Study of Water Quality Changes of Shatt Al-Arab River, South of Iraq

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Abstract

In this study, water samples were collected from six stations in January 2013 and April 2013 with the aim of determining the water quality of Shatt Al-Arab River, physical and chemical parameters (pH, dissolved oxygen, phosphate, nitrate, calcium, magnesium, total hardness, sulphate, chloride, total dissolved solids, electrical conductivity, and alkalinity) were evaluated. The parameters were analyzed and evaluated separately according to its suitability for drinking water as recommended by World Health Organization (WHO). The mean value of electrical conductivity is about 6800 µS/cm and exceeds 2000 µS/cm recommended by WHO. The concentration of sulfates is almost above 250 mg/L (recommended by WHO) in all the stations. The result of this evaluation showed that the water quality of Shatt Al-Arab River is not suitable for drinking. The comparison of the obtained and the WHO standards were indicated before using it in agricultural purposes.

Keywords: Shatt Al-Arab, River, Water quality.

1. Introduction

Water, which is of vital significance for the life of the living, is the most likely resource found naturally in the world. The total water in the world consists of 98% which is available in the oceans, sedimentary rocks and icebergs. Freshwater resources are even below 2%. For all living beings, the water resources that are of vital importance are not infinite but on the contrary, the amount of water that can be used with today's facilities is rather limited [1].

Over the years, water has become one of the key elements that define many life events, such as lifestyles, people's habitats, places of residence, living arrangements, and warriors. The availability of water used for cement, industry and agriculture is essential for the continuation of civilization.

The rapid decline of clean water resources, the imposition of water supply and the increasing water poverty have become the biggest problems in the world. Climatic changes, droughts and flawed industrialization make the water resources to become polluted and diminished very quickly. In order to avoid this problem, it is necessary to reduce the pollutant properties of waste and wastewater produced as a result of the production and other activities, and then to make the water quality as required for disposal water to rivers. As a result of human activities, irregular industrialization, and increase of population, all of these factors make the drinking water resources and other natural resources polluted rapidly. It has become a necessity to conduct operations in order to consciously use these resources, to increase the quality of their resources and to determine their usage areas according to their quantities. Physical and chemical analyses are carried out in order to determine the quality of the water and to reveal the state of pollution.

Rivers are ecosystems that are commonly affected by the environmental pollution. Pollutants impacts on the rivers, which are coming from domestic, industrial and agricultural activities. Domestic and industrial wastes have also taken up with the massive population increase and industrialization that accompanied development, and the rivers have become unable to clean themselves. In particular, aquatic resources that are compulsory but rapidly consumed by all living beings are so rapidly polluted. The discharged wastewater to the aquatic areas causes heavy metals, toxic compounds, nitrogen and organic carbon and inorganic compounds and other some living species, to cause physiological and morphological changes.

Public water treatment units are the most important among urban water pollution sources. In particular, the accumulation or spreading of the waste mud to the water sources without being treated and untreated can be one of the most important causes of pollution. Agricultural areas and fertilizers are the main causes of agricultural pollution. Prevention of water pollution, knowing the quality of water and protecting water quality is of great importance. Water quality can be defined as the sum of the existing physical, chemical and biological properties of a water body for a certain period of time. Water quality classes are determined by water quality criteria. Potentially hazardous water components and water quality are regulated to evaluate a quality of the water. Quality standards are determined according to the conditions of each region and country based on these criteria [2].

The water quality standard is defined as the rules or laws governing the intended use of the water body or mass and the water quality criteria that must be provided for these purposes. The standard will provide benefits in the provision of quality water by eliminating pollutants, which are harmful to human health, or by lowering their concentrations to a minimum.

The standards are revised by revising the changes in the water supply, improvements in the purification and chemical analysis, and so on. Each usage area has its own standard. Once the purpose of use of a water source has been determined, it should be determined that the acceptable chemical, physical, and biological properties are acceptable for this use [2].

2. Materials and Methods

2.1. Study Area

The study area, which covers the east parts of Basrah province, is located between 30°00 'and 31°00' north latitudes with 47°30' and 48°30' east longitudes. The confluence of Tigris and Euphrates rivers in the city of Al-Qurna form the Shatt Al-Arab River and its branches. The Basin size of the Shatt Al-Arab River is about 884,000 km^2. The Shatt Al-Arab River flows in the southeastward direction with a distance of about 193 kilometers, forming areas of the border between Iraq and Iran on the river way, after which eventually drainage to the Arabian Gulf. On its way to the Arabian Gulf, the river passes by two principal river ports, those being Basrah and Abadan, in Iraq and Iran, respectively. The river changes in width from 232 meters at Basrah to 800 meters at the river mouth. The prevalent climate of the Shatt al-Arab area is subtropical, arid, and hot. The water drainage of the Mesopotamian Marshes has had an influence that is negative on the Shatt al Arab and the Arabian Gulf: the raise of salinity levels in Shatt al Arab has triggered degradation which is apparent of coastal areas in Iraq because of the presence of toxic sediments within the Gulf. Increased pollution from domestic, industrial, and agricultural areas creates an additional issue.

2.2. Collection of samples

The Shatt Al-Arab water samples were collected from six stations between January 2013 and April 2013 for the purpose of determining the quality of water at two intervals. The Study area and stations are given in figure 1. The details and location of the sampling stations are shown in Table 1.

The physicochemical properties of the water samples were measured during the collection of the samples. pH, dissolved oxygen, total dissolved solids, and electrical conductivity; were tested in the field, whereas phosphate, nitrate, calcium, magnesium, total hardness, sulphate, chloride, and alkalinity; were tested and analyzed in the laboratory within 24 hours. All of the parameter’s tests were prepared according to standard methods [3].

2.3. Physical and Chemical Parameters

The pH in neutral waters do not have acid or alkali reactions. The pH values range from 0 to 14. Dissolved oxygen (DO) is one of the most important parameters related to water pollution. The oxygen level of the water in the dissolved water of the oxygen is about the temperature and salinity. The higher the temperature, the less oxygen is dissolved in water. Dissolved oxygen in the water comes from the oxygen that the photosensitizing bacteria end up in the water and the oxygen in the air. The amount of oxygen dissolved in the surface waters, such as lakes and rivers, with the dissolved oxygen concentration, is not less than 4 mg/L, or better than 5 mg/L, depending on the species of fish and other organisms is required. Thus, it will be possible to resume live life in shallow waters.

Electrical conductivity (EC) is a measure of the ability of water to transport electric current, and the dissolved solute, mineral acids in the water. The total dissolved solids (TDS) is obtained approximately by multiplying the conductivity by a factor ranged between 0.55 and 0.75. The conductivity of the water refers to the number of ions in the water. The quality of water for irrigation usage is given in accordance with the electrical conductivity values [4]. When the EC values be less than 250 µmhos/cm, the water will be of excellent type. But when the EC values ranged between 250 µmhos/cm to 750 µmhos/cm, the type of water will be good. Whenever, the EC values of water be in between 750-2000 µmhos/cm, the water type will be allowed for irrigation. The EC values ranged between 2000 µmhos/cm and 3000 µmhos/cm, the type of water will be suspect for irrigation usage. And finally, when the EC values of water be more than 3000 µmhos/cm, the water will be Inappropriate for irrigation.

Nitrate and nitrite are common substances in the natural nitrogen cycle. Nitrates are used as fertilizers. It is used in the construction of explosives, as an oxidizing agent and in the production of glass in the production of pure potassium nitrate. Nitrates also function as nitrite reservoirs.

The aim of this research project is to analyze the variations in water quality of Shatt Al-Arab River at Basrah district, south of Iraq. For this research, six monitoring stations for water quality have been used to investigate the variation in the quality of the Shatt Al-Arab River at monitored locations (Fig.1) during two months period. The water samples from the river were analyzed according to the standard methods for twelve different Physico-Chemical parameters which include pH, dissolved oxygen, phosphate, nitrate, calcium, magnesium, total hardness, sulphate, chloride, total dissolved solids, electrical conductivity, and alkalinity. In situ measurement was implemented to identify unstable parameters such as; pH, DO, TDS and EC by portable meters. The analysis procedures of the other water quality parameters were carried out by volumetric analysis in compliance with the standard methods of [3].

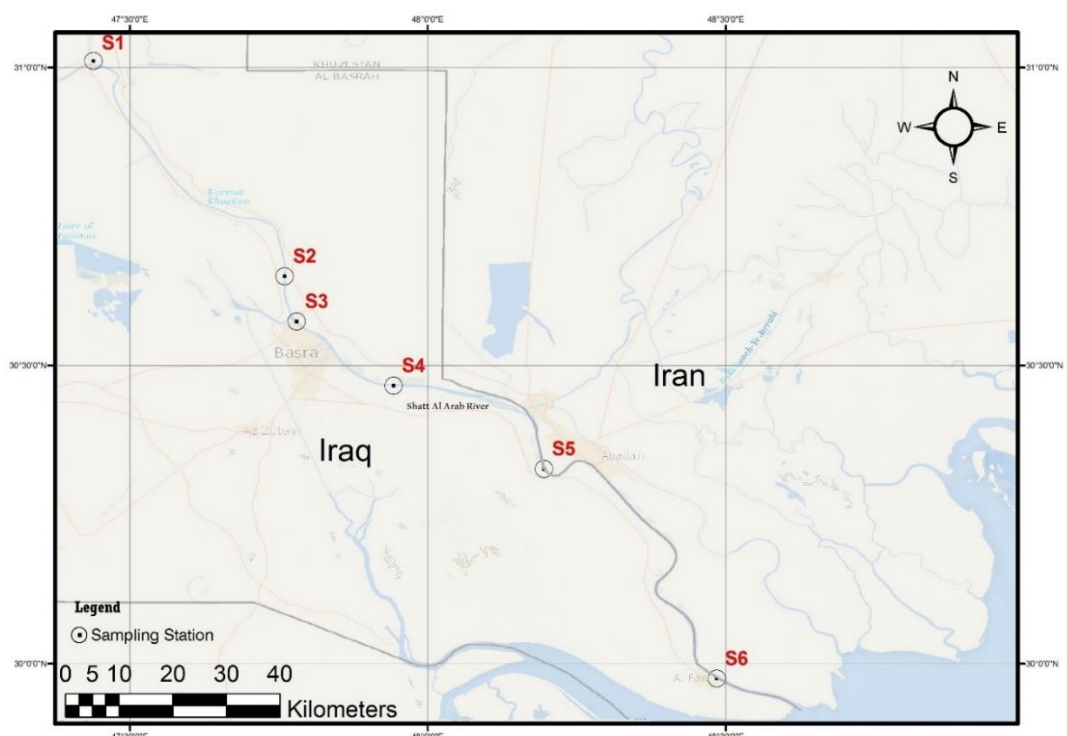

Figure 1: Shatt Al-Arab River and sampling stations.

Table 1. Details and location of the sampling stations in the study area.

Site	location	latitude	Longitude	Station description
S1	Qurna	31.01150 N	47.43842 E	Near the meet of the Tigris and the Euphrates
S2	Basrah	30.65019 N	47.75930 E	Before the river of Karma Ali
S3	Maqual	30.57420 N	47.77938 E	In the Corniche of Al-Maqual
S4	Abo Al-Khasib	30.46660 N	47.94231 E	Near desalination water plant in Al - Sanqir
S5	Sayba	30.32674 N	48.19429 E	Near the water project of Sehan
S6	Al-Fao	29.97501 N	48.48440 E	Near the boats berth

3. Results and Discussions

In order to determine the water quality of the Shatt Al-Arab River, the study area, water samples from six stations between January 2013 and April 2013 were collected and examined. The analytic results of the collected water samples are obtained and given in Table 2 at the six stations.

Table 2 and Fig. 2 explain the pH values at 6 different sites of the Shatt Al-Arab River at Basrah province. It can be observed that pH values of water samples of river ranged from 7.9 to 8.4 depending on the location. The average pH of water samples was found 8.13. The high values of pH in the river water is may due to the disposal of wastewater into the river from the individuals, industries and communities and chemical liquids or other pollutants which increase the pH of water. For that reason, the disposal of chemical compounds directly into the water system, such as rivers, will produce the water system to be less acidic and more basic.

It is found that pH of water in both January and April showed tendency to not exceed the values provided in the WHO guide-lines (6.5–8.5). The pH values approximately between 6.5 and 8.5 were documented appropriate for outdoor-bathing which is regarded safe for the ears, nose, eyes, and skin. Having said that, it is really becoming noted that, according to the WHO guideline, differences in pH of water within just certain limits have no direct impact or insignificant effect on human-consumption [5]. However, pH is directed to influence other physicochemical properties of the water, which influence the biotic composition of the systems [6]. The noticed values of the alkaline pH values in Shatt Al-Arab River could be partly attributed to the industrial-wastes disposal [7], existence of chemical detergent, domestic waste water pollution, production of bicarbonate and carbonate ions and are often because of limestone bed-rocks.

The tested values of dissolved oxygen in the Shatt Al-Arab River were discovered in the range of 4.05 to 9.66 mg/L, with an average of 5.72 mg/L which showed considerably low DO value when compared with other sites in the study area (Table 2, Fig. 3). At every site of study area, DO values weren't only more than the minimum desired as recommended by WHO (5 mg/L) but also very near the saturation amount. The results of the current study have shown notably higher DO values in January which might be ascribed to factors like phytoplankton, temperature and others. The available lower DO values in Shatt Al-Arab river water at station no.3 can be partly assigned to bacterial load and organic substances. A spot this is certainly notable of study is fairly higher oxygen level in water of Shatt Al-Arab River. This viewing needs deeper scientific studies to connect with elements which are contributory role of phytoplanktons looks appropriate [8]. The revealed low DO values recommend poor water quality and improper for consuming.

The lowest value of phosphate (0.24 mg/L) was found at third station in April 2013 and the highest value (0.35 mg/L) was found at fifth station in January 2013 when the measurements made on the Shatt Al-Arab River in terms of phosphate were evaluated (Table2, Fig.4). The runoff as a result of the agricultural field acquiring fertilizers at the river bank, waste outlets and domestic sewage may have offered to the noticed increased content of this ion.

For the nitrate, which is known as the last product of nitrification, the highest value of the measurements made at the sampling points in the Shatt Al-Arab River was found to be 13.67 mg/L at the first station in April 2013 (Table 2, Fig.5). The lowest value was measured in January 2013 as 10.15 mg/L at the forth station.

Table 2 and Fig. 6 explain the concentration of Ca2+ in water of the Shatt Al-Arab River which ranged from 126 mg/L to 560 mg/L. The range of Mg2+ concentration in water of Shatt Al-Arab River was found 72 mg/L –1763 mg/L (Table 2, Fig.7). Concentration of Mg2+ in water of Shatt Al-Arab River ranged from 11.39 ppm to 18.15 ppm. In January 2013, Shatt Al-Arab River Ca2+ concentration was significantly lower than its values in April 2013, except in sampling station no.3.

Concentration of tested cations was found not within the allowable limits particularly all water of the river at sampling stations. It is noticed that the higher concentration of cations may be believed to arise from discharged sewage which primarily due to Cl- ions in water of rivers [9].

The lowest SO42- value measured in the Shatt Al-Arab River was recorded as 250 mg/L in January 2013 (Table 2, Fig.9). Whereas, the highest value was found to be 1300 mg/L in the sampling in January 2013 at the sixth sampling station. As a result of these measurements, according to the WHO guidelines, all stations were found to be not suitable for human consumptions.

In the water of Shatt Al-Arab River, Cl- ions were discovered in range of 209 mg/L and 4228 mg/L (Table 2, Fig.10).

Table 2 and Fig. 11 show the concentration of total dissolved solids at the six different locations of Shatt Al-Arab River and tested values ranged from 1154 mg/L to 9774 mg/L with an average value (4727.33 mg/L). It was found that the total dissolved solids concentration at its higher values in the last sampling stations (towards the Arabian Gulf) due to the higher concentrations of salts in water there. Nonetheless, it is noticed that TDS values at all the location, were not within permissible limits (WHO, 1000 mg/L). High values of TDS in the Shatt Al-Arab River recommend pollution of river water perhaps because of agricultural run-off, domestic sewage, and industrial-wastewater [10].

Table 2 and Fig. 12 provide the EC values tested at the sampling stations. It can easily be observed that the values of EC ranged from 1640 µS/cm to 14300 µS/cm with an average value (6800 µS/cm). The values of EC demonstrated not good quality of water at these locations as per the standards by WHO. The data recommend that water of Shatt Al-Arab River falls under the class of not good water for human consumptions.

The distribution of alkalinity in the samples of Shatt Al-Arab River has been displayed in Table 2 and Fig. 13. Alkalinity was noticed in the range of 118 mg/L to 170 mg/L. These values were within the suitable limits recommended by WHO (200 mg/L). It is to be mentioned that alkalinity of water commonly identifies river's capability to neutralize acidic-pollution provided by wastewater or rainfall.

Table 2. Analytic results of water quality parameters in the study area.

Station	pH	DO	PO_4^{3-}	NO_3^-	Ca^{2+}	Mg^{2+}	TH	SO_4^-	Cl^-	TDS	EC	Alk.
S1												
Min	**8.10**	**4.50**	**0.27**	**11.46**	**126.00**	**72.00**	**620.00**	**250.00**	**209.00**	**1154.00**	**1640.00**	**130.00**
Max	**8.30**	**5.70**	**0.31**	**13.67**	**128.00**	**78.00**	**636.00**	**260.00**	**350.00**	**1422.00**	**2230.00**	**150.00**
Mean	**8.20**	**5.10**	**0.29**	**12.57**	**127.00**	**75.00**	**628.00**	**255.00**	**279.50**	**1288.00**	**1935.00**	**140.00**
SD	**0.10**	**0.60**	**0.02**	**1.11**	**1.00**	**3.00**	**8.00**	**5.00**	**70.50**	**134.00**	**295.00**	**10.00**
CV	**1.22**	**11.76**	**6.90**	**8.79**	**0.79**	**4.00**	**1.27**	**1.96**	**25.22**	**10.40**	**15.25**	**7.14**
S2												
Min	**8.10**	**4.29**	**0.26**	**10.21**	**126.00**	**94.00**	**705.00**	**300.00**	**309.00**	**1450.00**	**2050.00**	**140.00**

Max	**8.40**	**6.24**	**0.28**	**12.50**	**136.00**	**96.00**	**740.00**	**300.00**	**509.00**	**1884.00**	**2900.00**	**142.00**
Mean	**8.25**	**5.27**	**0.27**	**11.36**	**131.00**	**95.00**	**722.50**	**300.00**	**409.00**	**1667.00**	**2475.00**	**141.00**
SD	**0.15**	**0.97**	**0.01**	**1.15**	**5.00**	**1.00**	**17.50**	**0.00**	**100.00**	**217.00**	**425.00**	**1.00**
CV	**1.82**	**18.52**	**3.70**	**10.08**	**3.82**	**1.05**	**2.42**	**0.00**	**24.45**	**13.02**	**17.17**	**0.71**
S3												
Min	**7.90**	**4.05**	**0.24**	**11.47**	**177.00**	**147.00**	**1056.00**	**550.00**	**1133.00**	**3890.00**	**5420.00**	**142.00**
Max	**8.40**	**5.45**	**0.35**	**11.75**	**560.00**	**1763.00**	**8772.00**	**600.00**	**1473.00**	**4814.00**	**6250.00**	**170.00**
Mean	**8.15**	**4.75**	**0.30**	**11.61**	**368.50**	**955.00**	**4914.00**	**575.00**	**1303.00**	**4352.00**	**5835.00**	**156.00**
SD	**0.25**	**0.70**	**0.06**	**0.14**	**191.50**	**808.00**	**3858.00**	**25.00**	**170.00**	**462.00**	**415.00**	**14.00**
CV	**3.07**	**14.74**	**18.64**	**1.21**	**51.97**	**84.61**	**78.51**	**4.35**	**13.05**	**10.62**	**7.11**	**8.97**
S4												
Min	**8.10**	**6.45**	**0.28**	**10.15**	**154.00**	**127.00**	**921.00**	**550.00**	**1319.00**	**2904.00**	**4070.00**	**118.00**
Max	**8.40**	**9.66**	**0.29**	**11.95**	**277.00**	**253.00**	**1747.00**	**1150.00**	**1939.00**	**5992.00**	**8430.00**	**148.00**
Mean	**8.25**	**8.06**	**0.29**	**11.05**	**215.50**	**190.00**	**1334.00**	**850.00**	**1629.00**	**4448.00**	**6250.00**	**133.00**
SD	**0.15**	**1.61**	**0.00**	**0.90**	**61.50**	**63.00**	**413.00**	**300.00**	**310.00**	**1544.00**	**2180.00**	**15.00**
CV	**1.82**	**19.93**	**1.75**	**8.14**	**28.54**	**33.16**	**30.96**	**35.29**	**19.03**	**34.71**	**34.88**	**11.28**
S5												
Min	**8.10**	**5.16**	**0.29**	**12.45**	**196.00**	**101.00**	**923.00**	**500.00**	**1046.00**	**2570.00**	**3500.00**	**150.00**
Max	**8.20**	**5.33**	**0.35**	**13.21**	**200.00**	**131.00**	**1032.00**	**500.00**	**1207.00**	**3118.00**	**4700.00**	**154.00**
Mean	**8.15**	**5.25**	**0.32**	**12.83**	**198.00**	**116.00**	**977.50**	**500.00**	**1126.50**	**2844.00**	**4100.00**	**152.00**
SD	**0.05**	**0.09**	**0.03**	**0.38**	**2.00**	**15.00**	**54.50**	**0.00**	**80.50**	**274.00**	**600.00**	**2.00**
CV	**0.61**	**1.62**	**9.38**	**2.96**	**1.01**	**12.93**	**5.58**	**0.00**	**7.15**	**9.63**	**14.63**	**1.32**
S6												
Min	**7.90**	**4.68**	**0.28**	**11.61**	**161.00**	**285.00**	**1858.00**	**900.00**	**4128.00**	**9432.00**	**13860.00**	**148.00**
Max	**8.10**	**5.30**	**0.30**	**11.65**	**277.00**	**349.00**	**1882.00**	**1300.00**	**4228.00**	**9774.00**	**14300.00**	**152.00**
Mean	**8.00**	**4.99**	**0.29**	**11.63**	**219.00**	**317.00**	**1870.00**	**1100.00**	**4178.00**	**9603.00**	**14080.00**	**150.00**
SD	**0.10**	**0.31**	**0.01**	**0.02**	**58.00**	**32.00**	**12.00**	**200.00**	**50.00**	**171.00**	**220.00**	**2.00**
CV	**1.25**	**6.21**	**3.45**	**0.17**	**26.48**	**10.09**	**0.64**	**18.18**	**1.20**	**1.78**	**1.56**	**1.33**

CONFLICT OF INTERESTS.

There are no conflicts of interest.

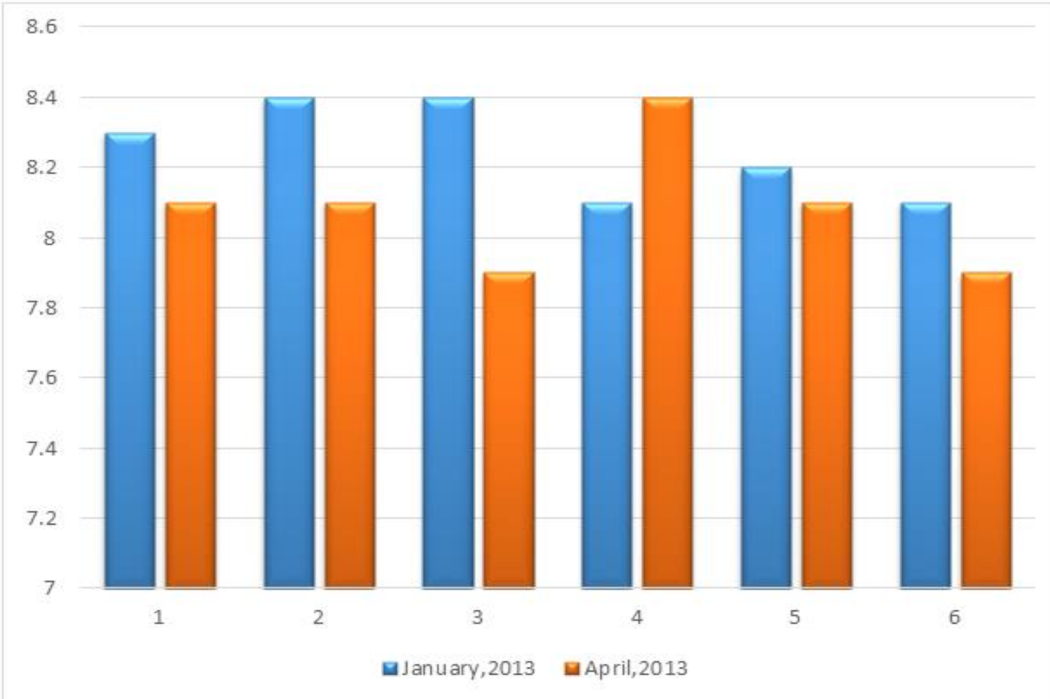

Figure 2: Seasonal variation of pH in six stations.

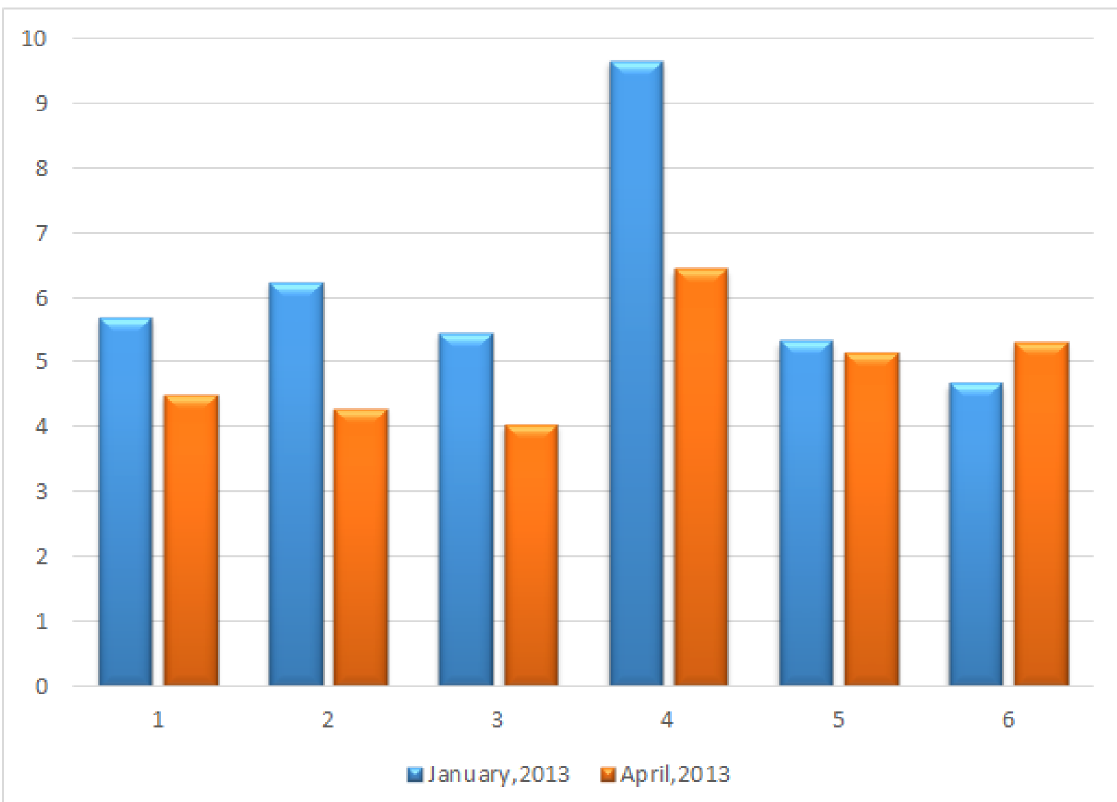

Figure 3: Seasonal variation of DO in six stations.

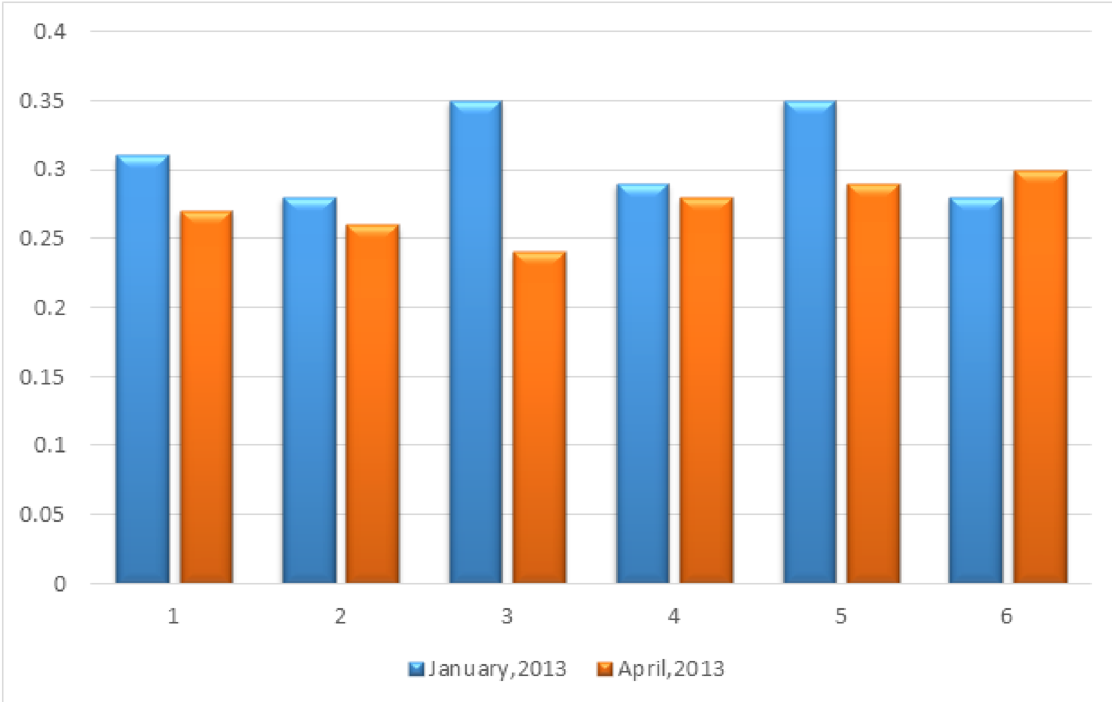

Figure 4: Seasonal variation of PO4 in six stations.

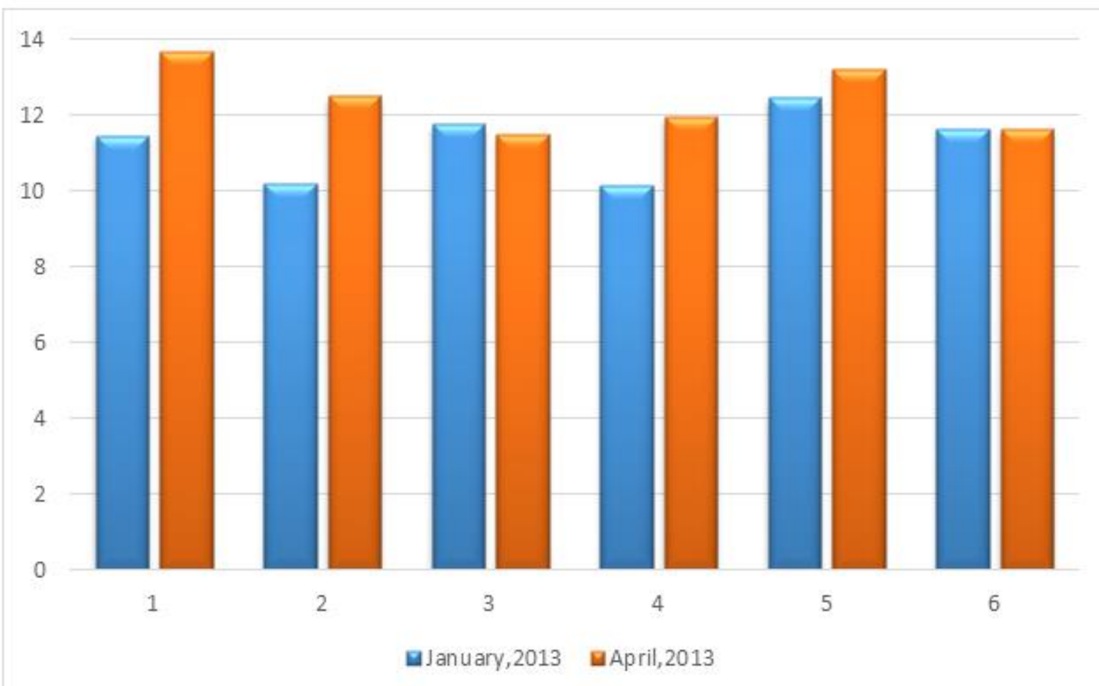

Figure 5: Seasonal variation of NO3 in six stations.

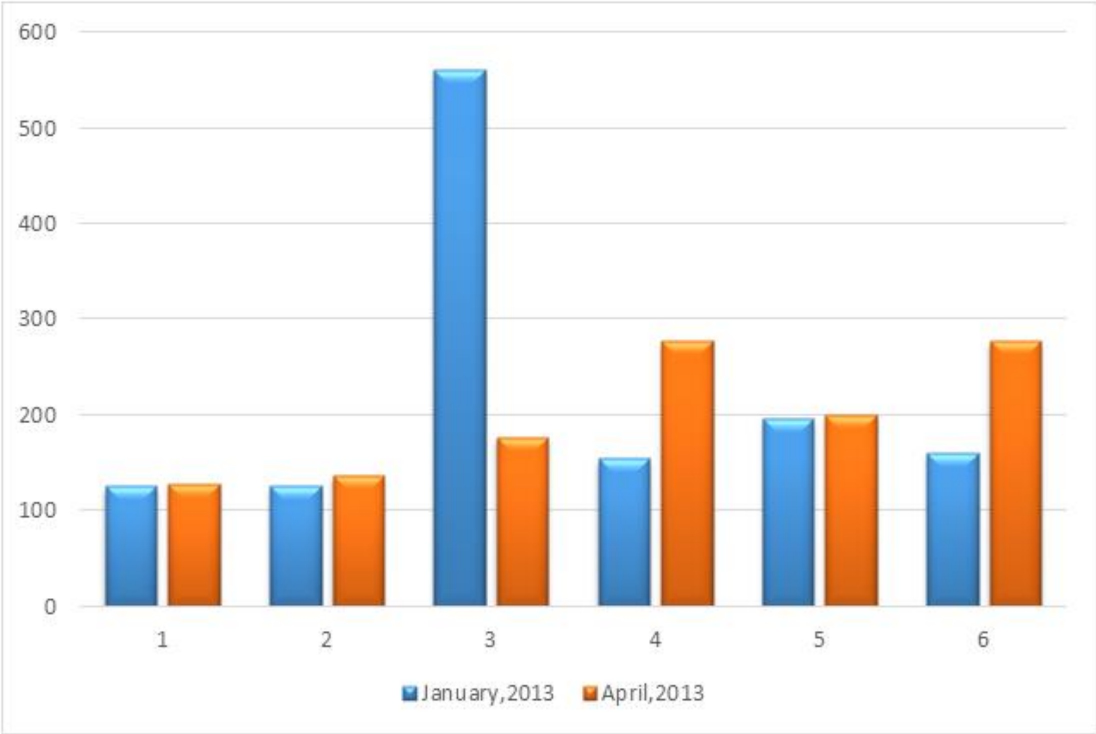

Figure 6: Seasonal variation of Ca in six stations.

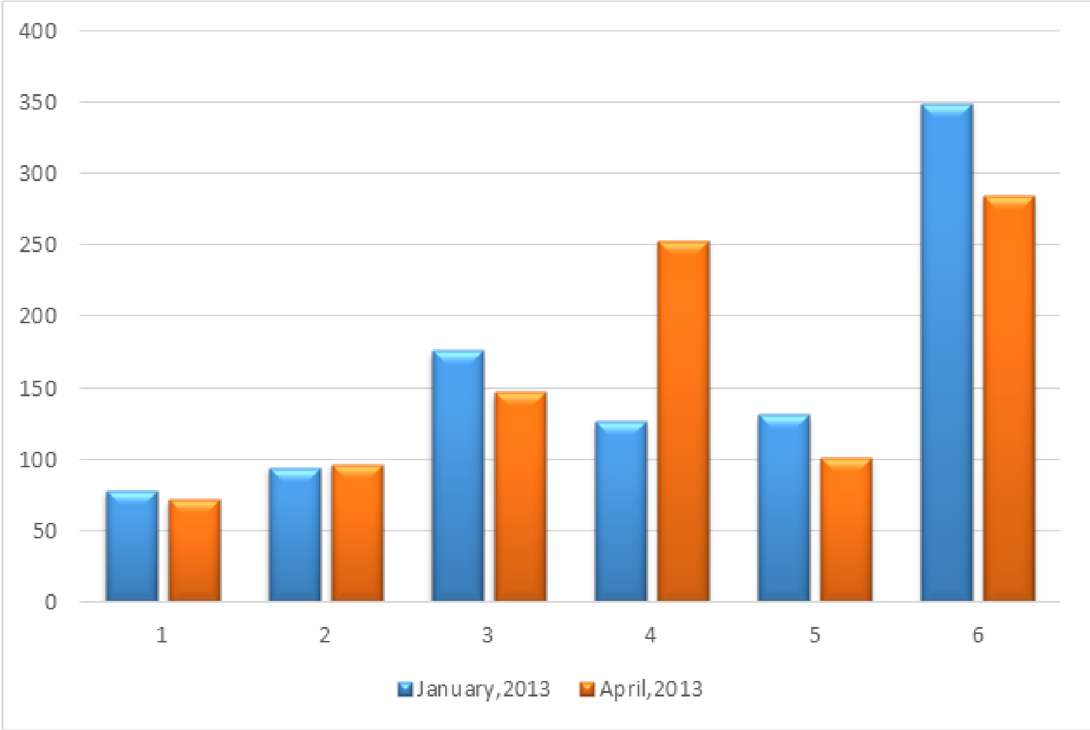

Figure 7: Seasonal variation of Mg in six stations.

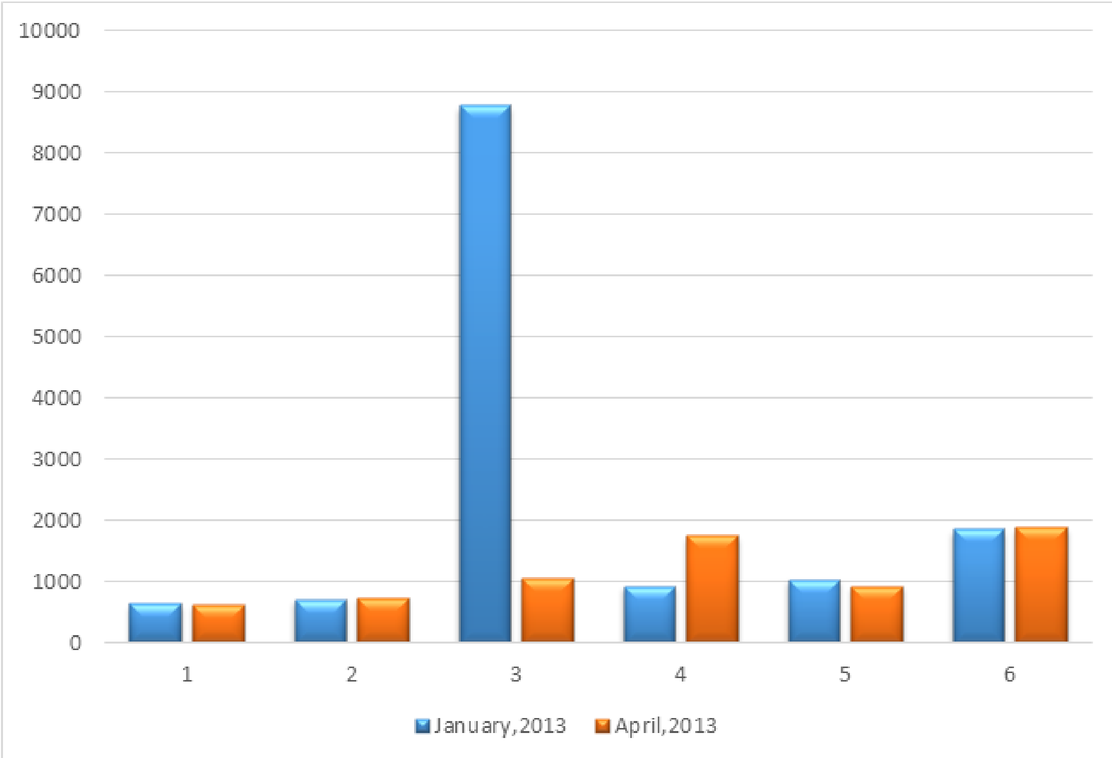

Figure 8: Seasonal variation of TH in six stations.

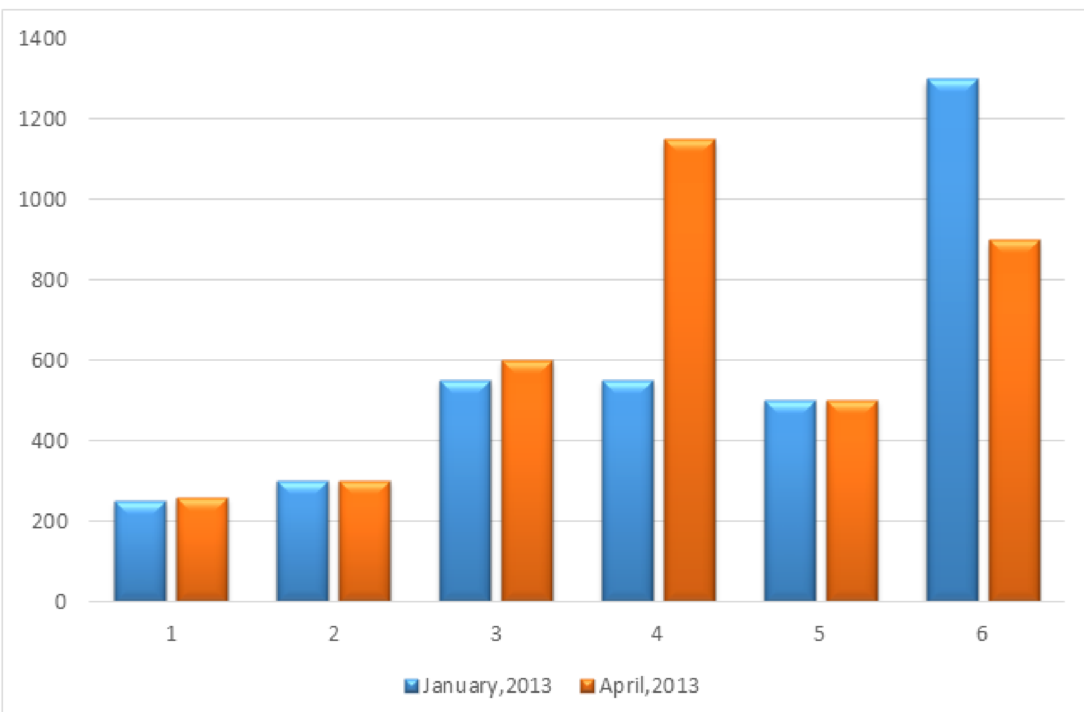

Figure 9: Seasonal variation of SO4 in six stations.

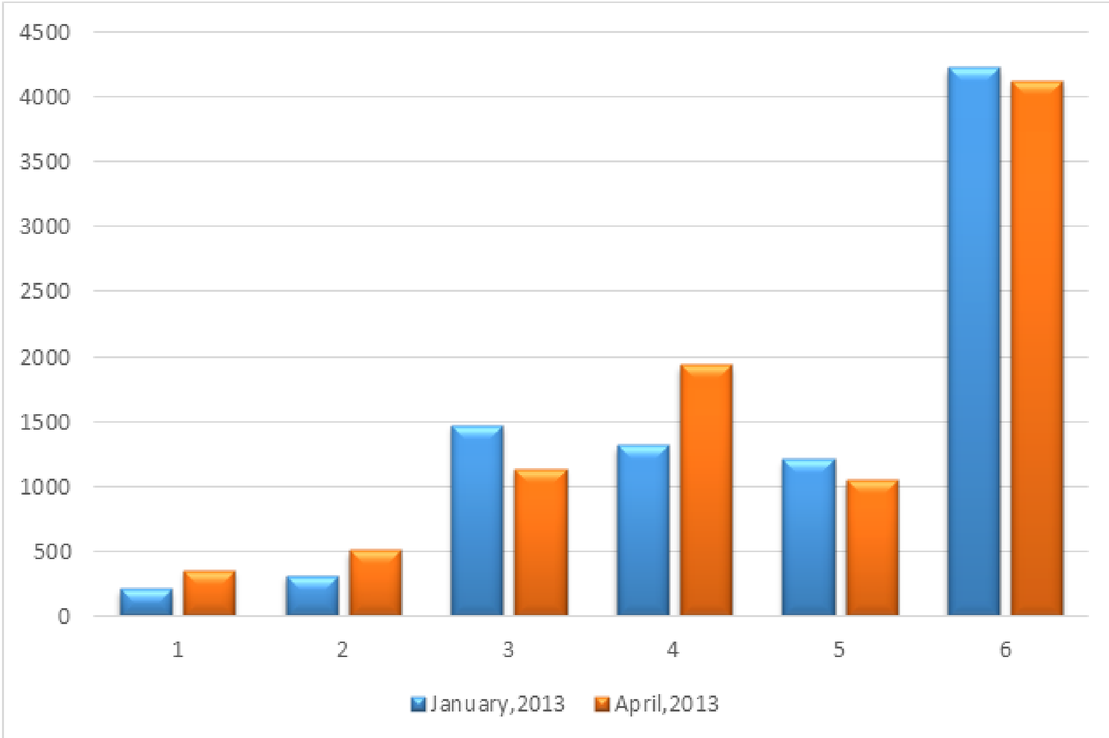

Figure 10: **Seasonal variation of Cl in six stations.**

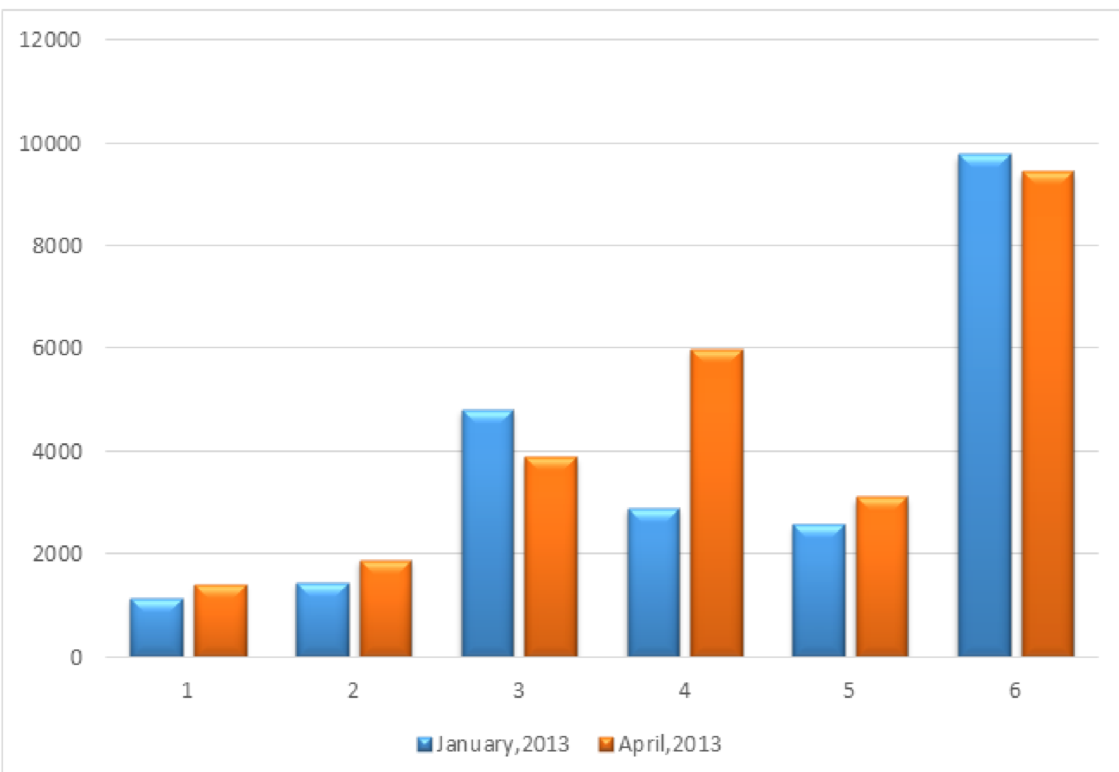

Figure 11: Seasonal variation of TDS in six stations.

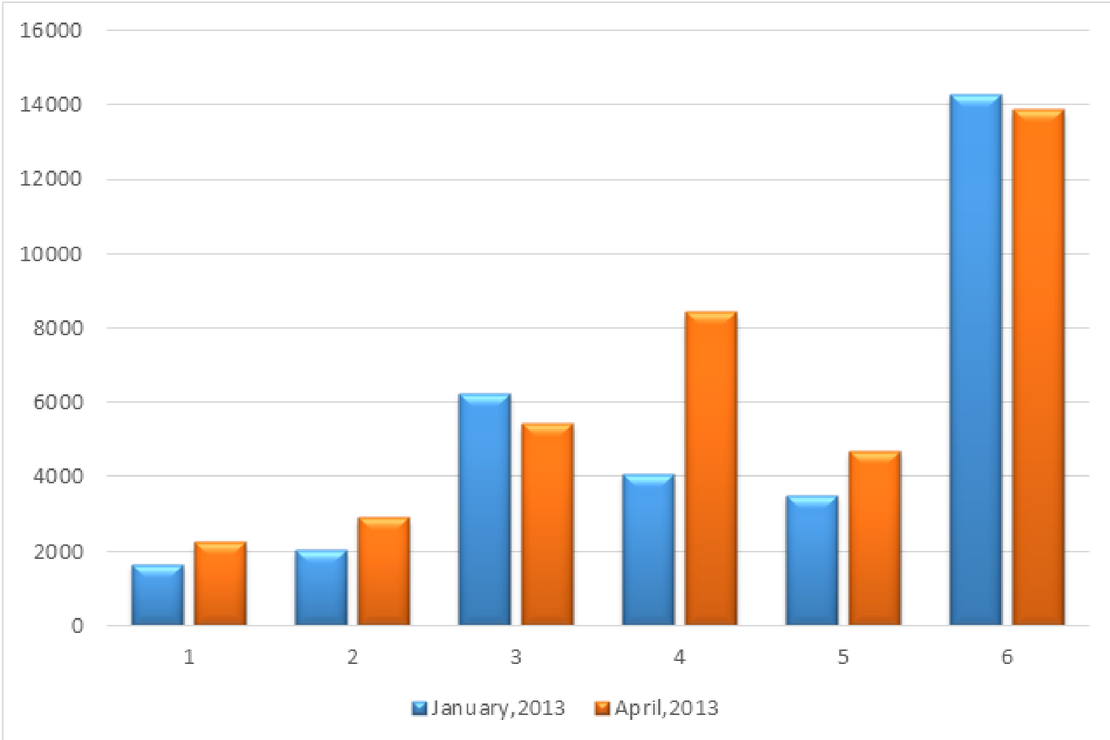

Figure 12: Seasonal variation of EC in six stations.

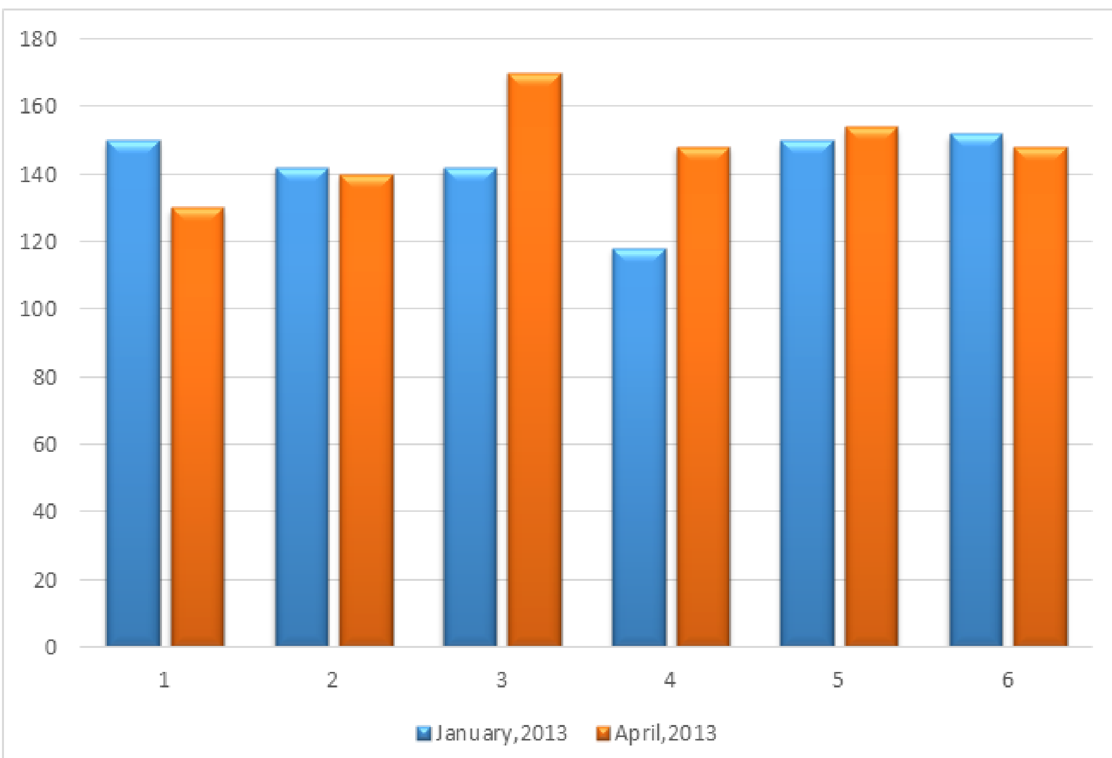

Figure 13: Seasonal variation of Alk. in six stations.

4. Conclusions

As a result, it is seen that the Shatt Al-Arab River, Basrah has been polluted by domestic and industrial wastewaters and this process has continued. In recent years, there has been an increase in the awareness of the environment and the increase in the number of measures to protect water resources and the number of industrial establishments having treatment facilities in both the basin and the cities. One of the causes of pollution in the Shatt Al-Arab River is the un-controlled irrigated water in the basin. The water returning from the irrigation to the Shatt Al-Arab River is very rich in nitrogen and phosphorus as a result of the fertilizers used. The amount of these substances increased in our rivers as long as the aquatic systems assume the role of receiving environment for rich waters in terms of manure nitrogen and phosphorus. Especially in non-fluvial stabilized water bodies, the increase in the amount of these substances that can endanger the continuation of aquatic life.

Results encourage that purification of water might be necessary for human-consumption such as drinking and irrigation purposes. The current study advises the pushing need for continuous-monitoring of the water quality of the river to determine the factors influencing contamination and its effect on the water quality.

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الخلاصة

في هذه الدراسة، تم جمع عينات المياه من ست محطات تم تحديدها في كانون الثاني ونيسان في عام 2013 بهدف تحديد جودة مياه نهر شط العرب، حيث تم جمع وتقييم بعض المعلمات الفيزيائية والكيميائية (الأس الهيدروجيني، الأكسجين المذاب، الفوسفات، النترات، الكالسيوم، المغنيسيوم، الكبريتات، الكلوريدات، المواد الصلبة الذائبة الكلية، التوصلية الكهربائية، وقلوية الماء. حيث يتم تحليل هذه المعلمات وتقييمها بشكل منفصل وفقًا لمدى ملاءمتها لمياه الشرب وفقًا لما أوصت به منظمة الصحة العالمية (WHO) ان القيمة المتوسطة للتوصلية الكهربائية حوالي 6800 µS / cm وتجاوزت 2000 µS / cm التي أوصت بها منظمة الصحة العالمية. ان تركيز الكبريتات كان يزيد عن 250 mg/l (موصى به من قبل منظمة الصحة العالمية) في جميع المحطات. أظهرت نتائج هذا التقييم أن جودة مياه شط العرب غير مناسبة للشرب. تشير المقارنة بين المعايير التي تم الحصول عليها ومعايير منظمة الصحة العالمية إلى امكانية استخدامها في الأغراض الزراعية.

الكلمات الداله: شط العرب، نهر، نوعية مياه.