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Arithmetic Water Quality Index of the Euphrates River in Al-Musyiab/Babil province-Iraq

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Abstract

The study was carried out in Euphrates/Al-Musayyib River. Water samples were collected for testing the physical, chemical once every month from Euphrates/Al-Musayyib River. The analysis was done for six months (July 2020 to Decembers 2020) from three sites during the dry and wet seasons. These samples have been chosen from three stations to help in understanding the variability of water quality due to seasonal differences. Wet and dry weather have been analyzed to better determine the river pollution rates. Thirteen parameters with their limits were considered in the present work according to the standard specifications, collected and analyzed from physical and chemical parameters (pH, DO, EC, TDS, NO3, PO4, SO4, Mg, Na, Ca, K, TH, and TUR) were chosen parameter using water quality indices (WQI). The results from Water Quality Index show that water quality was unsuitable to use in drinking in the dry and wet weather unless treat of it.

Keywords: Water Quality Index (WQI), Water Quality, Dry Weather, Wet Weather.

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1. Introduction

Particular goals were developed and tested the method for estimating water quality in watersheds where no or less data of WQ available [1]. Employing a statistical method, the relations between the watershed characteristics and WQ within a particular area or topographical area were specified and utilized for predicting the likely WQ data of poor watersheds inside such that area [2]. Statistical analyses were conducted to obtain which of the important parameters were highly related with WQ, and predictive relations of WQ were evolved [3].

The WQIs give a means for comparing the WQ could through the time as well as space founded upon a compound indicator [4]. The values of index and sub-index can be utilized for flagging the concerned contaminants, guiding the administration labors arrangement, and for prognostic purposes

[5].

Water is the major element that responsible for the life upon the earth [6]. The variation of climate is influencing the precipitation and eventually influences the available freshwater amount, while, raising the waste water loads from the point source as well as the non-point source deteriorates the WQ of surface in addition to the resources of ground water [7].

Data of WQ data are frequently collected at various sites through the time for improving the management of WQ. WQ data typically display these characteristics: presence of outliers, non-normal distribution, serial dependency, values below detection limits (censored), and missing values [8]. It's necessary to implement proper statistical methodology to analyze the data of WQ for drawing useable inferences and therefore give beneficial counsel in the management of water [9]. The data of WQ show that the significant temporal changeability presents as a consequence of the fluctuations of the flow of stream through the yearly cycle of flow. Attempts to teach statistical methods which are appropriate for the analysis of water resources data are presented [10].

2. The Aim of Study

The objective of the study is to analyze and monitor the water quality of Euphrates /Al-Musayyib River supplied to the humans and agriculture areas alongside this river, aiming to assess the quality of water by the relevant statistical tools.

3. Literature Review

Costa et al., 2020 [11] collected fifty-four water samples during the July and December of 2019 at 9 monitoring stations, and 15 factors were scrutinized for providing an updated diagnosis of the quality of water of the Piabanha River. Othman et al.,2020 [12]created an input method utilizing the Artificial Neural Networks (ANNs) for computing the Water Quality Index (WQI) from the input factors in place of utilizing the factors indices if one factor being none exist. Data were gathered from 9 stations of the monitoring of the quality of water at the basin of Klang River, Malaysia. Prasad D. Et al., 2020 [13] explored numerous deep learning algorithms for estimating the Water Quality Index (WIQ), which is a singular index for describing the overall water quality, and the Water Quality Class (WQC), which is a typical class defined upon the the (WIQ) basis. Samples of water were gathered from Korattur Lake in the city of Chennai. The factors of the quality of water, like pH, iron, Total Dissolved Salts (TDS), nitrate, phosphate, chemical

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oxygen demand, sodium, chloride and turbidity, were measured from the gathered samples of water. The utilized models to train and test comprise models of Deep Learning (DL), like Long-Short Term Memory (LSTM), Recurrent Neural Network (RNN), and Artificial Neural Network (ANN), for the two binary and multi-class classifications. The used metrics to evaluate the models were the models precision, accuracy, and implementation time, which were utilized to compare and analyze the overhead stated models. From determined findings, it was noticed that the (LSTM) produced the highest accurateness of about (94%) and also consumed the least implementation time if compared to the else models of (DL).

4. Method and Methodology

4.1 Study Area

It is located in Babil province, situated in the Iraqi central zone, occupying the northern part of the province . The case study was the river passing through the north of Hilla city at Euphrates River/Al-Musayyib located between latitude (32°47'14.95752- 32°45' 9.36573 N) and longitude (44°17' 32.37432- 44°16' 25.59445 E). Three stations were taken on the river namely and measured the monthly environmental parameters, which were equal to thirteen parameters. Agriculture farms and villages with moderately sized populations are distributed in the surrounding areas of study area.

4.2Water Sampling

Water samples were collected at each site from the middle of the river (0.5 m) below the surface of water; it is unlikely that the sediments will be disturbed by a 250 ml white plastic pot at the middle. Samples were put in bottles with a volume of 1L. The bottles were plastic for the physical and chemical samples. The plastic bottle has been used for sampling, because it is cheaper and the chemical composition of sample doesn't really alter when preserved.

The container was rinsed three times with the water to be sampled before sampling. The bottle was flooded in water with ensure that the water still stable with the lack of sediment and do not disturb anything in the direction of bottles in the area of taking samples. Samples have been transferred and put at 4°C in the refrigerator into the laboratory until examination, since after sampling from the source; the chemical characteristics of the water begin to change.

Water Samples of the Euphrates river/Al-Musayyib were collected once every month (during a period of six months). Samples were taken in the dry and wet seasons. The dry season included (July 2020, August 2020, September 2020, and October 2020), while the wet seasons was at (November 2020 and December 2020). Samples were preserved and analyzed according to Iraqi standards. Velocity of flow was measured and was approximately close and constant for most months and sites where it ranged between (0.6 and 0.8 m/s). Table (1) presents the monitored water quality parameters.

Table (1): Water Quality Parameters

N	Parameters	Unit	Site
1	PH	PH units	In Laboratory
2	DO	mg/l	In Laboratory
3	EC	µs/cm	In Laboratory

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4	TDS	mg/l	In Laboratory
5	NO_3	mg/l	In Laboratory
6	PO_4	mg/l	In Laboratory
7	SO_4	mg/l	In Laboratory
8	Mg	mg/l	In Laboratory
9	Na	mg/l	In Laboratory
10	Ca	mg/l	In Laboratory
11	K	mg/l	In Laboratory
12	TH	mg/l	In Laboratory
13	TUR	NTU	In Laboratory

4.3 Water Quality Index (WQI)

Water quality index can be evaluated using weighted arithmetic strategy that provides details about assessment of water quality body ,the equation is:

WQI=K ∑_(i=1)^n(Wi Qi)/ Wi ………(1)

Qi= × 100 ....(2)

Where:

Qi: The sub-index of the ith parameter

Mi: The observed value of parameter

Ii: The ideal value

Si: The standard value of the ith parameter

Wi = k ....(3)

si

Where:

Wi: The unit weightage of the ith parameter

Si: The standard value of the ith parameter

K: The constant of proportionality

The pH ideal value is (7), the dissolved O2 value is (14.6 mg/l), and for the else parameters, it is equal to zero [J. K. Tripathy and K. C. Sahu, 2005] [14],[R. M. Chowdhury, S. Y. Muntasir, and M. M. Hossain, 2012][15]

5. Results And Discussions

5.1 Water Quality Parameter Changes of AL-Musayyib River

5.1.1Average of PH between sampling three sites

The average PH at each site was measured as shown in figure (1), PH values were ranged between (6.75 – 6.86) mg/L in wet weather, while PH values were ranged between (6.82 - 6.93) mg/L in dry weather. The highest value recorded in the site R 2, during dry weather, was 6.96, and the reason for the increase in this value is the increase in the rate of photosynthesis of algae and plankton, which consume carbon dioxide, which in turn increases the pH [16]. While the lowest pH value was recorded in the site R2, it was 6.75 during wet weather, and the reason for this decrease is the decrease in the photosynthesis process [17].

The PH results conformed to the standard specifications for Iraqi drinking water for the year (2009) and ranged within (6.5 - 8.5) and for the year (2008) WHO, its values ranged within (6.5 - 9), in the three stations, during the wet and dry weather.

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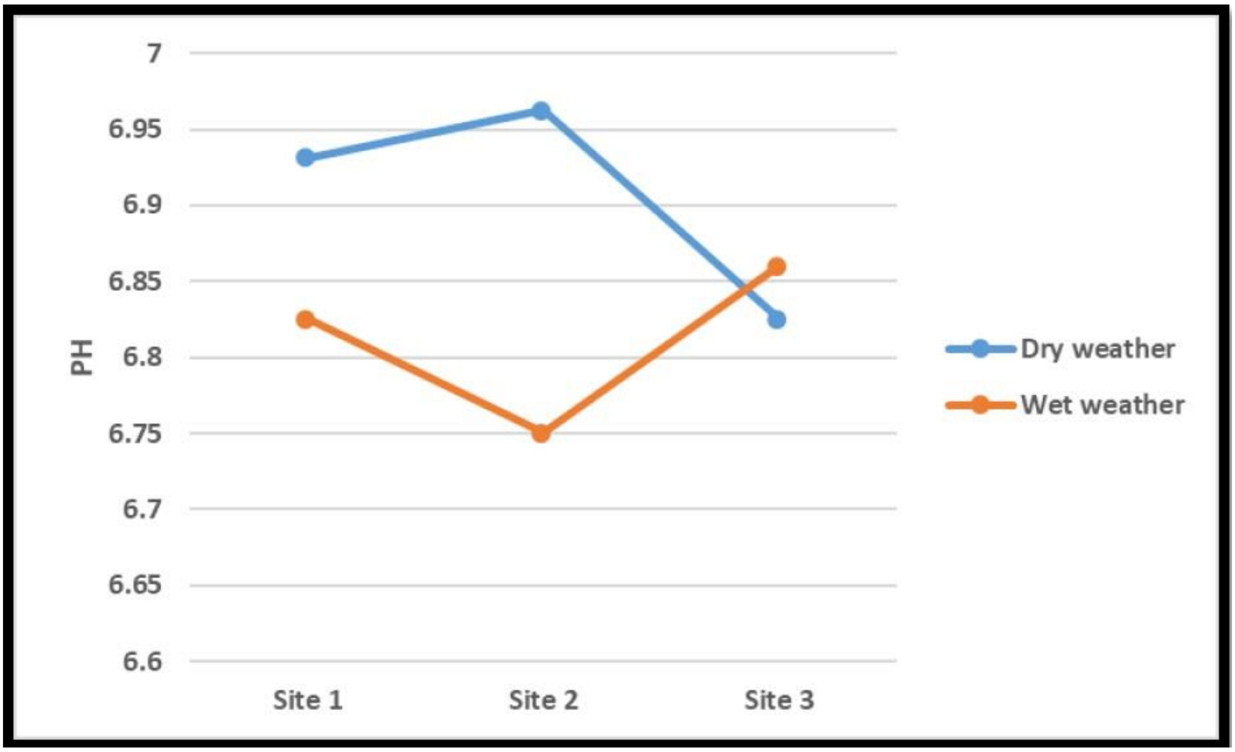

Figure (1) Variation of PH at sampling three sites during dry and wet weather period

5.1.2 Average of dissolved oxygen between sampling three sites:

The average dissolved oxygen at each site is measured as shown in Figure (2). DO values were ranged between (7.60 – 7.62) mg/L in wet weather while the values were ranged between (6.95 – 7.05) mg/L in dry weather. The highest value of dissolved oxygen was recorded during wet weather (7.62) in the site R3, and the reason for this is due to serious ventilation, continuous mixing, and high water level [18], while the lowest value was recorded during the dry weather (6.95) in the site R2. This is due to the gradual rise in temperature and the oxidation of organic matter by microorganisms, as well as due to the decrease in the water level in the river .

The results of the research showed a significant increase in the value of dissolved oxygen during dry and wet weather, as it exceeded the permissible limit of (0-0.5) mg/liter in clean drinking water according to the global standards WHO (2011).

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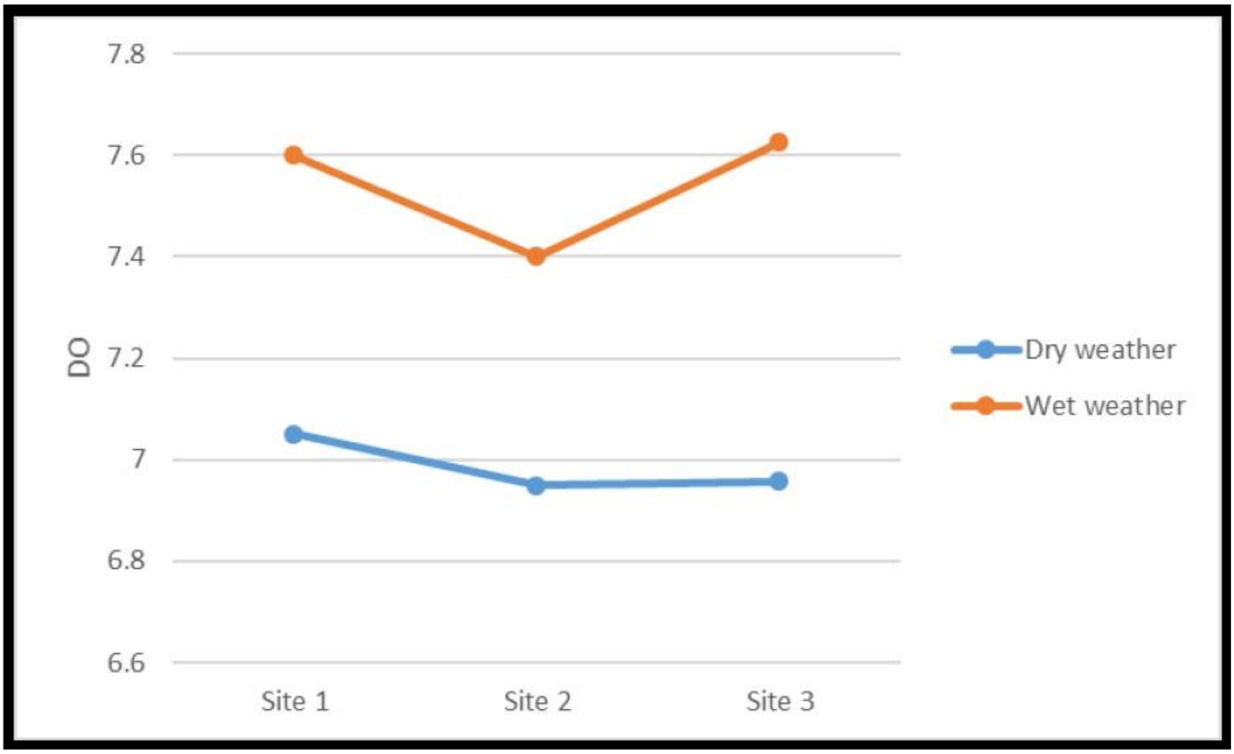

Figure (2): Variation of DO at sampling three sites during dry and wet weather period

5.1.3Average of phosphate between sampling three sites

The average phosphate at each site is measured as shown in Figure (3). Phosphate values were ranged between (0.242 – 0.248) mg/L in wet weather while the values were ranged between (0.236 – 0.251) mg/L in dry weather. The highest value of phosphate was recorded during dry weather (0.251) in site R1, And the reason for the increase is due to the disposal of household sewage waste, as well as to some types of phosphate fertilizers that increase the concentration of the amount of phosphorous due to what it carries in its composition [19]. While the lowest value of phosphate during dry weather was (0.236), the reason for the decrease in phosphate concentrations in the water is due to the high water hardness. Which makes the dissolved phosphates compounds of little ready, to be used by phytoplankton [20].

The results of the research showed a significant increase in the value of DO during dry and wet weather, as it exceeded the permissible limit of (0-0.5) mg/liter in clean drinking water according to the global standards WHO (2011).

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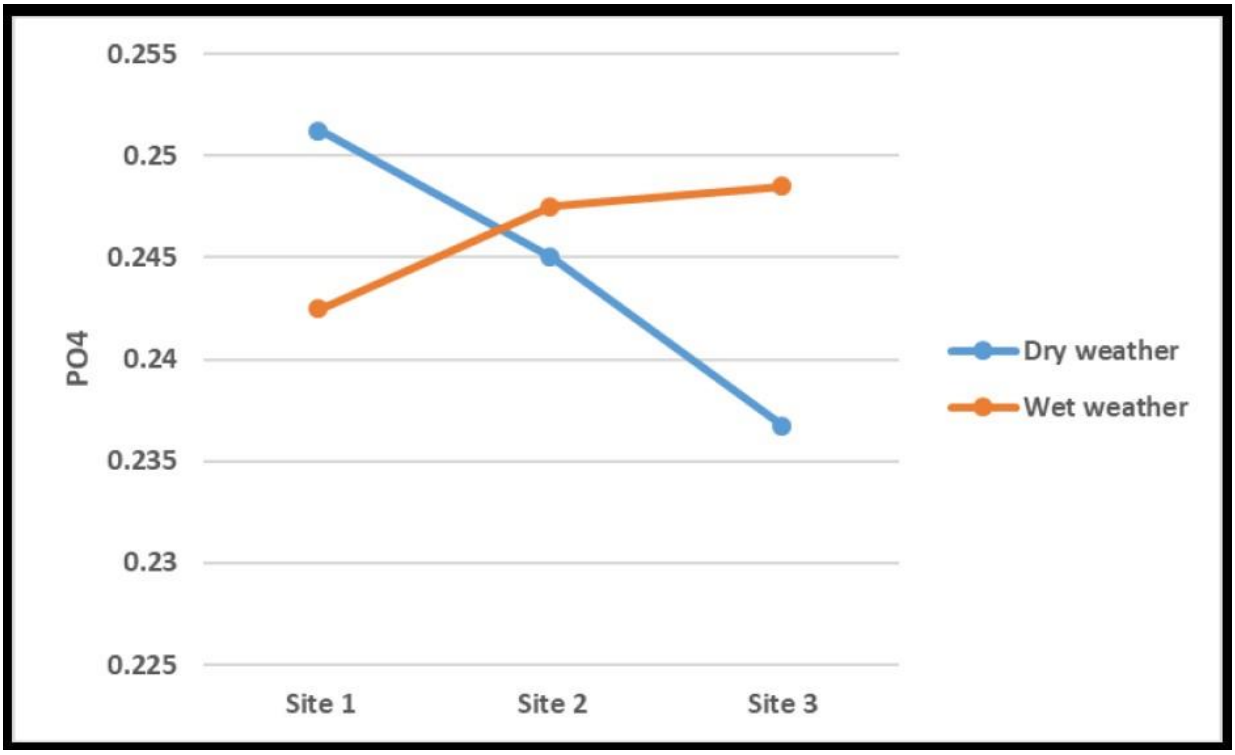

Figure (3): Variation of PO4 during dry and wet weather period

5.1.4Average of nitrates between sampling three sites:

The average nitrates at each site are measured as shown in Figure (4). Nitrates values were ranged between (3.86–4.32) mg/L in wet weather while the values were ranged between (4.25–4.33) mg/L in dry weather. The highest value of nitrates was recorded during wet weather (0.251) in site R1, The reason for the high level of nitrates in the water of the river is due to its passage in agricultural lands where the compound fertilizers containing nitrates and pesticides are used, which descends into the waters of the river[21]. The reason for the rise and fall of nitrates in drinking water is that it depends on cleaning the sedimentation basins from algae from time to time. The results of the research showed that all nitrate values were lower than the Iraqi drinking water specifications (2009), which they set at a rate of 50 mg/liter.

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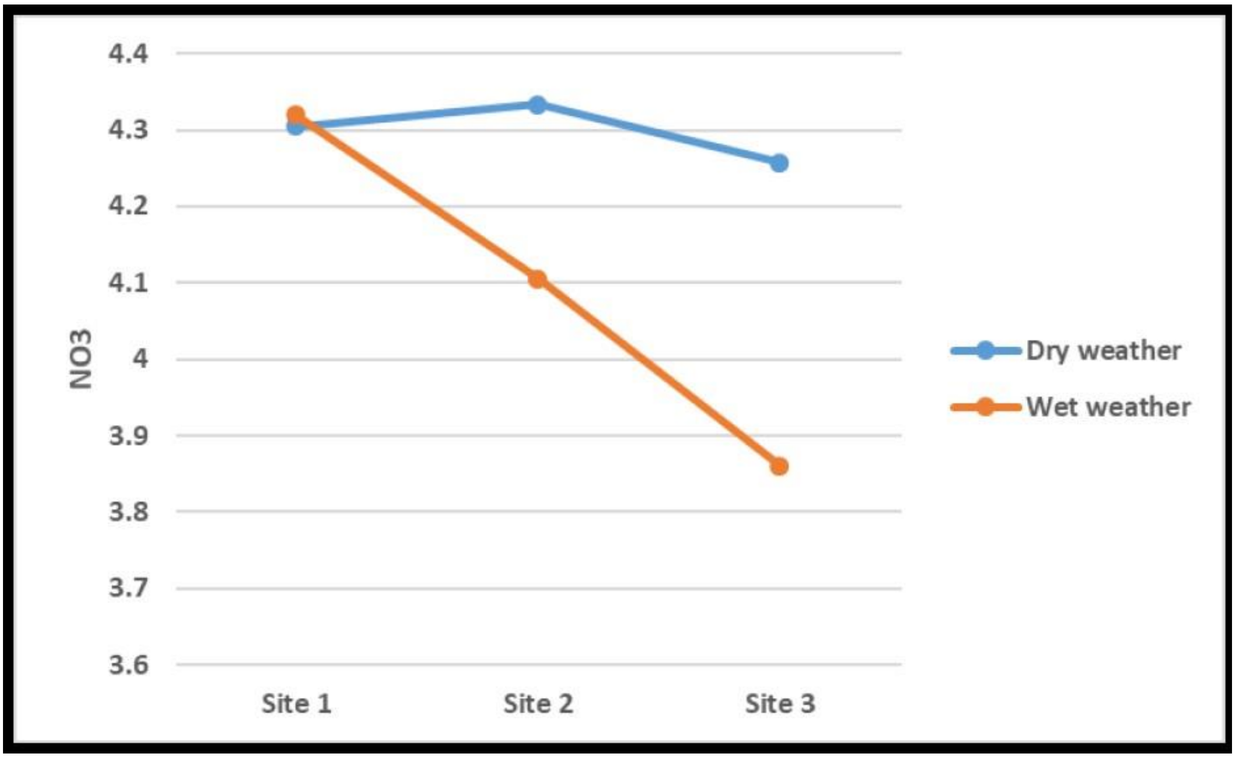

Figure (4): Variation of NO3 during dry and wet weather period

5.1.5Average of calcium between sampling three sites

The average calcium at each site is measured as shown in Figure (5). Calcium values were ranged between (84.32–90.80) mg/L in wet weather while the values were ranged between (104.88–106.91) mg/L in dry weather. The highest value of phosphate was recorded during dry weather (106.91) in site R1, The reason is the precipitation process of calcium with phosphate in the form of (calcium phosphate), When adding alum to the sedimentation basins in study stations, In addition to the project's production capacity and local water consumption [22]. Calcium concentrations may often decrease or rise, Calcium concentrations can be decreased or increased sometimes or Not affected when filtering, or as a result of the lack of cleanliness of sedimentation and filtration basins.

The results of the study showed that calcium concentrations are within the Iraqi specifications for the year (2009) for the normal drinking water allowed (150) mg/L.

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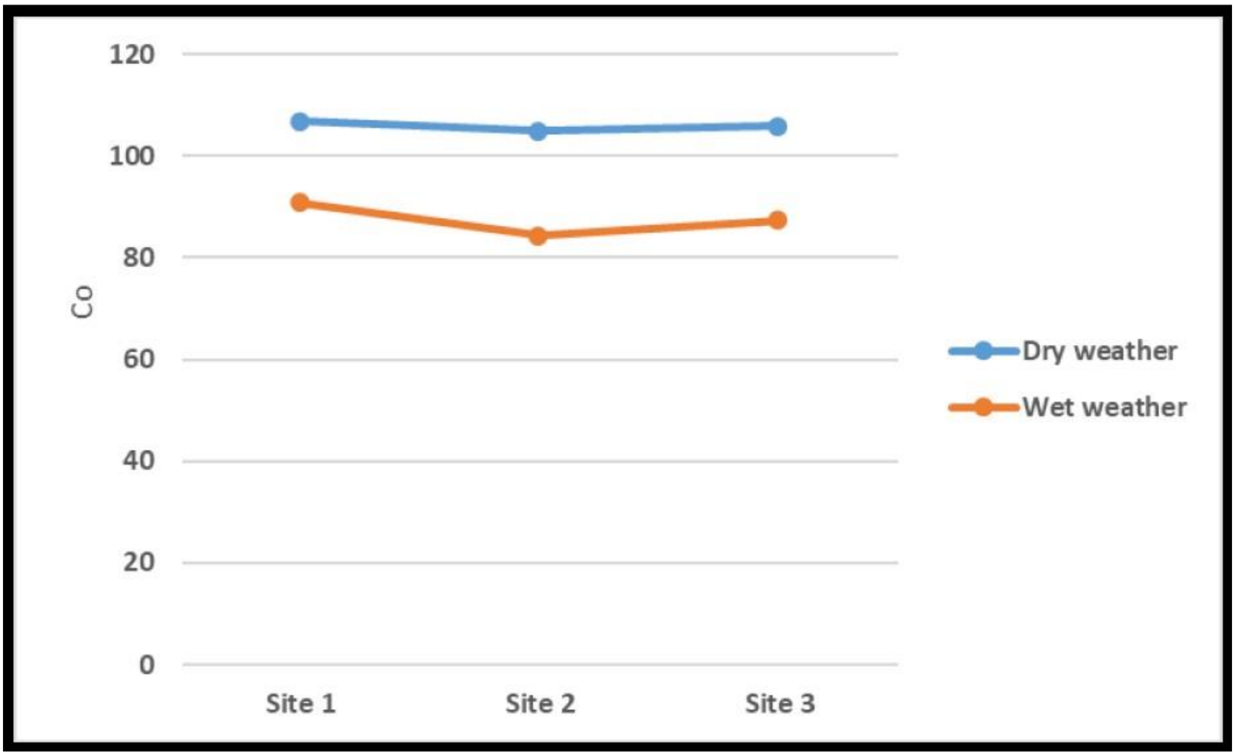

Figure (5): Variation of Co during dry and wet weather period

5.1.6 Average of magnesium between sampling three sites

The average magnesium at each site is measured as shown in Figure (6). Magnesium values were ranged between (33.12–34.95) mg/L in wet weather while the values were ranged between (33.27–33.81) mg/L in dry weather. The highest value of magnesium was recorded during wet weather (34.95) in site R3, The reason for this is the low discharge that leads to a high concentration of magnesium, and the magnesium concentrations can decrease or rise when cleaning or the sedimentation and filtration basins are not clean.

The results of the study showed that the concentrations of magnesium are within the Iraqi (2009) permissible normal specifications (100) mg/liter.

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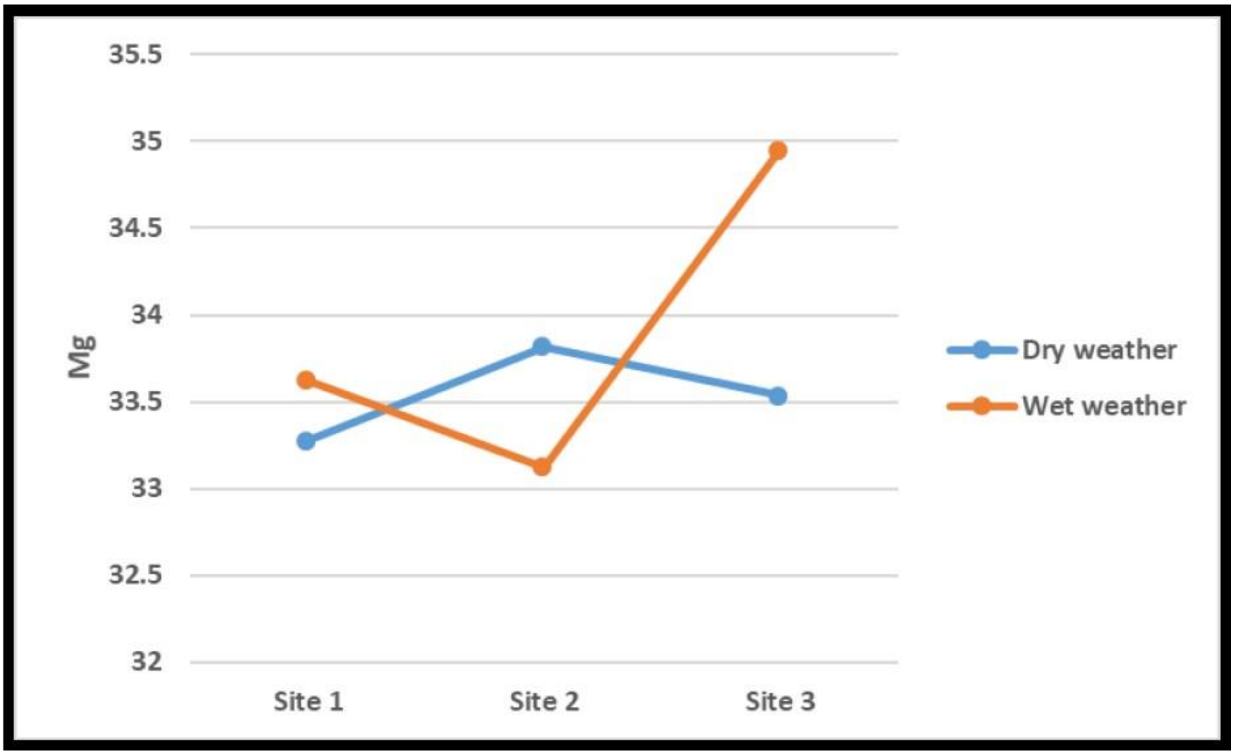

Figure (6) Variation of Mg during dry and wet weather period

5.1.7 Average of total hardness between sampling three sites

The average total hardness at each site is measured as shown in Figure (7). Total hardness values were ranged between (334.42–357.47) mg/L in wet weather, while the values were ranged between (371.45–379.52) mg/L in dry weather. The highest value of total hardness was recorded during dry weather (379.52) in site R2, The reason for the increase in total hardness is due to the erosion of the soil into the river, as well as from industrial, human, and agricultural waste.

The values of the total hardness can sometimes be higher or lower in the raw water in the sedimentation basins, and the reason for this is the high amount of salts in the sedimentation basins.

The results of the study showed that the drinking water in the three stations, during the dry and wet seasons, conforms to the Iraqi standard specifications for the year (2009), which recorded 500 mg/liter and conforms to the specifications of the World Health Organization (2008).

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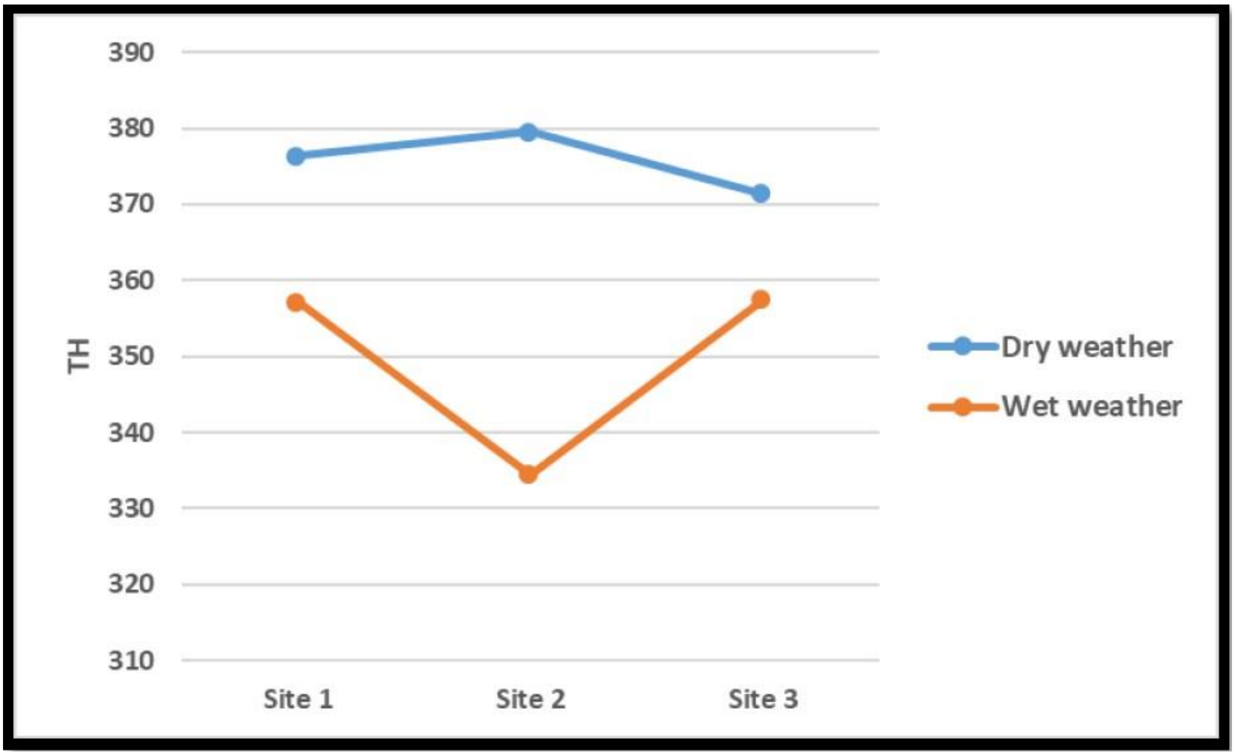

Figure (7) Variation of TH during dry and wet weather period

5.1.8 Average of potassium between sampling three sites 05

The average potassium at each site is measured as shown in Figure (8). Potassium values were ranged between (3.60–4.05) mg/L in wet weather, while the values were ranged between (3.67–4.10) mg/L in dry weather. The highest value of potassium was recorded during dry weather (4.10) in site R3, The reason for the increase is because potassium enters as an essential component in the manufacture of chemical fertilizers and thus enters the river through the drains.

The decrease in potassium is due to the high temperatures that lead to an increase in the dissolution of salts and an increase in the consumption of salts and minerals by aquatic organisms, especially algae .

The presence of high values of potassium with permanent hardness poses a threat to the general health of the population, where many cases of vascular diseases and atherosclerosis were recorded, as well as kidney disease and skin rashes, In concentrations that ranged between (30-100) mg /L [23]

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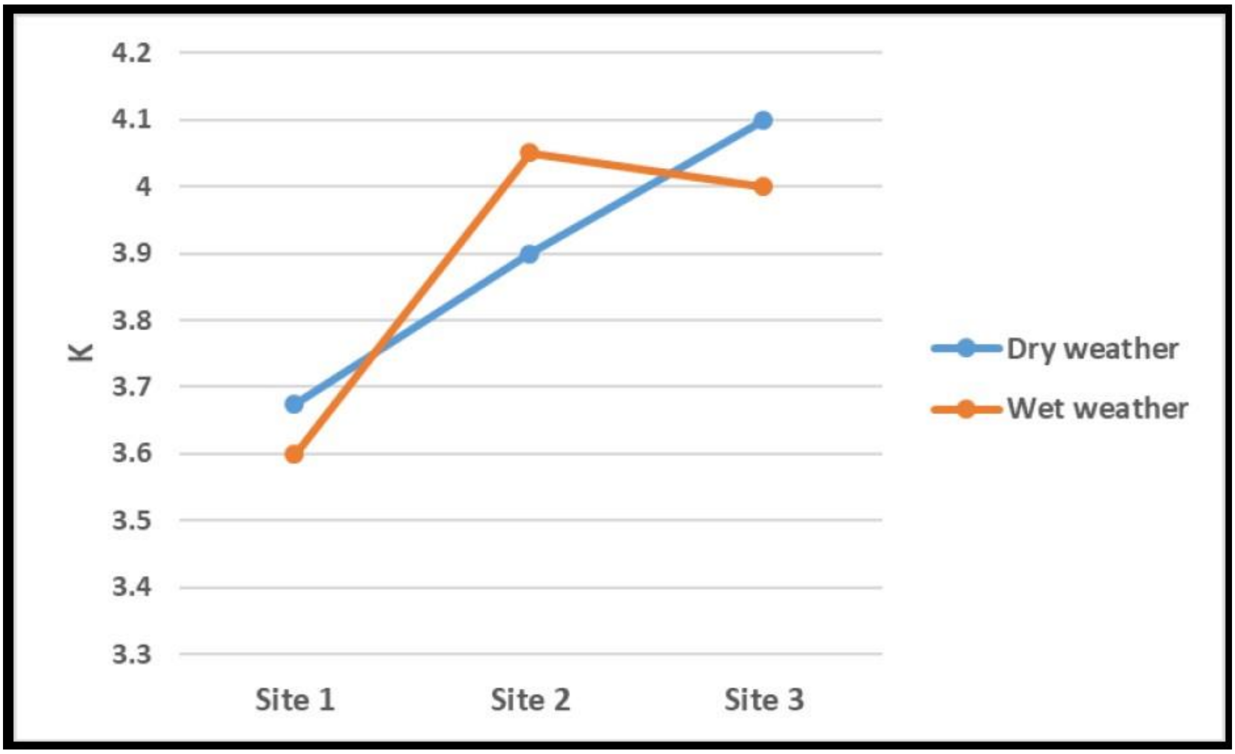

Figure (8): Variation of K during dry and wet weather period

5.1.9Average of sodium between sampling three sites 05

The average sodium at each site is measured as shown in Figure (9). Sodium values were ranged between (63.02–68.55) mg/L in wet weather, while the values were ranged between (58.56–59.31) mg/L in dry weather, the highest value of sodium concentration recorded during wet weather in Site R3 is (68.55) And the reason is due to the processes of washing salts from the soil and geological formations as a result of rainwater and irrigation water [24].

The results of the study showed that the concentration of sodium in the three stations during dry and humid weather is outside the limits of Iraqi specifications.

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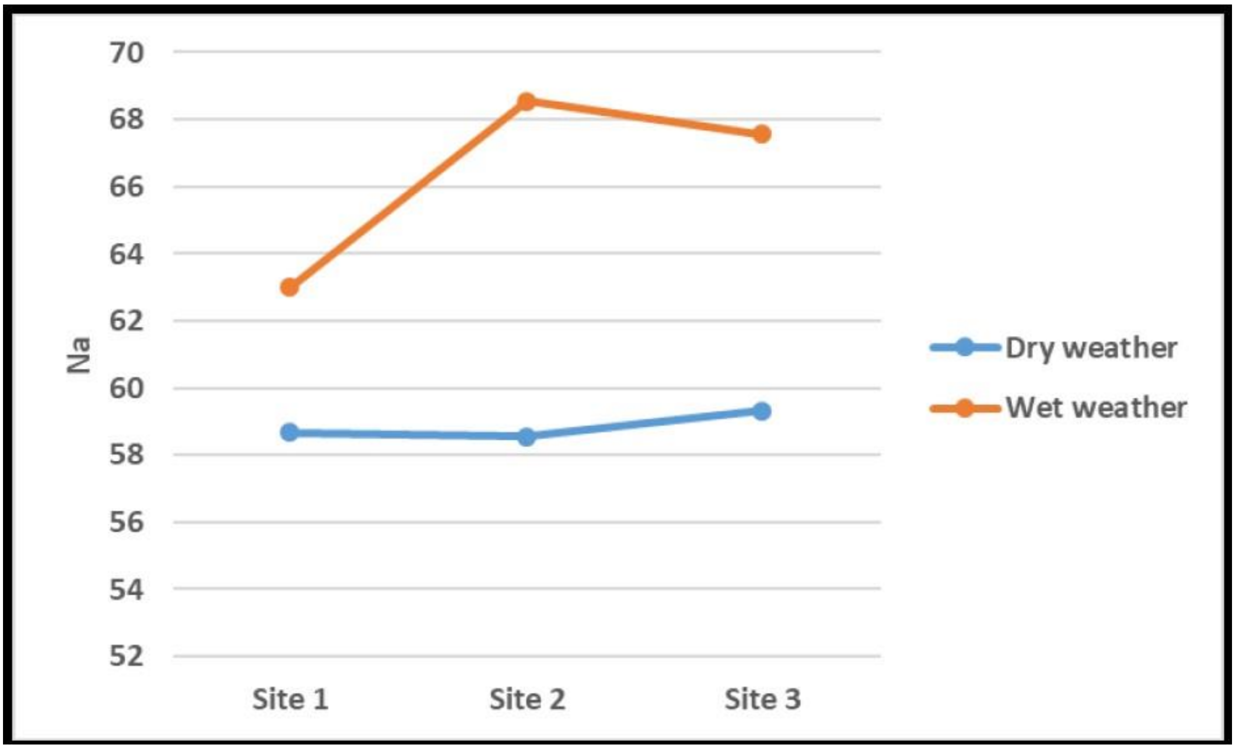

Figure (9): Variation of Na during dry and wet weather period

5.1.10Average of sulfate between sampling three sites

The average sulfate at each site is measured as shown in Figure (10) Sulfate values were ranged between (327.55–333.60) mg/L in wet weather, while the values were ranged between (334.23–356.10) mg/L in dry weather, the highest value of sulfate concentration recorded during wet weather in Site R2 is (356.10) mg/L, The reason for the rise of sulfates is due to the gypsum nature of sedimentary rocks Which is a major source of dissolved sulfate in water[25].The reason is also due to the use of chemical fertilizers, especially in the agricultural season [21].The other reason for the rise of sulfates in the sedimentation basins is the lack of cleanliness in the sedimentation basins.

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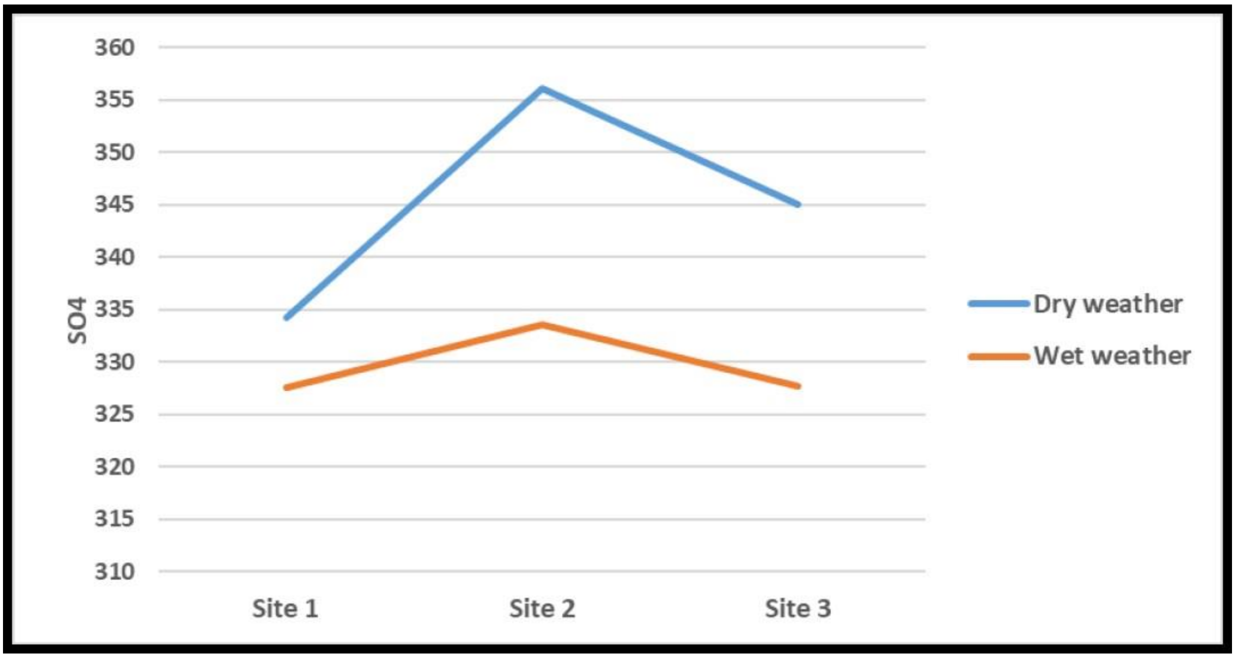

Figure (10): Variation of SO4 during dry and wet weather period

5.1.11 Average of total dissolved solids between sampling three sites

The average total dissolved solids at each site are measured as shown in figure (11). The total dissolved solids values were ranged between (611.42–620.40) mg/L in wet weather, while the values were ranged between (612.42–613.32) mg/L in dry weather, the highest value of total dissolved solids concentration recorded during wet weather in Site R3 is (620.40) mg/L, the reason for the increase in the concentrations of total dissolved solids in the water is the natural hydrological processes, untreated sewage water, industrial waste, and irrigation water. Increasing the total dissolved solids in the water above the permissible level leads to an increase in algae that increases the percentage of dissolved oxygen produced in the water.

Thus, this leads to an increase in the lifespan of microorganisms [26].The results of the study showed that the water in the three stations, during dry and wet weather, is within the Iraqi standards (2009) and the organization (WHO, 2008), which allows a concentration of 1000 mg/liter of TDS.

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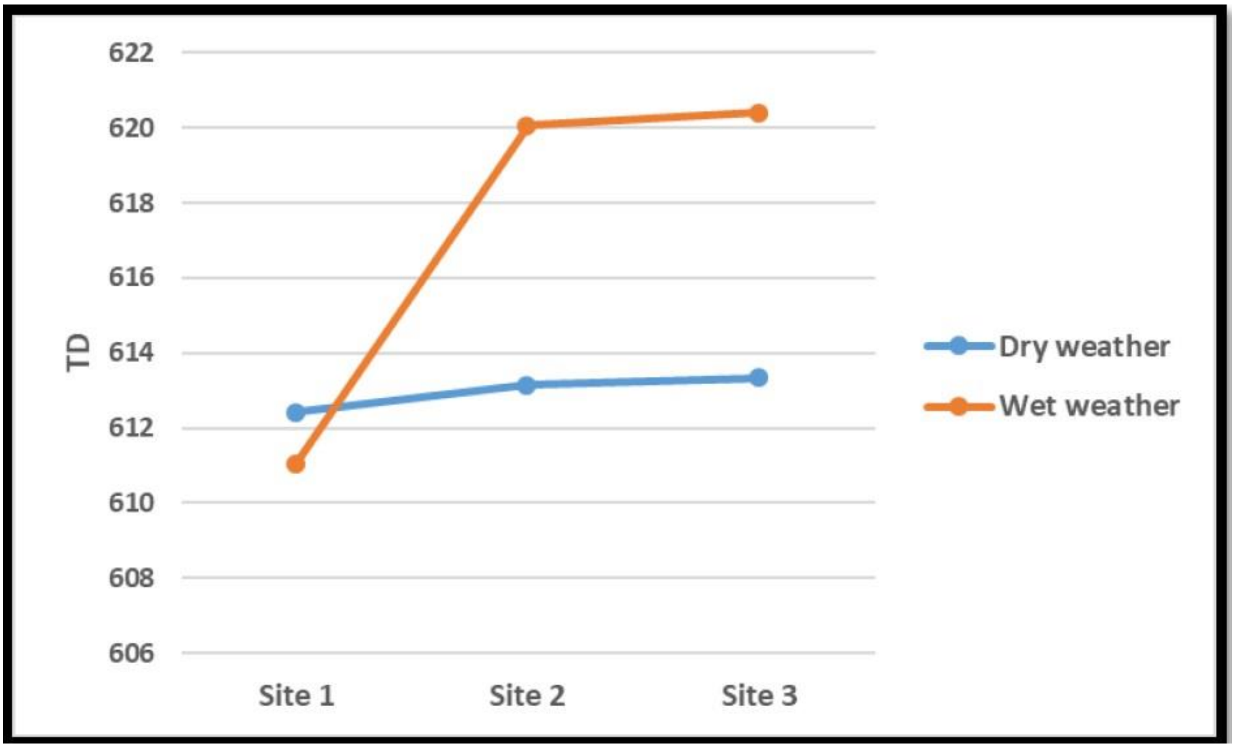

Figure (11): Variation of TDS during dry and wet weather period

5.1.12 Average of electric conductivity between sampling three sites

The average electric conductivity at each site is measured as shown in figure (12). The electric conductivity values were ranged between (939.75–943.25) Micro Siemens/cm in wet weather, while the values were ranged between (955.73–964.12) Micro Siemens/cm in dry weather, the highest value of electric conductivity concentration recorded during wet weather in Site R2 is (964.12) Micro Siemens/cm, the process of electrical conductivity in water is related to the rise and fall of salinity values through the precipitation of calcium carbonate and the rise and fall of temperatures.

The study showed that all electrical conductivity values for the water of the three stations during dry and wet weather are outside the permissible limits according to the international standard specifications (WHO, 2008). The electrical conductivity value was set at 250 Siemensmicro/cm in potable water.

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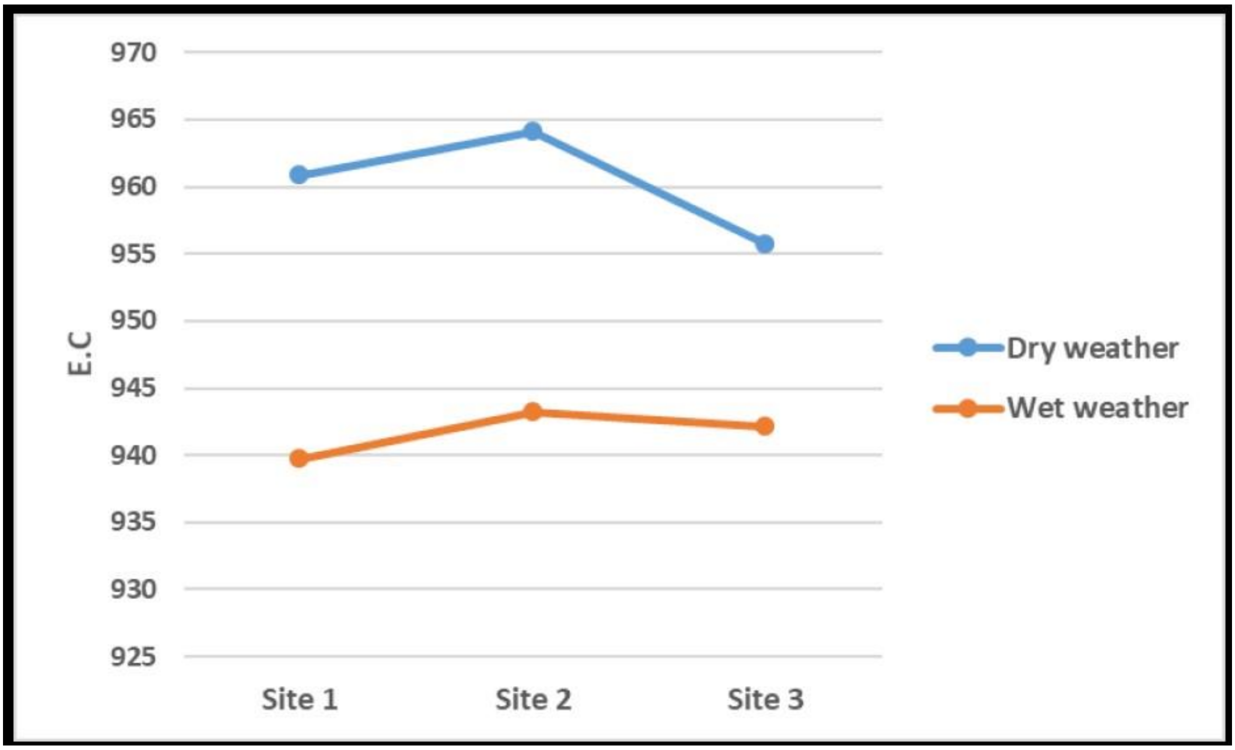

Figure (12): Variation of E.C during dry and wet weather period

5.1.13Average of turbidity between sampling three sites

The average turbidity at each site is measured as shown in figure (13). The turbidity values were ranged between (3.40–3.65) NTU in wet weather, while the values were ranged between (4.20–5.01) NTU in dry weather, the highest value of turbidity concentration recorded during wet weather in Site R3 is (5.01) NTU The reason for the increase in turbidity in the stations is due to the amount of alum that is added to the water, the method of operating the water stations and the age of the project, which have a significant impact on increasing the turbidity values. The study showed that all turbidity values in the three stations and during dry and humid weather fall within the Iraqi specifications for the year (2009) for drinking water, which was set at (50 NTU) and the parameters of the World Health Organization and was set at (0-50) NTU.

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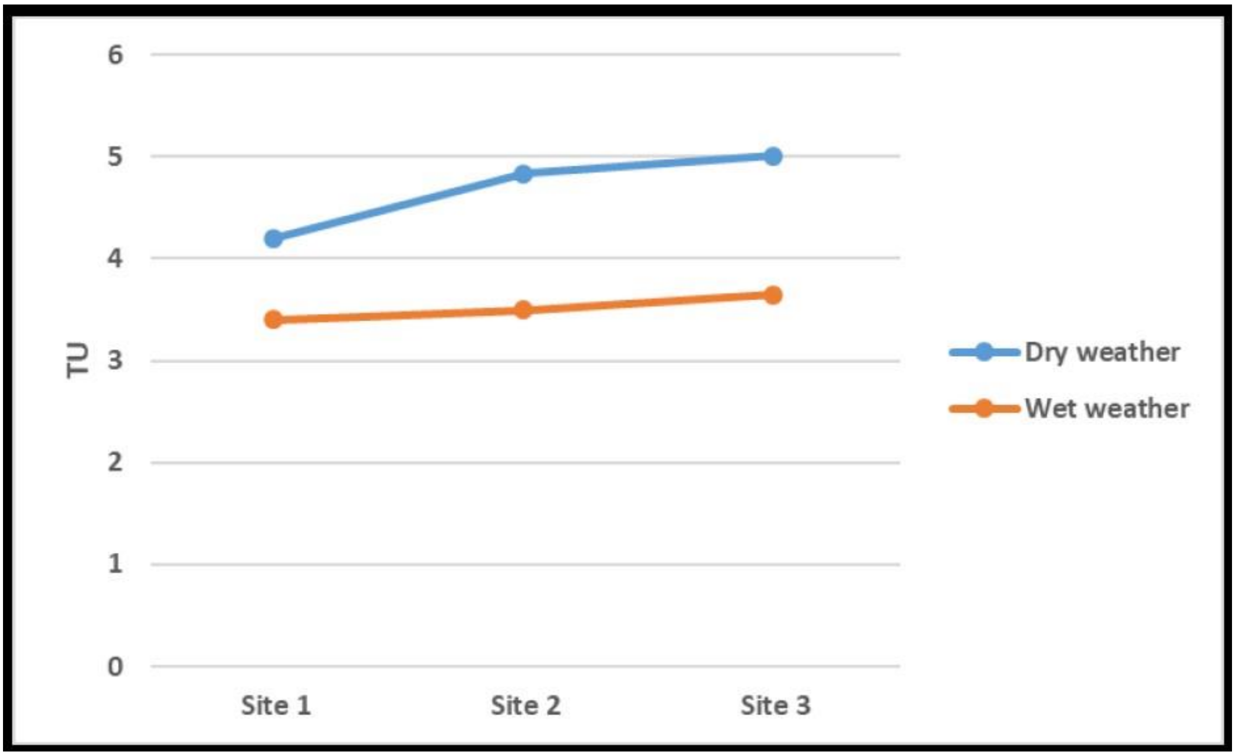

Figure (13) Variation of TU during dry and wet weather period

5.2 Water quality index

Quality of water in Al-Musayyib River measured to determine river water quality. On the basis of the 13 measured parameters of water quality (pH, DO, EC,…) and the other parameters, we calculated the WQI over periods of sampling. Mean WQI values was 62.174, 61.564, and 61.528 in all stations during the dry season, respectively, and that means the WQ of the river of Al-Musayyib being 'poor' . While, the WQI was 59.959, 61.858 and 61.070 in the stations during the wet season, respectively, and that means the WQ of this river being also 'poor'.

6. Conclusions:

The study was carried out in Euphrates/Al-Musayyib River. Water samples were collected for testing the physical, chemical once every month from Euphrates/Al-Musayyib River. The analysis was done for six months (July 2020 to Decembers 2020) from three sites during the dry and wet seasons. These samples have been chosen from three stations to help in understanding the variability of water quality due to seasonal differences. Wet and dry weather have been analyzed to better determine the river pollution rates. Thirteen parameters with their limits were considered in the present work according to the standard specifications, collected and analyzed from physical and chemical parameters (pH, DO, EC, TDS, NO3, PO4, SO4, Mg, Na, Ca, K, TH, and TUR) were chosen parameter using water quality indices (WQI).

7. Recommendations:

1. Developing management strategies and policies, like the strict water and sanitation legislation for the industries that discharge their water in Al-Musayyib River in order to enhance the resources of water.

2. Monitoring the load of sediment gathered in Al-Musayyib River for a long

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period for determining the daily, monthly and annual variations in the yield of sediment.

3. For a good water quality, it is necessary to control the chemical and physical parameter contents, especially the Calcium (Ca) in Al-Musayyib River by testing more samples that should be taken during the different months of year.

4. Using other methods to obtain the water quality index (QWI) of Al-Musayyib River which are not utilized in the present study, such as Harkins' water quality index, Simple deletion/substitution methods, Parametric methods, Nonparametric methods, etc.

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