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Ground Water Quality of Selected Wells in Zaweta District, Northern Iraq

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Abstract

In order to characterize ground water quality in Zaweta district / Dohuk governorate, eight wells are selected to represent their water quality. Monthly samples are collected from the wells for the period from October 2005 to April 2006. The samples are tested for conductivity, total dissolved solids, pH, total hardness, chloride, alkalinity and nitrate according to the standard methods. The results of statistical analysis showed significant difference among the wells water quality in the measured parameters. Ground water quality of Zaweta district has high dissolved ions due to the nature of studied area rocks. Total dissolved solids of more than 1000 mg/l made the wells Gre-Qassroka, Kora and Swaratoka need to be treated to make taste palatable. Additionally high electrical conductivity and TDS made Zaweta ground water have a slight to moderate restriction to crop growth. The high alkalinity of Zaweta ground water indicated stabilized pH. The water quality of all the wells is found excessively hard. The nitrate concentration of Zaweta ground water ranged between 0.19-42.4 mg/l below the guidelines for WHO and the maximum nitrate concentration is recorded in Kora well .

Keywords: Wells, Ground water quality, Drinking water,

نوعية المياه الجوفية في أبار مختارة لمنطقة زاويتة شمال العراق

الخلاصة

لغرض التعرف على نوعية المياه الجوفية في منطقة زاويتة في محافظة دهوك ، تم اختيار ثمانية أبار لتمثيل نوعية المياه فيها. تم جمع نماذج شهرية من هذه الآبار للفترة من أيلول 2005 ولغاية نيسان 2006. تم إجراء بعض فحوصات التوصيلية الكهربائية والمواد الصلبة المذابة الكلية والدالة الحامضية والعسرة الكلية و الكلوريدات والقاعدية والنترات على النماذج وحسب الطرق القياسية . تم تحليل النتائج إحصائيا وبينت النتائج وجود فروق معنوية في الخصائص المقاسة بين الآبار المدروسة . كما تبين ان المياه الجوفية لمنطقة زاويتة تحتوي على تراكيز عالية من المواد الصلبة المذابة الكلية نتيجة للتكوينات الجيولوجية للمنطقة واحتوائها على صخور الكالسايت القابلة للذوبان . كانت التوصيلية الكهربائية عالية بحيث ان المياه لها تحديدات قليلة إلى متوسطة للاستخدام الزراعي. ان ارتفاع المواد الصلبة المذابة الكلية فوق 1000 ملغم/لتر يجعل طعم الماء غير مستساغاً للآبار جري–كاسوركا وكورا وسواراتوكا. ان ارتفاع القاعدية يعمل على ثبات قيمة الدالة الحامضية ، وان المياه الجوفية للمنطقة هي عسرة جداً . كان تركيز النترات (0.19–42.3 ملغم/لتر) ضمن الحدود المسموح بها من قبل منظمة الصحة العالمية وقد سجلت المياه الجوفية في بئر كورا أعلى تركيز للنترات .

الكلمات الدالة : مياه الآبار ، نوعية مياه الآبار ، صلاحية المياه للشرب

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Introduction

Some water underlies the Earth's surface almost everywhere, beneath hills, mountains, plains, and deserts. It is not always accessible, or fresh enough for use without treatment, and its sometimes difficult to be located or to be measured and described. This water may present close to land surface, as in a marsh, or it may lay many hundreds of feet below the surface. Water at very shallow depths might be just a few hours old; at moderate depth, it may be 100 years old; and at great depth or after having flowed long distances from places of entry. Water may be several thousands of years old.

Ground water is replenished by precipitation and, depending on the local climate and geology, is unevenly distributed in both quantity and quality. When rain falls or snow melts, some of the water evaporates, some is transpired by plants, some flows overland and collects in streams, and some infiltrates into the pores or cracks of the soil and rocks.

Ground water quality has been studied in Northern Iraq. Al-Layla et al.[1] evaluate the physicochemical characteristics of ground water for eleven wells around Mosul dam lake.

Habib et al.[2] found the majority of Erbil ground water hard. They found some elements higher than the recommended level for drinking water.

Al-Rawi et al.[3] evaluated ground water quality in some parts of Mosul city for agricultural use. They concluded that the wells of the studied area were highly saline and affecting crop growth and productivity.

Abdulhussein[4] studied the hydrogeology of groundwater of Makhmour plain.

Additionally, Shihab and Hashim[5] classify 66 wells in Ninevah governorate according to their water quality using cluster analysis.

Ahmed et al.[6] studied the water quality of selected springs in Zaweta city. They found the water very hard with high conductivity and total solids.

Shihab[7] arrange 78 wells according to their water quality for agricultural use in Ninevah Governorate using water quality index. This research tried to define the ground water quality of Zaweta district for drinking and agricultural use.

Materials and Methods

Eight wells were selected in Zaweta district, Duhok governorate (Fig. 1). Monthly samples are collected from the wells during the period from October 2005 to April 2006. Electrical conductivity, total dissolved solids (TDS), pH, total hardness, chloride, alkalinity and nitrates are tested. pH was measured in the field, while other tests are performed according to the procedures outlined in the standard methods for the examination of water and wastewater[8] with three replications.

The collected data are statistically analyzed to compare water quality of the wells using ANOVA and Duncan multiple range test. The results are considered significant at $p \leq 0.05$

The geological formations of the area consisted of deposits of the Eocene age and they are represented by many formations. Pelaspi Limestone represented by slightly dolomitic limestone and dolomite, while Gecus represented by an alteration of dolomitic marl, marly dolomite and siltstone with some gypsum rocks. Additionally, Kolosh represented by an alteration of clay marl, dolomitic marl, and clay limestone polemicist sandstone, while fragmental detritus formation represented by small rocks fragments. The quaternary is represented by alluvial and diluvia deposit.

Results and Discussion

Table (1) shows variations in the electrical conductivity of the studied wells with significant difference of electrical conductivity between Kora and the other studied wells except Gre-Qassruka and Swaratoka wells. The highest values is recorded in the wells Gre-Qassruka, Kora and Swaratoka with conductivity values of more than 1000 μmos/cm. Conductivity is mostly naturally occurring according to the geological formation of the feeding area. These results indicate high concentration of dissolved chemical ions in these three wells, since the feeding water passing through more soluble rocks. This also indicated high total dissolved solids (TDS) as conductivity is related to TDS[9]. These values are lower than conductivity of the groundwater in Al-Qonsia village studied by Al-Safawi[10] south of Mosul dam lake which reached to 6000 μmos/cm.

Table (1) also shows that all the water of the studied wells have slight to moderate restrictions to crop growth as the electrical conductivity of the groundwater of the studied wells is more than 700 μmos/cm except for Bagera well. In other words, the water of the studied well except Bagera will cause a reduction in crop growth and yield loss as the plant will redirect the energy from growing to extracting pure water from the saline water in the root zone[11].

Total dissolved solids (TDS) is the best individual value representing the salinity of the water. Table (2) shows variation in TDS of the wells in the studied area with significance between Kora and the other wells except Gre-Qassruka and Swaratoka along the studied period. It ranged between 600-1569 mg/l. Bagera well recorded the minimum TDS values along the studied period with a maximum TDS value of 751 mg/l, while Kora well recorded the maximum TDS values along the studied period with 1242 to 1439 mg/l. Although TDS values of the studied wells are below the upper limit for drinking by WHO and EPA of less than 1500 mg/l, but water with 1000 mg/l or more usually yield poor taste and unpalatable. Therefore, the wells sited in Gre-Qassruka, Kora and Swaratoka need to be softened when used for drinking. These values are lower than the TDS of some wells in the south west and south of Mosul dam lake according to Al-Layla et al.[1] and of Humedat[12].

Additionally, the groundwater of the studied area have slight to moderate restriction to agricultural use as TDS values are higher than 450 mg/l for all studied wells according to FAO[11].

Table (3) shows a variation in pH values of the studied wells included in the study with a range from 7.35 to 8.95. These variations are statically significant in most of the months between Gre-Qassruka versus Sarke and Bade wells water. For wells Gre-Qassruka, Sendora, Kora and Swaratoka, pH is higher than 8.0 along the studied period, while other wells swung between 7.35 to 8.16. These pH values are alkaline and did not depress chlorine and corrode the metals. Also no effect on taste will be observed. For agricultural use most of the obtained values are within the normal range from 6.5-8.4 according to FAO guidelines[11].

Table (4) shows differences in alkalinity of groundwater of the studied wells. The differences are significant in most of the months for the studied period between the alkalinity of Swaratoka well and Sendora and Bade. The highest values are recorded in Swaratoka well above 600 mg/l, while the lowest values are recorded in

Sendora well at some months and at Bade at the other months. As alkalinity is naturally occurring in water, its variation can be related to the geological formation of the sites of the wells. The values of alkalinity of 100-200 mg/l as $CaCO_3$ indicated a stabilized pH values of water, but higher values may cause scale problems and corrosion.

Water of high alkalinity exerts the most significant effects on growing plants, fertility and plant nutrition.

Hardness is a common problem associated with groundwater, generally related to the abundance of calcium and/or magnesium. Table (5) shows the mean hardness of ground water of the studied wells. Hardness of Kora and Swaratoka wells has significant difference from that of Bade, Zaweta, Bagera and Sarke wells. Hardness of the ground water ranged from 342 to 1318 mg/l as $CaCO_3$. The lowest hardness altered between Sendora and Bagera wells with values between 385 to 532 mg/l as $CaCO_3$. On the other hand, Kora well recorded the highest hardness for the other wells with values of more than 1000 mg/l as $CaCO_3$. These values are higher than the hardness of the wells studied by Al-Layla et al.[1] around Mosul dam lake.

Generally, groundwater in the studied area can be considered as excessively hard as hardness was more than 250 mg/l as $CaCO_3$ for all studied wells according to various classifications like WHO[13]. These results reflect the characteristics of the geological formations which is rich with calcium and magnesium. Also Erbil ground water[2] and Mosul ground water[3] were very hard water.

The results for chloride test are listed on (Table 6). The lowest concentrations are recorded in Bagera and Sarke wells with range of 14.67-15.83 mg/l, while Gre-Qassruka well water had the highest concentration among the studied wells from 42.37 to 56.3 mg/l. All the values are within the recommended levels of WHO[13] of 250 mg/l. Chloride concentration can be used as an indication of sewage, agricultural and industrial pollution since chlorides are soluble and can pass through previous soils and rocks for great distances without diminution in concentration. Also chlorides concentration decreased in areas of impervious formations. These concentrations are lower than those recorded in the wells of Mosul city studied by Al-Rawi et al.[3], and Erbil ground water[2].

Table (7) shows the mean nitrate concentration in the studied wells. It ranged between 0.19 to 42.4 mg/l with significant difference between the nitrate concentration in Gre-Qassruka well and some of the wells included in the study. The lowest concentrations are recorded in Zaweta ground water, while the highest nitrate concentration is observed in Kora well. Nitrate is very soluble and do not bind with soil, therefore it has high potential to migrate to groundwater, especially when the wells near agricultural areas and runoff transport nitrate from sewage and fertilizers to ground water. Water with high nitrate concentrations is harmful to infants. The nitrate concentration in the wells of the studied area is below the guidelines of drinking water by WHO[13] of 50 mg/l. In addition, the high nitrate concentration in Kora well is However, the upper level of specification must be considered when used for drinking.

For agricultural use, slight to moderate restriction appear on water of 5-30 mg/l nitrate for the wells Bade, Sendora, Gre-Qassruka and Swaratoka; while Kora well has severe restriction.

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Conclusions

1. Ground water quality of Zaweta district has high total dissolved ions due to the dissolved rocks of studied area. Kora well showed the highest TDS with significance from the other wells except Gre-Qassruka and Swaratoka wells along the months of the studied period.
2. High Electrical conductivity of Zaweta ground water has a slight to moderate restriction to crop growth. The highest conductivity is recorded in Kora well with significant difference from the other wells except Gre-Qassruka and Swaratoka wells along the studied period.
3. High total dissolved solids of more than 1000 mg/l made the wells Gre-Qassruka, Kora and Swaratoka need to be treated to make taste palatable when used for drinking.
4. For pH, Gre-Qassruka and Kora wells are more alkaline than Sarke and Bade wells with significance along most of the months of the study period.
5. The high alkalinity of Zaweta district ground water indicated stabilized pH.
6. Zaweta ground water is excessively hard. The hardest water is found in Kora and swaratoka wells with significant difference from the other wells along most of the months of the studied period.
7. Using Kora well water for drinking must be restricted as it recorded high nitrate concentration near the upper limit of specification.
8. Chloride concentration is higher in Gre-Qassraka well than other wells especially Bagera along most of the months of the studied period.

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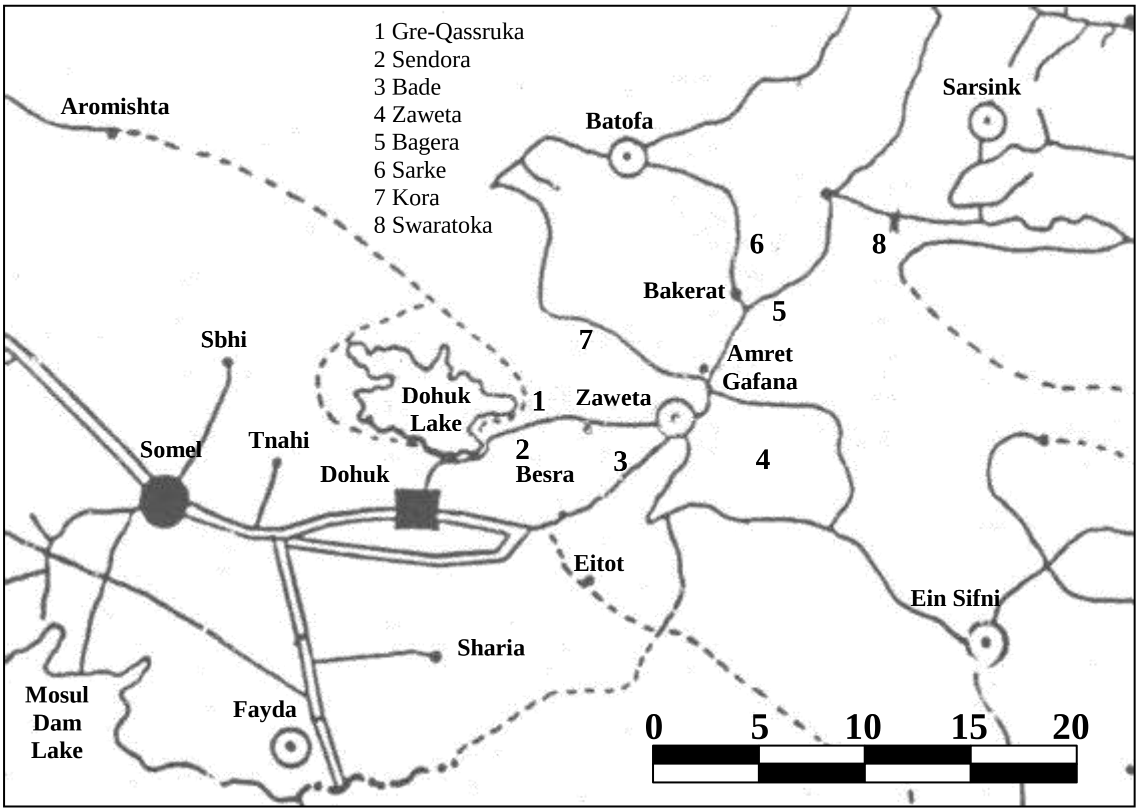

Figure (1) Site location of the studied wells.

Table (1) Variation of electrical conductivity for the studied wells.

Sites	Oct.		Nov		Dec		Jan		Feb		Mar		Apr	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Gre-Qassruka	1056.3 abc	148.2	1035.7 bc	153.9	1150 ab	146.1	1111 bc	139.1	1089.7 abc	153.9	1157.7 abc	197.4	1137 abc	188.2
Sendora	755.67 cd	9.33	750.33 cd	18.11	883.33 bc	39.14	829.67 cd	7.22	791 cd	2.52	769 cd	6.93	754.3 cd	2.33
Bade	783.67 cd	2.96	739.33 cd	47.37	878 bc	82.13	790.67 cd	18.22	771 cd	22.65	757.33 cd	19.8	749.0 cd	16.09
Zaweta	711.33 cd	51.3	612.67 d	29.54	720.67 c	5.04	729.67 d	8.82	725.33 cd	17.9	705.33 d	22.26	691.3 d	32.27
Bagera	650.67 d	16.7	616.0 d	45.57	714.67 c	5.17	691 d	8.33	679 d	5.69	669 d	2.0	649.3 d	10.48
Sarke	992.33 bcd	283.9	985.33 cd	281.8	1006 bc	303.0	969.67 bcd	284.67	966.67 bcd	287.2	961.67 bcd	284.2	951 bcd	289.0
Kora	1434.3 a	106.7	1457.3 a	100.2	1490 a	115.0	1480 a	64.13	1462.3 a	77.77	1456.3 a	94.75	1406 a	98.57
Swaratoka	1232 ab	11.9	1273.0 ab	21.78	1260.7 ab	6.94	1317.3 ab	29.87	1324 ab	19.86	1267.3 ab	23.59	1213 ab	4.00

Means with different letters vertically have significant difference at $p \leq 0.05$.

Table (2) Variation of TDS for the studied wells.

Sites	Oct.		Nov		Dec		Jan		Feb		Mar		Apr	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Gre-Qassruka	1016 bc	131.5	1043.7 bc	154.86	1156 ab	152.6	1111.7 abc	127.89	1048 abc	102.1	1002.3 abc	114.2	916.3 bc	93.7
Sendora	759.67 c	7.51	758.67 c	13.32	885 bc	30.09	868 cd	9.71	860.33 bcd	7.69	759.67 cd	3.28	737.3 cd	3.93
Bade	732 c	50.52	739.33 c	56.69	862 bc	97.52	822.67 cd	78.88	796.67 cd	83.35	695.67 d	46.37	697 cd	43.06
Zaweta	643.33 c	3.28	677 c	43.58	671.33 c	16.05	657.33 d	9.49	634 d	16.26	621.67 d	14.31	605.7 d	2.96
Bagera	658.33 c	29.42	733 c	11.72	684.33 c	32.46	686.67 d	4.67	679 d	10.15	652 d	12.12	632.3 cd	15.51
Sarke	989 bc	287.5	981.33 bc	274.85	911.33 bc	286.3	970.67 bcd	260.2	929.33 bcd	214.4	903 bcd	215.0	868.3 bcd	217.3
Kora	1439.7 a	122.4	1429.7 a	109.36	1407 a	84.1	1436.3 a	51.78	1289.3 a	58.74	1268.7 a	57.41	1242 a	61.76
Swaratoka	1204.7 ab	7.51	1250 ab	38.16	1219.7 ab	4.37	1274 ab	60.14	1135.7 ab	19.1	1098.3 ab	50.23	1122 ab	7.23

Means with different letters vertically have significant difference at $p \leq 0.05$.

Table (3) Variation of pH for the studied wells.

Sites	Oct.		Nov		Dec		Jan		Feb		Mar		Apr	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Gre-Qassruka	8.61 a	0.07	8.87 a	0.11	8.95 a	0.13	8.54 ab	0.09	8.61 a	0.19	8.52 a	0.12	8.33 a	0.14
Sendora	8.22 ab	0.24	8.62 ab	0.76	8.39 abc	0.66	8.42 ab	0.38	8.01 ab	0.42	8.12 abc	0.47	8.01 ab	0.45
Bade	8.09 ab	0.11	7.5 d	0.26	7.32 d	0.21	7.59 b	0.1	7.52 b	0.24	7.48 c	0.25	7.35 b	0.07
Zaweta	8.1 ab	0.14	7.97 cd	0.15	7.58 cd	0.07	8.16 ab	0.22	7.68 ab	0.17	7.55 bc	0.12	7.49 b	0.13
Bagera	7.97 ab	0.27	7.86 bcd	0.07	7.7 bcd	0.05	8.03 ab	0.46	7.56 ab	0.35	7.48 c	0.28	7.43 b	0.08
Sarke	7.66 b	0.48	8.1 bcd	0.54	7.86 bcd	0.37	7.61 b	0.44	7.61 ab	0.59	7.49 c	0.39	7.4 b	0.31
Kora	8.73 a	0.12	8.67 ab	0.09	8.64 ab	0.09	8.66 a	0.08	8.38 ab	0.15	8.41 ab	0.21	8.32 a	0.07
Swaratoka	8.37 ab	0.17	8.42 ab	0.08	8.56 ab	0.21	8.33 ab	0.1	8.37 ab	0.07	8.09 abc	0.08	8.23 a	0.09

Means with different letters vertically have significant difference at $p \leq 0.05$.

Table (4) Variation of total alkalinity for the studied wells.

Sites	Oct.		Nov		Dec		Jan		Feb		Mar		Apr	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Gre-Qassruka	428 abc	110.7	477.67 ab	122.79	478.33 abc	123.45	490.33 ab	85.35	414 ab	106.37	448.67 bc	64.48	469 abc	77.6
Sendora	320.33 bc	33.6	294 b	47.65	265.33 c	19.19	303 b	50.21	247 b	18.01	256.67 abc	28.92	224 d	15.5
Bade	283 c	33.5	292.33 b	29.87	321.67 cd	11.7	288 b	31.82	233 b	44.16	247.33 abc	21.4	298.7 cd	17.29
Zaweta	327 bc	37.24	303.33 b	13.54	333.33 cd	31.05	304.67 b	14.86	285 b	17.16	278.67 c	47.66	226.3 d	23.25
Bagera	389.33 abc	72.47	460.33 ab	78.46	405.33 abc	68.76	481.33 ab	93.45	408 ab	112.34	308 c	40.11	396 bcd	62.98
Sarke	547.67 ab	71.61	455.33 ab	84.46	507.67 abc	53.44	490.67 ab	99.15	501.67 ab	106.96	298 bc	21.52	480 ab	59.35
Kora	432 abc	97.37	450.67 ab	124.79	461.67 abc	84.67	459 ab	139.34	471 ab	119.5	401 a	103.91	427.3 bc	90.14
Swaratoka	611.67 a	41.33	661.33 a	27.45	602.67 a	50.22	638.67 a	71.47	594.33 a	58.16	614.33 ab	30.31	627 a	16.26

Means with different letters vertically have significant difference at $p \leq 0.05$.

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Table (5) Variation of total hardness for the studied wells.

Sites	Oct.		Nov		Dec		Jan		Feb		Mar		Apr	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Gre-Qassruka	777.33 b	139.6	790 bc	125.83	754 bc	52.7	723 bc	57.33	729.33 b	71.79	799.33 abc	40.18	704.3 b	67.11
Sendora	385.33 c	25.41	412.67 d	30.64	542.67 c	14.67	529.33 c	40.25	525.67 b	47.74	709.67 bcd	35.79	452.7 b	28.75
Bade	509.67 bc	33.27	510.67 cd	35.82	655.33 c	19.88	688.67 c	23.33	692.67 b	18.84	588.67 cd	33.21	640.7 b	41.38
Zaweta	483 bc	21.17	457.33 cd	46.77	535.33 c	53.55	554 c	45.36	549.67 b	74.14	562.67 cd	38.2	520.3 b	69.85
Bagera	557.33 bc	29.46	469 cd	20.52	532.67 c	13.53	578 c	19.01	538.67 b	25.87	436.33 d	31.49	478 b	22.5
Sarke	609 bc	190.4	603.67 cd	190.07	623.33 c	176.0	630 c	169.58	635 b	176.7	622 cd	213.8	582.7 b	190.4
Kora	1160 a	81.69	1150.7 a	77.17	1139.7 a	82.63	1116.7 a	47.98	1120 a	39.7	1088.7 a	53.38	1072 a	45.32
Swaratoka	1093.3 a	135.	1034.7 ab	160.98	1026.7 ab	179.4	963.67 ab	125.87	1031.7 a	81.52	938 ab	128.8	1027 a	118.1

Means with different letters vertically have significant difference at $p \leq 0.05$.

Table (6) Variation of chlorides for the studied wells.

Sites	Oct.		Nov		Dec		Jan		Feb		Mar		Apr	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Gre-Qassruka	50.57 a	12.51	45.43 a	9.23	56.3 a	13.92	43.07 a	11.17	44.83 a	8.54	43.77 ab	6.62	42.37 a	6.39
Sendora	27.77 ab	1.73	28.77 a	1.73	31.33 b	1.39	26.2 ab	4.99	31.33 ab	1.96	31.77 c	2.23	27.07 ab	0.92
Bade	28.73 ab	1.73	31.17 a	1.17	31.3 b	1.74	32.13 ab	2.05	31.73 ab	1.99	32.5 bc	1.07	29.17 ab	1.96
Zaweta	29.62 ab	3.79	29.3 a	2.95	27.7 b	2.8	28.23 ab	3.13	27.53 ab	2.56	26.57 bc	2.97	26.23 ab	1.41
Bagera	18.57 b	2.68	17.2 a	2.72	19.23 b	1.71	17.73 b	2.05	19.37 b	2.59	22.27 bc	1.07	17.97 b	3.57
Sarke	19.87 b	4.95	17.7 a	4.11	19.83 b	2.83	18.83 ab	3.58	18.8 b	3.97	14.67 bc	1.48	15.83 b	3.25
Kora	22.37 b	7.19	18.8 a	5.1	19.27 b	4.41	19.77 ab	4.78	20.97 b	5.2	19.13 a	2.26	16.6 b	3.87
Swaratoka	25.07 b	14.47	31.73 a	20.64	25.73 b	14.39	26.3 ab	14.65	24.83 ab	12.89	21.33 a	11.3	26.63 ab	17.4

Means with different letters vertically have significant difference at $p \leq 0.05$.

Table (7) Variation of nitrate for the studied wells.

Sites	Oct.		Nov		Dec		Jan		Feb		Mar		Apr	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Gre-Qassruka	20.96 ab	6.7	22.36 ab	7.8	28.05 bc	7.7	25.8 bcd	6.5	22.58 bcd	5.2	20.27 bcd	5.8	15.9 bc	4.7
Sendora	7.99 a	0.4	7.94 a	0.7	14.33 ab	1.5	13.47 ab	0.5	13.08 abc	0.4	7.99 ab	0.2	6.86 ab	0.2
Bade	6.59 a	2.6	6.96 a	2.9	13.17 ab	4.9	11.18 ab	4.0	9.86 ab	4.2	4.75 a	2.4	4.82 ab	2.2
Zaweta	2.1 a	0.2	3.8 a	2.2	3.52 a	0.8	2.81 a	0.5	1.63 a	0.8	1.0 a	0.7	0.19 a	0.1
Bagera	2.86 a	1.5	6.64 a	0.6	4.17 a	1.6	4.29 a	0.2	3.9 a	0.5	2.54 a	0.6	1.54 ab	0.8
Sarke	19.59 ab	14.6	19.21 ab	13.9	15.66 ab	14.5	18.67 abc	13.2	16.57 abc	10.9	15.24 abc	10.9	13.5 abc	11.0
Kora	42.4 c	6.2	41.9 c	5.5	40.75 c	4.3	42.23 d	2.6	34.79 d	3.0	33.75 d	2.9	32.4 d	3.1
Swaratoka	30.51 bc	0.4	32.8 bc	1.9	31.27 bc	0.2	34.02 d	3.0	27.02 d	1.0	25.13 cd	2.5	26.3 cd	0.4

Means with different letters vertically have significant difference at $p \leq 0.05$.