber Pakhtunkhua Pakistan". J. Europ. Acad. Res., 11: 1560-1571.
18. Sirajudeen, J., Mohidheen, K., M. and Abdul Vahith, R. 2014, Plegia Research library Advances in. Appl. Sci. Res., 5(2): 49-54.
19. Szabolcs, l. and Darab,1964." The influence of irrigation water of high sodium carbonate content of soil." In: Proceedings of 8 th international congress of Isss, trans, 2: 803-812.
20. WHO. 2011. Guidelines for drinking water quality. World Health Organization. 4th Ed. Geneva, Switzerland.
21. WHO. 1993. Guideline for drinking water quality, World Health Organization. Geneva, 1, P.56, 124 .
22. Wilcox, L.V. 1995. Classification and Use of Irrigation Water, US Department of Agriculture Circular, Washington DC. US Department of Agriculture P.19.