Application of Water Quality Index to Assessment of Tigris River

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ABSTRACT

This study aimed at using the application of Water Quality Index (WQI) in evaluating the quality of Tigris River in Misan province, Iraq for public usage. Fourteen water quality parameters were considered (pH, Electrical conductivity, Total dissolved solids, Total hardness, Total alkalinity, Turbidity, Calcium, Magnesium, Sodium, Potassium, Chloride, Nitrate, Sulphate, Phosphate). WQI values ranged from 93.78 and 264.29 for winter and summer season respectively, and its ranged for all sites between 65.581 to 160.461 and 173.589 to 446.478 for both season respectively. The high value of WQI had been found mainly from the higher values of pH, total hardness, total alkalinity, turbidity, potassium, nitrate and phosphate. The analysis reveals that the WQI of Tigris river its poor and unsuitable for human consumption and other purposes, and its need some treatments before consumption and its also needs to be protect from pollution.

Keywords: Water Quality Index, Tigris River.

Article Info

Accepted: 14 September 2016
Available Online: 10 October 2016

Introduction

Water is the most essential and prime necessity of life. It is an essential requirement for the life supporting activities. Surface water generally available in rivers, lakes, ponds and dams is used for drinking, irrigation and power supply etc. Tigris river consider the main source of surface water in Misan province. Water is polluted artificially by naturally or human activities. In newly reclaimed lands, agricultural and industrial activities may create different sources of pollution (Barbooti et al., 2010).

In Iraq, the municipalities are responsible for the production and delivery of drinking water, because of the war operations in this country, these led to an increase in environmental problems, including water contamination (Euphrates and Tigris), air pollution and ecosystem degradation (Hassan et al., 2010).

The availability of water in Iraq shows a great deal with spatial and temporal variability. The increase in population and expansion of economic activities undoubtedly leads to increasing demand of water use for various purposes. Water resources in Iraq, especially in the last two decades have also suffered of remarkable stress in terms of water quantity due to different reasons such as the dams built on Tigris and Euphrates in the riparian countries, the global climatic changes and
the local severe decrease of the annual precipitation rates and improper planning of water uses inside Iraq (Rahi and Halihan, 2010).

Water Quality Index (WQI) is a very useful and efficient method for assessing the suitability of water quality. It is also a very useful tool for communicating the information on overall quality of water (Asadi et al., 2007; Buchanan and Triantafilis, 2009). WQI may be defined as ‘a rating that reveals the composite influence of a number of water quality parameters on the overall water quality’ (Shankar and Sanjeev, 2008).

WQI reflects the composite influence of different water quality parameters and is calculated from the point of view of the suitability of (both surface and groundwater) for human consumption.

It is the aim of the present study to make a comprehensive evaluation of the physicochemical parameters of the drinking water supplied to the homes in Amara city from the many water sites along the Tigris river in Misan Province.

**Materials and Methods**

In this study, ten sites were selected along the Tigris River (Ali El-Gharbi, Kumait, Amara dam, Alwiha, Al-Misharh, Al-Kahla’a, Qalat Saleh, Al- Azir, Al-Majar and Al-Maymonah) Figure 1. Water samples were collected from the surface water during the months of November 2014 to August 2015. These samples were analyzed for 14 physicochemical parameters by following the established procedures. The parameters pH, electrical conductivity were monitored at the sampling site and other parameters like total dissolved solids, total alkalinity, total hardness, turbidity, calcium, magnesium, sodium, potassium, chloride, nitrate, Sulphate and phosphate were analyzed in the laboratory as per the standard procedures of APHA (1995).

### Calculation of WQI

The Water Quality Index (WQI) was calculated using the standards of drinking water quality recommended by the World Health Organization (WHO, 2006). The weighted arithmetic index method (Brown et al., 1970) was used for the calculation of WQI of the surface water. The quality rating scale for each parameter qn was calculated by using the following expression.

\[
qn = \frac{100 (Vn - Vio)}{Sn - Vn} \text{........}(1)
\]

(Let there be n water quality parameters and quality rating or sub index (qn) corresponding to nth parameter is a number reflecting the relative value of this parameter in the polluted water with respect to its standard, maximum permissible value).

\[
qn = \text{Quality rating for the nth water quality parameter}
\]

\[
Vn = \text{Estimated value of the nth parameter at a given sampling point.}
\]

\[
Sn = \text{Standard permissible value of the nth parameter.}
\]

\[
Vio = \text{Ideal value of nth parameter in pure water (i.e. 0 for all other parameters except the parameter pH and Dissolved Oxygen (7.0 and 14.6 mg/l respectively).}
\]

Unit weight was calculated by a value inversely proportional to the recommended standard value Sn of the corresponding parameter.

\[
Wn = \frac{K}{Sn} \text{........}(2)
\]
Wn = unit weight for the nth parameters.
Sn = standard value for the nth parameters.
K = constant for proportionality.

The overall WQI was calculated by aggregating the quality rating with the unit weight linearly and then compared with the WQI categories (Table 1).

\[ WQI = \sum qn Wn / \sum Wn \]

During the study period showed that the mean of pH values were ranged from 7.53 in winter season (Table 2) to 7.69 in summer season (Table 3), these values of pH within allowable limits for surface water (WHO, 2006). pH is an important parameter which determines the suitability of water for various purposes (Yogendra and Puttaiah, 2008).

Mean values of EC, Total hardness, TDS and Total alkalinity ranged from 2053.10 – 2352.64 dS/m, 618.00 – 642.93 mg CaCO3/L, 1275.90 – 1348.46 mg/L and 194.50 – 220.60 mg/L respectively, these values increased in winter season and decreased in summer season, the high values of EC, TDS, T.H and T.A parameters in winter season may be attributed to the high precipitation in this season which due to dissolution and leaching the salts from soil to the Tigris river (Al-Sabah et al., 2011). All mean values of these parameters were above the permissible limits (WHO, 2006), and the high concentration especially total dissolved solids in the surface water is a pointer to the fact that there are intense anthropogenic activities along the river and run off with high suspended matter content (Chapman, 1996).

Values of Turbidity decreased in winter and ranged between 10.64 – 41.70 NTU. Mean concentrations of calcium, magnesium, sodium, chloride, Sulphate and phosphate increased during winter season compared with the summer season (Table 2&3), this may be attributed to the high rain fall in this season which dissolve the salts from soil to the river (Hassan et al., 2010).

High concentrations of some ions such as chloride indicate higher degree of organic pollution (Munawar, 1970). Magnesium in water may be attributed to the chemistry of the geological composition of the river bed-rock. Excess in Mg in drinking water might impair human health and lead to heart and kidney diseases (Ayeni et al., 2011; Ojosipe, 2007).

| Water Quality Index Level | Water Quality Status               |
|---------------------------|-----------------------------------|
| 0 -25                     | Excellent water quality           |
| 26 – 50                   | Good water quality                |
| 51 - 75                   | Poor water quality                |
| 76 – 100                  | Very poor water quality           |
| > 100                     | Unsuitable for drinking           |
Table 2: Physicochemical parameter values for all sampling sites of Tigris river (winter season)

| No. of site | Sites             | pH   | EC μS/cm | TDS mg/l | T.H mg/l | T.A mg/l | Turb. NTU | Ca   | Mg   | Na   | K   | Cl   | NO3 | SO4 | PO4 |
|-------------|-------------------|------|----------|----------|----------|----------|-----------|------|------|------|-----|------|-----|-----|-----|
| 1           | Ali El-Gharbi     | 7.55 | 2441.5   | 1355.5   | 675.0    | 225.0    | 6.5       | 167.5| 37.5| 146.0| 4.25| 417.5| 6.86| 425.0| 0.083 |
| 2           | Kumait            | 7.45 | 2331.3   | 1371.6   | 646.5    | 225.0    | 6.4       | 161.0| 39.5| 141.4| 4.35| 390.5| 5.27| 415.0| 0.089 |
| 3           | Amara dam         | 7.80 | 2328.5   | 1329.0   | 636.3    | 234.0    | 8.5       | 150.0| 46.0| 134.0| 3.94| 400.0| 5.35| 424.0| 0.184 |
| 4           | Al-Wihda          | 7.70 | 2384.5   | 1298.0   | 624.0    | 215.0    | 5.5       | 155.0| 43.5| 148.5| 3.80| 364.0| 5.25| 371.5| 0.176 |
| 5           | Al-Misharah       | 7.50 | 2205.0   | 1295.5   | 635.0    | 200.0    | 8.5       | 153.5| 44.5| 130.0| 3.65| 139.4| 5.39| 419.0| 0.105 |
| 6           | Al-Kahla’a        | 7.40 | 2427.0   | 1391.0   | 625.0    | 222.0    | 20.5      | 147.5| 48.0| 139.0| 3.55| 430.5| 5.10| 437.5| 0.101 |
| 7           | Qalat Saleh       | 7.35 | 2285.0   | 1335.5   | 646.0    | 215.0    | 9.0       | 150.0| 42.5| 129.0| 3.40| 424.0| 6.20| 425.0| 0.067 |
| 8           | Al-Azir           | 7.65 | 2393.6   | 1397.5   | 625.0    | 232.5    | 9.5       | 157.5| 39  | 137.5| 4.10| 386.0| 5.27| 416.0| 0.091 |
| 9           | Al-Majar          | 7.60 | 2430.5   | 1346.0   | 660.0    | 232.5    | 9.0       | 164.0| 39.5| 144.5| 4.40| 402.5| 5.52| 395.0| 0.112 |
| 10          | Al-Maymonah       | 7.30 | 2299.5   | 1365.0   | 656.5    | 205.0    | 23.0      | 146.5| 47.5| 129.5| 3.40| 415.0| 5.15| 441.0| 0.128 |
| Min.        |                   | 7.3  | 2205    | 1295.5   | 624      | 200      | 5.5       | 146.5| 37.5| 129   | 3.4 | 364   | 5.10| 371.5| 0.067 |
| Max.        |                   | 7.8  | 2441.5  | 1397.5   | 675      | 234      | 23        | 167.5| 48  | 148.5| 4.4 | 430.5| 6.86| 441   | 0.184 |
| Mean        |                   | 7.53 | 2352.64 | 1348.46  | 642.93   | 220.60   | 10.64     | 155.25| 42.75| 137.94| 3.88| 402.4| 5.64| 416.9| 0.114 |
Table 3 Physiochemical parameter values for all sampling sites of Tigris river (summer season)

| No of site | Sites          | pH  | EC μS/cm | TDS mg/l | T.H mg/l | T.A mg/l | Turb. NTU | Ca    | Mg    | Na    | K     | Cl    | NO₃   | SO₄   | PO₄   |
|------------|----------------|-----|----------|----------|----------|----------|-----------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1          | Ali El-Gharbi  | 7.8 | 2027     | 1066     | 630      | 180      | 68        | 153   | 33    | 135   | 5.2   | 330   | 8.3   | 300   | 0.028 |
| 2          | Kumait        | 7.5 | 2003     | 1278     | 620      | 190      | 75        | 160   | 38    | 145   | 5.3   | 318   | 8.1   | 298   | 0.031 |
| 3          | Amara dam     | 7.7 | 2060     | 1312     | 610      | 200      | 38        | 162   | 33    | 148   | 5.8   | 300   | 6.28  | 258   | 0.045 |
| 4          | Al-Wihda      | 7.8 | 2055     | 1272     | 635      | 200      | 45        | 149   | 28    | 130   | 4.8   | 300   | 6.81  | 278   | 0.051 |
| 5          | Al-Misharah   | 8.1 | 2142     | 1285     | 618      | 185      | 41        | 162   | 38    | 143   | 5.0   | 381   | 7.5   | 345   | 0.037 |
| 6          | Al-Kahla’a    | 8.0 | 2048     | 1332     | 610      | 200      | 25        | 165   | 40    | 142   | 4.6   | 338   | 6.5   | 320   | 0.048 |
| 7          | Qalat Saleh   | 7.6 | 2044     | 1276     | 640      | 200      | 30        | 145   | 30    | 128   | 4.7   | 352   | 5.85  | 285   | 0.061 |
| 8          | Al-Azir       | 7.3 | 2047     | 1310     | 600      | 200      | 28        | 150   | 31    | 127   | 4.5   | 340   | 5.47  | 308   | 0.073 |
| 9          | Al-Majar      | 7.2 | 2072     | 1365     | 600      | 190      | 27        | 147   | 45    | 130   | 4.7   | 348   | 6.8   | 310   | 0.045 |
| 10         | Al-Maymonah   | 7.9 | 2033     | 1263     | 617      | 200      | 40        | 155   | 37    | 139   | 5.2   | 340   | 7.3   | 295   | 0.028 |
| Min.       | Min.          | 7.2 | 2003     | 1066     | 600      | 180      | 25        | 145   | 28    | 127   | 4.5   | 300   | 5.47  | 258   | 0.028 |
| Max.       | Max.          | 8.1 | 2142     | 1365     | 640      | 200      | 75        | 165   | 45    | 148   | 5.8   | 381   | 8.3   | 345   | 0.073 |
| Mean       | Mean          | 7.69| 2.531    | 1275.9   | 618      | 194.5    | 41.7      | 154.8 | 35.3  | 136.7 | 4.98  | 334.7 | 6.89  | 299.4 | 0.045 |
### Table 4: Calculation of Water Quality Index of Tigris River (winter season)

| Parameter   | mean value | Standard permissible value (Si) | Unit weight (Wi) | Quality rating (qi) | Wiqi   |
|-------------|------------|---------------------------------|------------------|---------------------|--------|
| pH          | 7.53       | 8.5                             | 0.117            | 88.58               | 10.36  |
| E.C         | 2352.64    | 1000                            | 0.001            | 235.26              | 0.23   |
| TDS         | 1348.46    | 500                             | 0.002            | 269.69              | 0.54   |
| T.H         | 642.93     | 200                             | 0.005            | 321.46              | 1.60   |
| T.A         | 220.60     | 120                             | 0.009            | 183.83              | 1.65   |
| Turbidity   | 10.64      | 5                               | 0.2              | 212.8               | 42.56  |
| Ca          | 155.25     | 200                             | 0.005            | 77.62               | 0.38   |
| Mg          | 42.75      | 200                             | 0.005            | 21.37               | 0.10   |
| Na          | 137.94     | 250                             | 0.004            | 55.17               | 0.22   |
| K           | 3.88       | 10                              | 0.1              | 38.8                | 3.88   |
| Cl          | 402.4      | 250                             | 0.004            | 160.96              | 0.64   |
| NO₃         | 5.64       | 10                              | 0.1              | 56.4                | 5.64   |
| SO₄         | 416.9      | 200                             | 0.005            | 208.45              | 1.04   |
| PO₄         | 0.114      | 5.5                             | 0.181            | 2.07                | 0.37   |

\[
\text{WQI} = \frac{\sum \text{Wiqi}}{\sum \text{Wi}} = 93.78
\]
\[
\sum \text{Wi} = 0.738
\]
\[
\sum \text{Wiqi} = 69.21
\]

### Parameter Table

| Parameter   | mean value | Standard permissible value (Si) | Unit weight (Wi) | Quality rating (qi) | Wiqi   |
|-------------|------------|---------------------------------|------------------|---------------------|--------|
| pH          | 7.53       | 8.5                             | 0.117            | 88.58               | 10.36  |
| E.C         | 2352.64    | 1000                            | 0.001            | 235.26              | 0.23   |
| TDS         | 1348.46    | 500                             | 0.002            | 269.69              | 0.54   |
| T.H         | 642.93     | 200                             | 0.005            | 321.46              | 1.60   |
| T.A         | 220.60     | 120                             | 0.009            | 183.83              | 1.65   |
| Turbidity   | 10.64      | 5                               | 0.2              | 212.8               | 42.56  |
| Ca          | 155.25     | 200                             | 0.005            | 77.62               | 0.38   |
| Mg          | 42.75      | 200                             | 0.005            | 21.37               | 0.10   |
| Na          | 137.94     | 250                             | 0.004            | 55.17               | 0.22   |
| K           | 3.88       | 10                              | 0.1              | 38.8                | 3.88   |
| Cl          | 402.4      | 250                             | 0.004            | 160.96              | 0.64   |
| NO₃         | 5.64       | 10                              | 0.1              | 56.4                | 5.64   |
| SO₄         | 416.9      | 200                             | 0.005            | 208.45              | 1.04   |
| PO₄         | 0.114      | 5.5                             | 0.181            | 2.07                | 0.37   |

\[
\text{WQI} = \frac{\sum \text{Wiqi}}{\sum \text{Wi}} = 93.78
\]
\[
\sum \text{Wi} = 0.738
\]
\[
\sum \text{Wiqi} = 69.21
\]

All values in mg/l except pH, E.C(µS/cm) and turbidity (NTU)
Table 5 Calculation of Water Quality Index of Tigris River (Summer season)

| parameter | mean value | Standard permissible value (Si) | Unit weight (Wi) | Quality rating (qi) | Wiqi |
|-----------|------------|---------------------------------|------------------|---------------------|------|
| pH        | 7.69       | 8.5                             | 0.117            | 90.47               | 10.58|
| E.C       | 2053.1     | 1000                            | 0.001            | 205.31              | 0.20 |
| TDS       | 1275.9     | 500                             | 0.002            | 255.18              | 0.51 |
| T.H       | 618        | 200                             | 0.005            | 309                 | 1.54 |
| T.A       | 194.5      | 120                             | 0.009            | 162.08              | 1.45 |
| Turbidity | 41.7       | 5                               | 0.2              | 834                 | 166.8|
| Ca        | 154.8      | 200                             | 0.005            | 77.4                | 0.38 |
| Mg        | 35.3       | 200                             | 0.005            | 17.65               | 0.09 |
| Na        | 136.7      | 250                             | 0.004            | 54.68               | 0.22 |
| K         | 4.98       | 10                              | 0.1              | 49.8                | 4.98 |
| Cl        | 334.7      | 250                             | 0.004            | 133.88              | 0.53 |
| NO₃       | 6.89       | 10                              | 0.1              | 68.9                | 6.89 |
| SO₄       | 299.4      | 200                             | 0.005            | 149.7               | 0.74 |
| PO₄       | 0.045      | 5.5                             | 0.181            | 0.82                | 0.14 |

\[
\text{WQI} = \frac{\sum \text{Qi}}{\sum \text{Wi}} = \frac{195.05}{0.738} = 264.29
\]

\[
\Sigma \text{Wi} = 0.738
\]

\[
\Sigma \text{Wiqi} = 195.05
\]

Fig. 1 Mapping of study area with the location of sampling points
| No. of site | pH qiwi | EC qiwi | TDS qiwi | TH qiwi | TA qiwi | Turb. qiwi | Ca qiwi | Mg qiwi | Na qiwi | K qiwi | Cl qiwi | NO3 qiwi | SO4 qiwi | PO4 qiwi | ∑qiwi | WQI |
|------------|---------|---------|----------|---------|---------|------------|--------|--------|--------|-------|--------|---------|---------|---------|-------|-----|
| 1          | 10.392  | 0.2442  | 0.542    | 1.787   | 1.687   | 26.0       | 0.418  | 0.093  | 0.233  | 4.25  | 0.668  | 6.86    | 1.062   | 0.273   | 54.509 | 73.860 |
| 2          | 10.255  | 0.2331  | 0.598    | 1.616   | 1.687   | 25.6       | 0.402  | 0.098  | 0.226  | 4.35  | 0.624  | 5.27    | 1.037   | 0.293   | 52.239 | 70.784 |
| 3          | 10.735  | 0.2329  | 0.532    | 1.591   | 1.755   | 34.0       | 0.375  | 0.115  | 0.214  | 3.94  | 0.640  | 5.35    | 1.060   | 0.605   | 61.145 | 82.852 |
| 4          | 10.599  | 0.2385  | 0.519    | 1.560   | 1.612   | 22.0       | 0.387  | 0.108  | 0.237  | 3.80  | 0.582  | 5.25    | 0.928   | 0.579   | 48.399 | 65.581 |
| 5          | 10.324  | 0.2205  | 0.518    | 1.587   | 1.500   | 34.0       | 0.383  | 0.111  | 0.208  | 3.65  | 0.630  | 5.39    | 1.047   | 0.345   | 59.913 | 81.183 |
| 6          | 10.186  | 0.2427  | 0.556    | 1.562   | 1.665   | 82.0       | 0.368  | 0.120  | 0.222  | 3.55  | 0.688  | 5.10    | 1.093   | 0.332   | 107.684 | 145.913 |
| 7          | 10.117  | 0.2285  | 0.534    | 1.615   | 1.612   | 36.0       | 0.375  | 0.106  | 0.206  | 3.40  | 0.678  | 6.20    | 1.062   | 0.220   | 62.353 | 84.489 |
| 8          | 10.530  | 0.2394  | 0.559    | 1.562   | 1.744   | 38.0       | 0.394  | 0.097  | 0.220  | 4.10  | 0.617  | 5.27    | 1.040   | 0.299   | 64.671 | 87.630 |
| 9          | 10.461  | 0.2431  | 0.538    | 1.650   | 1.744   | 36.0       | 0.410  | 0.098  | 0.231  | 4.40  | 0.644  | 5.52    | 0.987   | 0.368   | 63.294 | 85.764 |
| 10         | 10.048  | 0.2300  | 0.546    | 1.641   | 1.537   | 92.0       | 0.366  | 0.118  | 0.207  | 3.40  | 0.664  | 6.14    | 1.102   | 0.421   | 118.420 | 160.461 |
Table 7 Calculation of sub – indices and WQI for the water samples (summer season)

| No. of site | pHqiwi | ECqiwi | TDSqiwi | THqiwi | TAqiwi | Turb. qiwi | Caqiwi | Mgqiwi | Naqiwi | Kqiwi | Clqiwi | NO3qiwi | SO4qiwi | PO4qiwi | $\sum$qiwi | WQI  |
|------------|--------|--------|---------|--------|--------|------------|--------|--------|--------|--------|--------|---------|---------|---------|----------|------|
| 1          | 10.736 | 0.2027 | 0.426   | 1.575  | 1.350  | 272.0      | 0.382  | 0.082  | 0.216  | 5.2    | 0.528  | 8.30    | 0.750   | 0.092   | 301.839  | 408.996 |
| 2          | 10.323 | 0.2003 | 0.511   | 1.550  | 1.425  | 300.0      | 0.400  | 0.095  | 0.232  | 5.3    | 0.508  | 8.10    | 0.745   | 0.112   | 329.501  | 446.478 |
| 3          | 10.598 | 0.2060 | 0.525   | 1.525  | 1.500  | 152.0      | 0.405  | 0.082  | 0.236  | 5.8    | 0.480  | 6.28    | 0.645   | 0.148   | 180.430  | 244.485 |
| 4          | 10.736 | 0.2055 | 0.509   | 1.587  | 1.500  | 180.0      | 0.372  | 0.070  | 0.208  | 4.8    | 0.480  | 6.81    | 0.695   | 0.167   | 208.139  | 282.031 |
| 5          | 11.149 | 0.2142 | 0.514   | 1.545  | 1.387  | 164.0      | 0.405  | 0.095  | 0.228  | 5.0    | 0.609  | 7.50    | 0.862   | 0.121   | 193.629  | 262.369 |
| 6          | 11.011 | 0.2048 | 0.532   | 1.525  | 1.500  | 100.0      | 0.412  | 0.100  | 0.227  | 4.6    | 0.540  | 6.50    | 0.800   | 0.158   | 128.109  | 173.589 |
| 7          | 10.461 | 0.2044 | 0.510   | 1.600  | 1.500  | 120.0      | 0.362  | 0.075  | 0.204  | 4.7    | 0.563  | 5.85    | 0.712   | 0.200   | 146.941  | 199.107 |
| 8          | 10.048 | 0.2047 | 0.524   | 1.500  | 1.500  | 112.0      | 0.375  | 0.077  | 0.203  | 4.5    | 0.544  | 5.47    | 0.770   | 0.240   | 137.955  | 186.930 |
| 9          | 9.910  | 0.2072 | 0.546   | 1.500  | 1.425  | 108.0      | 0.367  | 0.112  | 0.208  | 4.7    | 0.556  | 6.80    | 0.775   | 0.148   | 135.254  | 183.271 |
| 10         | 10.874 | 0.2033 | 0.505   | 1.542  | 1.500  | 160.0      | 0.387  | 0.092  | 0.222  | 5.2    | 0.544  | 7.30    | 0.737   | 0.092   | 189.198  | 256.365 |
Phosphate might be due to the leaching of agricultural wastes into the river or the use of phosphate additives in detergent formation which leached into water bodies through waste waters generated industrially, domestically or municipally (Olajire and Imeokparia, 2001).

Water quality index of the present water of Tigris river is established from important various physicochemical parameters in different seasons. The water quality index obtained for the river in different seasons of study period, winter and summer season (Table 4&5) were 93.78 and 264.29 in both season respectively, and its ranged for all sites between 65.581 to 160.461 and 173.589 to 446.478 (Table 6&7) for winter and summer season respectively, which indicate the poor quality of water and unsuitable for drinking (Chatterji and Raziuddin, 2002).

Water quality rating study clearly shows that the status of the water of Tigris river is unsuitable for the human uses and other purposes. Furthermore, the water samples were found to be more turbid especially during the summer season. This can be caused by reducing water body, more waste discharge, more urban domestic activities, algal growth and etc (Khwakaram et al., 2012). It is also showed that the pollution load is relatively high during summer season when compared to the winter season.

From Tables 6&7 water quality index of each site was ranged between 65.581 at site 4 to 160.461 at site 10 during winter season, while it is ranged between 173.589 at site 6 to 446.478 at site 2 during summer season. From all sampling sites had WQI greater than 100 except at site 4 (65.581) during winter season, this results can be considered as unsuitable for human consumption (Table 1), these waters must be treatment essential before using it for various purposes mainly drinking purposes (Das et al., 2012). The turbidity of the water samples is mainly responsible for the very high WQI values especially during summer season.

Average values of WQI indicate that water quality for drinking uses can be rated as poor and unsuitable in all study sites during two season, this may reflect the discharge of pollutants to the river from domestic sewers, storm water discharges, industrial wastes discharges, agricultural runoff and other sources (Alobaidy et al., 2010), all of which may be untreated, can have significant effects of both short term and long duration on the quality of a river system (Al-Janabi et al., 2012).

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How to cite this article:
Bashar J.J. AL-Sabah. 2016. Application of Water Quality Index to Assessment of Tigris River. Int.J.Curr.Microbiol.App.Sci. 5(10): 397-407. doi: http://dx.doi.org/10.20546/ijcmas.2016.510.045