ASSESSMENT OF WATER QUALITY IN THE EUPHERTES RIVER, SOUTHERN IRAQ

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ABSTRACT:
This study was carried out on Euphrates River, which is one of the main sources of water in Iraq to assess the water quality of Southeast of DhiQar province. Water samples were collected monthly and seasonally at three stations from October 2016 to September 2017. Eight parameters were analyzed, water temperature, dissolved oxygen, total hardness, total dissolved solid, hydrogen ion, turbidity, chloride and electrical conductivity. Monthly variations of water quality index were differing among months in three stations of study area in Euphrates River. The lowest value of WQI in station 1 was poor (1.32) in June, and the highest (2.30) in November, the value was indicated a good water. At station 2, WQI values ranged from 1.28 in August to 2.15 in February as good. The lowest of WQI (1.29) in June and the highest (1.58) in February was recorded at station 3. The ANOVA for water quality index was found statically significant (F= 0.008, P<0.05) of three stations and showed statistically significant seasonal variations of water quality index among study stations.

Keywords: Physiochemical, WQI, Monthly variations, DhiQar province.

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تقييم نوعية المياه في نهر الفرات جنوبي العراق

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المستخلص
أجريت الدراسة على نهر الفرات ، الذي يعد أحد المصادر الرئيسية للمياه في العراق، لتقييم دليل نوعية المياه في جنوب شرق محافظة ذي قار. جمعت عينات المياه شهريا وفصليا من ثلاث محطات خلال الفترة من تشرين الاول2016 إلى أيلول 2017. قيست ثمانية عوامل شملت درجة حرارة الماء والأوكسجين المذاب والعسرة الكلية والمواد الصلبة الذائبة الكلية والاس الهيدروجيني والعكارة والكلوريد والايصالية الكهربائية. أظهرت الاختلافات الشهرية كمؤشر نوعية المياه فروقا معنوية بين ألاشهر في محطات الدراسة. بلغت أدنى قيمة لدليل نوعية المياه في المحطة الأولى (1.32) في حزيران، مما صنفت نوعية المياه بانها فقيرة، بينما بلغت أعلى قيمة (2.30) في تشرين الثاني، أذ تشير إلى نوعية مياه جيدة. تراوحت قيم مؤشر نوعية المياه في المحطة الثانية من 1.28 في آب إلى 2.15 في شباط، مما تشير الى نوعية مياه جيدة. سجل أدنى مستوى لمؤشر نوعية المياه (1.29) في حزيران وأعلى (1.58) في شباط في المحطة الثالثة. بينت نتائج تحليل التباين لمؤشر نوعية المياه فروقات معنوية (F= 0.008, P<0.05) ببين محطات الدراسة.

الكلمات المفتاحية: الفيزيوكيميائية، مؤشر نوعية المياه، التغيرات الشهرية، محافظة ذي قار

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INTERDUCTION

Rivers are the most important natural resources for human life, but it is being polluted by sewage, industrial, and other human activities (14). The term water quality was developed to give an indication of how suitable the water is for consumption (23). The information on water quality is an important target for implementation of sustainable water usage for management strategies (6). Water quality were indicated by the physical and chemical characteristics of water sample (22), with water quality guidelines or standards and provides a single number that can expresses water quality at a certain location and time, based on several water quality parameters (2, 27). One of the most effective ways to obtain information on water quality trends is through using suitable indices. The use of indices in monitoring programs to assess ecosystem health has the potential to inform the general public and decision- makers about the state of ecosystem (3). Different water quality evaluation of methods has been developed for assessment the water of the river (26). Research on spatial variations of river water quality has been conducted in many basins in the word. The Euphrates River is one of two major rivers in Iraq, and main source of drinking, irrigation, agriculture, fishing and other purpose (20, 15). Studies investigating the monthly and seasonal variability of water quality have reported that water quality issues, such as eutrophication, are highly depended on land use patterns and influence from watershed runoff (8). Many of researchers are studied and application of water quality index of water bodies in Iraq (4, 7, 1). The aim of this study is to assess the water quality of Euphrates River by applying development WQI based on physiochemical of water quality parameters.

MATERIALS AND METHODS

Description of area

The study was carried out in the Southeast Al-Nasiriya city and is located between latitude 30° 56' 44.85" N and longitude 47˚08' 07.54" E with a distance 22km. The study area included three stations on Euphrates River. Station 1 located between latitude 30° 56' 44.85" N and longitude 46° 45' 06.21" E in Al-Hammar city, station 2 located 12km to the South of the station 1 in Al-Mawajid village between latitude 30° 56' 18.73" N and longitude 46° 58' 32.49" E. Station 3 located in Abu-Subat village between latitude 30˚ 57' 08.35" N and longitude 47˚08' 07.54" E (Figure 1).

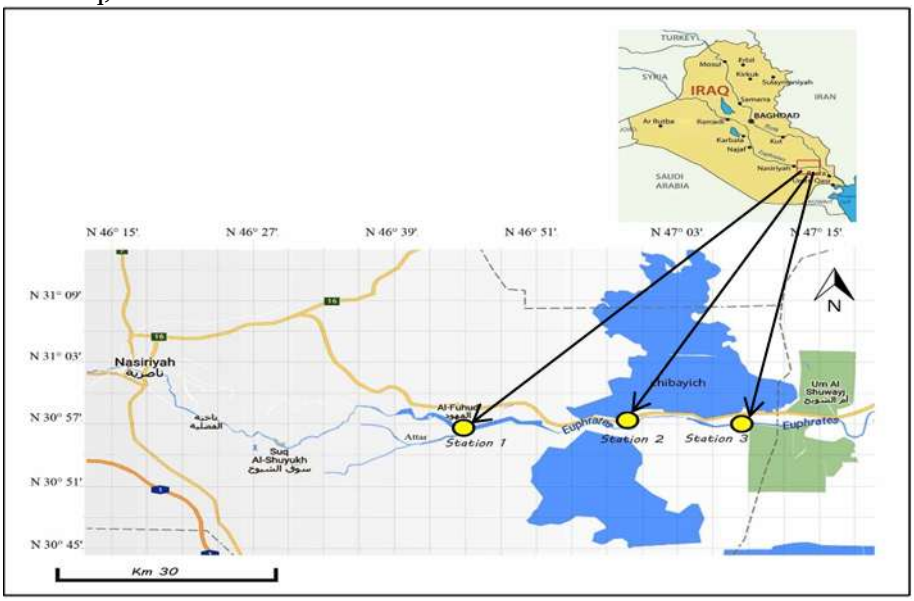

Fig. 1. Stations location of the Euphrates River, Southeast of Dhi Qar province, Al- Nasiriya city

Calculation and analysis of WQI

Water samples collected from the middle of the Euphrates River during the period from October 2016 to September 2017; the samples were collected monthly and seasonally from the stations by using clean polyethylene bottles. The WQI calculate according to (18). The following variables were evaluated in situ: Temperature (T), electrical conductivity (EC), total dissolved solids (TDS) and potential of

hydrogen (pH) were measured with a Hanna instrument (a waterproof HI-9146 pH/EC/TDS/ temp. model), turbidity was estimated with a turbid meter HI- 93703C. The temperature in Celsius degree (°C), EC in dS m^{-1}, TDS in mg L^{-1}, pH level is reported in pH units and turbidity is reported in nephelometric turbidity units (NTU). The following variables were evaluated in the laboratory: dissolved oxygen (DO) were determined according to (25) and the results are expressed in mg L^{-1}, total hardness (TH) was estimated by EDTA titration and the result are expressed in mg L^{-1}, while Chloride (Cl^-) were determined using the Mohr method (5). Data analysis was carried out in two steps (18). In the first, an analysis of variance (ANOVA) was performed for each variable. In the second step WQI was collected. In first step, each parameter given a specific weight in a range of 1 to 4 (the relative weight, Wi), the weight of each parameter which gives the numbers from 1 to 4 according to importance of water quality parameter. The Wi values were assigned as follows: pH, DO, and EC were assigned 4; T and turbidity were assigned 3; TDS and TH were assigned 2; and Cl was assigned 1. This information is present in (Table 1). In the second step, the result of each variables obtained previously from the ANOVA were examined independently to scrutinize the specific weights of the parameters according to a range of tolerance (Pi). Pi= 1 was assigned to the variables with values in the ideal ranges, while values outside the ideal range were given Pi= 2.The water quality index was calculated with the following Equation 1 as described by (19).

$$WQI = \frac{\sum_{i=1}^{n} Pi*wi}{\sum_{i=1}^{n} Pi} * k \qquad (1)$$

Where:-

WQI = water quality index

Wi = specific weight of each variable (1-4).

Pi = Range tolerance

K = constant (1; 0.75; 0.50)

K; represents a constant according to the level of contamination when the sample was taken. A value of 1 was assigned to clear water without apparent contamination; 0.75 to water with a low of turbidity from natural processes; and the 0.50 to contaminated water.

Table1. Calculated water quality according to the following range. (19)

Level of water quality	Water quality status
>2.5	Excellent
2.0-2.5	Good
<2.0	Poor

RESULTS AND DISCUSSION

Physicochemical parameters

Monthly variations in rates of eight ecological factors features were examined in represented stations during the duration of the study (Fig. 2). The lowest rates of water temperature and dissolved oxygen (DO) (10.3°C, 5.53 mg L^{-1}) were in January and August, while the highest (38.6°C, 8.63 mg L^{-1}) were observed in August and December with average values of 25.29°C ± 10 and 7.12 mg L^{-1} ± 0.95 respectively (Fig. 2 a Tab. 2). Total hardness (TH) values (Fig.2b, Table 1) ranged from 943 mg L^{-1} in February to 2354 mg L^{-1} in July the mean value was 1610 mg L^{-1} ± 467. Minimum value of total dissolved solids (TDS) (1791 mg L^{-1}) in December, while maximum value (3737 mg L^{-1}) was recorded in July of the average 2555 mg L^{-1} ± 580. Potential of hydrogen (pH) values varied from 7.78 in September to 8.57 in January, the mean value 8.16 ± 0.25. Result showed that the lowest rate value of turbidity (12.27 NTU) in January and the highest (30.40 NTU) in October and mean value 20.9 ± 6.26 (Fig.2C Tab. 2). The lowest values of electrical conductivity (EC) and Chloride (Cl^{-1}) (2.39 dS m^{-1}, 608 mg L^{-1}) in January and February, whereas the highest (5.96 dS m^{-1}, 978 mg L^{-1}) were recorded in August with a mean values 4.27 dS m^{-1} ± 1.73 and 925 mg L^{-1} ± 455 respectively (Fig.2d Tab. 2).

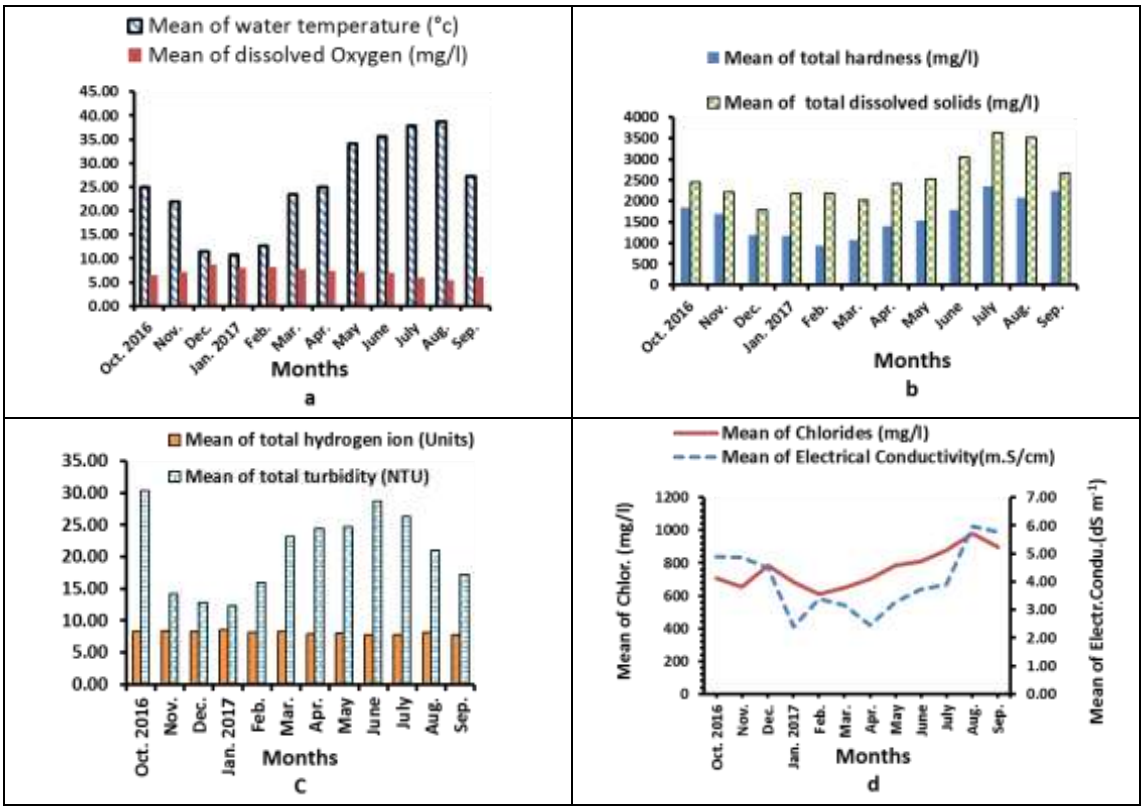

Fig. 2. Variations in monthly levels of values at, T, DO,TH, TDS, pH, turbidity, Cl^{-1}, and EC in water samples in Euphrates River during the period from October 2016 to September 2017

Table 2. Statistical analysis of the physicochemical parameters for variations in eight ecological factors in Euphrates River during the study period

Parameter	Unit	Minimum	Maximum	Mean	STD
T	°C	10.83	38.67	25.29	±10
EC	dS m^{-1}	2.39	5.96	4.27	±1.73
DO	mg L^{-1}	5.53	8.63	7.12	±0.95
TDS	mg L^{-1}	1791	3528	2555	±580
TH	mg L^{-1}	943	2354	1610	±467
Cl	mg L^{-1}	425	809	925	±455
pH	-	7.80	8.57	8.16	±0.25
Turbidity	NTU	16	30.4	20.9	±6.26

Water quality index of the present study in Euphrates River was deal with the most important physiochemical variables in monthly and seasonally (Fig 2). Water temperature was the most important parameter, that showed monthly and seasonally variations in values and directly affected on dissolved oxygen levels in investigated stations (Fig.2, a). This result is consistent with (1). The lowest values of dissolved oxygen recorded in hot months and seasonally in summer for the represented stations, may be due to increase discharge of organic materials with increasing water temperature (17). Moreover, the solubility of gases in water inversely proportional with water temperature (13). The highest values rates of DO were found relatively in cold months and seasonally recorded in winter season, that were observed in all stations due to the rapid melting and continuous mixing of water, this is coincided with finding (11). Table 3. Shows the Personas matrix, refers to the correlation among physiochemical factors in study stations. The water temperature was negatively correlated with pH and DO (r = - 0.648, r = - 0.836) respectively. From the other hand the water temperature that positively correlated with TDS and turbidity (r = 0.671, r =0.709) same order. Electrical conductivity was negatively correlated with DO (r =- 0.584) at the level 0.05, positively with TDS, TH and Cl (r =0.735, r = 0.764, r = 0.820) at the level

0.01 respectively. Dissolved oxygen was negatively correlated with TDS and TH (r = -0.917, r = -0.774) at the level 0.01. Total dissolved solids were positively correlated with TH and Cl (r = 0.814, r = 0.883) at the level 0.05 and 0.01 respectively, while the result of total hardness was appeared positive correlation with chloride (r = 0.817) at the level 0.01. The present results showed low concentrations values of total dissolved solid, total harnesses and electrical conductivity during December to March that may be due to high amount of water, which caused reduction of salinity concentrations (27). Highest in TDS, TH and EC were also found during June, July and August (Fig. 2, b and d), that could be due to low river discharge during the summer which increased the concentration of ions. Our findings confirmed by (16) results. pH of water at the study stations were always within the base direction for average values in Iraqi surfaces water (12, 1). The values of turbidity were found highest than 5 NTU in all stations. This result agreed with (24) for drinking water. The present result showed high concentrations of chloride in all stations, were over than 145 mg L^{-1} of mean values about (21), the values of chloride and salinity were increased relatively and gradually at downstream in station 3 in the river, that may be affected by activates of pesticides, irrigation and fertilizers applied (10).

Table 3. Correlation coefficient for the physicochemical parameters at Euphrates River during the period from October 2016 to September 2017

Parameter	pH	T	EC	DO	TDS	TH	Cl
T	-0.648*						
EC	-0.085	0.165					
DO	0.469	-0.836**	-0.584*				
TDS	-0.400	0.671*	0.735**	-0.917**			
TH	-0.047	0.404	0.764**	-0.774**	0.814*		
Cl	0.075	0.244	0.820**	0.263	0.883**	0.817**	
Turbidity	-0.551	0.709*	-0.032	-0.529	0.226	0.123	-0.074

*** Correlation is significant at the level of 0.05**
**** Correlation is significant at the level of 0.01**

Water quality index (WQI)

Monthly variations of water quality index were differing among months in the three stations of study area in Euphrates River (Fig. 3. Table 4). The lowest value of WQI in station 1 was (1.28) in June, the water was poor because the index below 2.0 and the highest (2.30) in November, the value was shown a good water because the index above 2.0, while the mean value and standard deviation was 1.90 ± 0.40. In station 2 values ranged from 1.28 in August to 2.15 in February, the mean 1.57 ± 0.32. The lowest of WQI (1.29) in June and the highest (1.58) in February was recorded in station 3 with the mean 1.42 ± 0.09. Significant relationships were found (F= 0.008, P<0.05) in water quality index among the stations

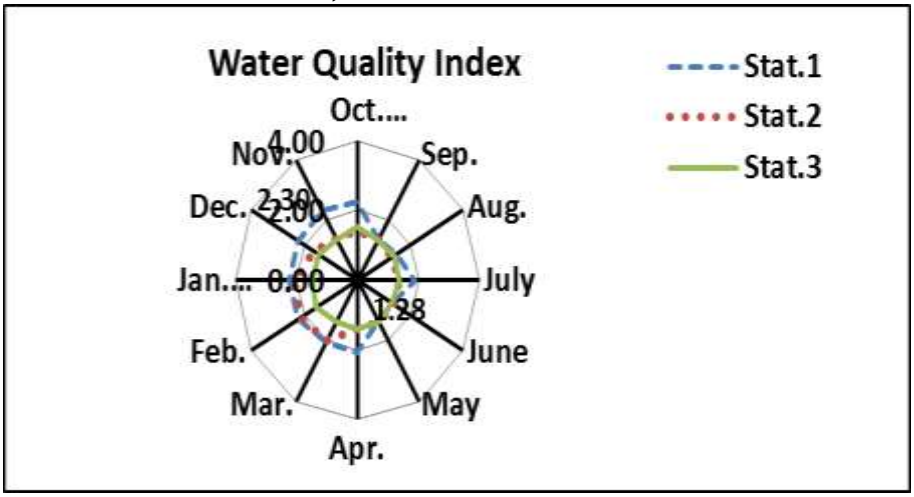

Fig. 3. Monthly variations in values of water quality index in the three stations in the Euphrates River during the study period

Table 4. Water quality index in three stations at the Euphrates River in the studying area

Stations	Minimum	Maximum	Mean	STD
Stat.1	1.89	2.30	1.90	±0.40
Stat.2	1.28	2.15	1.57	±0.32
Stat.3	1.29	1.58	1.42	±0.09

The season's variations of water quality index in the represented stations (Fig. 4). The minimum values of WQI in the station 1 was (1.39) in summer, but the maximum (2.25) in winter with the mean value 1.58 ±0. 36 Station 2 values varied from 1.47 in summer to 2 in winter, the average 1.67 ± 0.22. The lowest value of WQI in station 3 was (1.32) in summer, whereas the highest (1.80.) in winter, the water was poor because the index below 2.0, while the mean value and standard deviation was 1.22 ± 0.21. Significant relationship (F= 0.06, P<0.05) in water quality index seasonally was shown between the station 1 and 3.

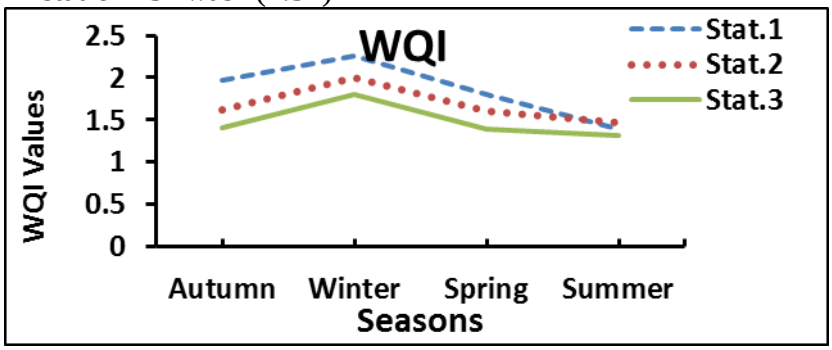

Fig.4. Seasonally variations in values of water quality index in the three stations at the Euphrates River during from October 2016 to September 2017

Monthly variations rates of WQI in Euphrates River with general mean 1.65 ± 0.30 revealed that water from the river can be considered poor. The best WQI level (2.01, 2.30) was noted in the January and February respectively, the water was good due to the index above 2.0 and the lowest (1.28) in June (Fig.5). ANOVA analysis of water quality index significant (F= 13.890, P<0.05) for all months in the study area. Water quality index in the present stations differ from the lowest in August to highest in November (Fig.3. Table 4.). The values of index were observed below 2.0 during the hot months and autumn, spring and summer seasons (Fig. 4), because some of parameters, such as turbidity was outside the Pi ranged reflected the result values of water quality, which obtained at all selected E. T. stations, was found to be above the standard permissible limits of (24). This could be attributed to presence of runoff, organic matter pollution, agriculture and human activates (9). The best water quality values were shown in November, February as well as in winter season indicate to improved water quality in stations 1and 2 (Fig.3, 4) which compatible with results of (7).

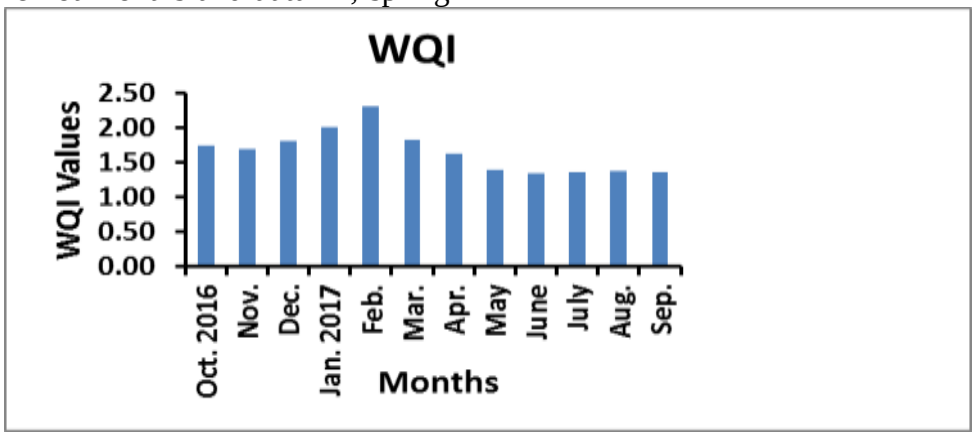

Fig. 5. Monthly variations in the rates of WQI in Euphrates River at study area during the study period

Seasonally, the result shows that the best water quality index was in winter (2.02) when the water classified as good. The lowest value was recorded (1.39) in summer with average and standard deviation 1.67 ± 0.25 (Fig. 6).

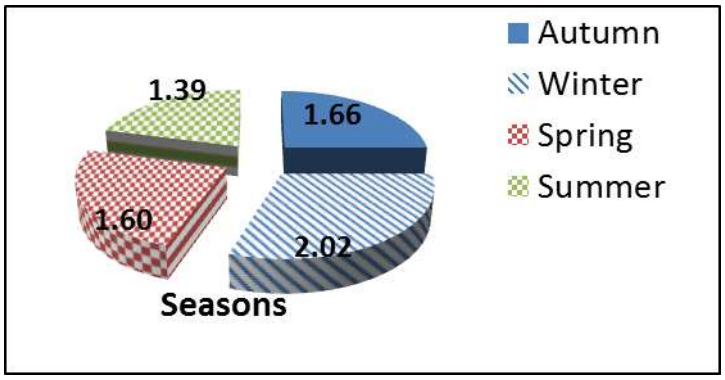

Fig. 6. Seasonally variation in rates of WQI in Euphrates River in the study area from October 2016 to September 2017

The preferable values rates of index in study area were recorded in January, February and winter season. The lowest values of index observed from May to September also during spring, summer and autumn seasons (Fig.5,6), water quality is worse in the dry season than flood season, may be attributed to presence values of parameters such as TDS, EC, TH and turbidity were above of Iraqi limited standard specification (21).

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