Seasonal Variations in the Physico-chemical and Biological Characteristics of Al-Gharraf River within Al-Haay City Southern of Iraq.

Wisam Th. Al-Mayah\textsuperscript{1}, Ali O. Shawardi\textsuperscript{2} and Rasha M. Salman\textsuperscript{2}

\textsuperscript{1}Department of Soil and Water Resources, College of Agriculture, University of Wasit

\textsuperscript{2}Department of Basic Science, College of Dentistry, University of Wasit

\textsuperscript{2}Department of Biology, College of Science, University of Wasit

Abstract

The study reports the seasonal changes in water quality of Al-Gharraf, one of the main tributaries of the Tigris river. Monthly sampling was carried out from December 2015 till November 2016 for a year. The study location situated in the south-eastern sector of Iraq and surrounded by wide and fertile agricultural lands. Three stations were selected to. The former is located at 5 km before entrance of AL-Hayy City as control. The second is situated at distance 5 km away from the former (mid of AL-Hayy City) represented study area and the latter station is located at 15 km apart from the second one (end of AL-Hayy City). collecting samples monthly, two samples were taken each month.

In the present study Fourteen physical and chemical parameters were analyzed based on the importance of these parameters. These Fourteen parameters are ranged as following: air temperature (16 to 32) °C, water temperature (11 to 26) °C, pH (7.05 to 8.35), E.C. (827 to 1558) µS/cm, salinity (0.54 to 0.99) ppt, DO (7.04 to 10.38) mg/L, BOD (0.90 to 7.01) mg/L, turbidity (31.0 to 177.0) NTU, TDS (550.78 to 1108) mg/L, TSS (38 to 636.5) mg/L, T.H (275 to 520) mg/L, Cl\textsuperscript{-} (95.9 to 213.7) mg/L, NO\textsubscript{3} (15.4 to 25.0) mg/L and PO\textsubscript{4} (0.15 to 0.59) mg/L. The results showed that most parameters are exceeding permissible limits for Iraqi standard specifications and WHO standard for drinking.

The study results also showed that the heavy metals concentrations (cadmium and lead) were 0.002-0.089 ppm and 0.031-0.21 ppm respectively. Concentrations of these metals of Al-Gharraf River showed seasonal variations during the study period and they are exceeding permissible limits for Iraqi standard specifications and WHO standard for drinking.

The highest bacterial count was recorded at sit.2 the during winter 2016, 2800 cell /1 ml, whereas the lowest value was found during summer 2016, 320 cell /100ml. whereas numbers of E.coli were (230-1700) cell/10ml.

Key Words: physic – chemical and biological parameters, water quality, Al-Gharraf river.
دراسة التغيرات الفصلية في الخصائص الفيزيائية والكيميائية والبيولوجية لمياه نهر الغراف ضمن مدينة الحي جنوب العراق.

الخلاصة:

درست التغيخات الفرمية في الخصائص الفيزيائية والكيميائية والبيولوجية لمياه نهر الغراف بناءً على تقييم نوعية مياه نهر الغراف بين عام 2015 إلى 2016 لمدة عام. توفرت مياه نهر الغراف في الجزء الجنوبي الشرقي من العراق وتحيط فيه مساحات شاسعة وخصوصة من الأراضي الزراعية. يستثم النهر أغلب مياه الفيضات من العديد من المدن بضمنها مياه الفيضات المحلية والزراعية والصناعية. وارتبطاً بتطور المنطقة فأثر زيادة تسلب الملوثات إلى النهر كانت سبباً للقلق في الفترة الأخيرة.

تم اختيار ثلاثة محطات للمراقبة، تقع المحطة الأولى في مدينة الحي حيث تمثل نقطة الدراسة. أما المحطة الثالثة فتقع في مدينة الحي. تم أخذ العينات شهرياً وبها قواعد الحيوية لكل شهرين.

تراوحت قيم وترابع مؤشرات الماء الشهرية كالالتالي: درجة الحرارة البدائية (6 إلى 23 °C) و ماء (11 إلى 26 °C). و عناصر المياه (31.01 إلى 177.04 جزء من الألف واحد) عبارة عن تراكم البيرنيكنتوري (627 إلى 5080 ملغم/لتر) والمواد الصمغية الغامضة (38 إلى 126.5 ملغم/لتر) وتراكم الأووكسيدات (93.24 إلى 38.13 ملغم/لتر) والمادة الهيدروجينية (26.01 إلى 19.41 ملغم/لتر) والمادة الهيدروجينية (516.70 إلى 67.03 ملغم/لتر) وتراكم سمك الاتجاه (15.64 إلى 20.00 ملغم/لتر) وتراكم السيليكا (275 إلى 50.00 ملغم/لتر) و تراكم الصوديوم (95.69 إلى 216.74 ملغم/لتر) و تراكم النترات (15.64 إلى 20.00 ملغم/لتر). حددت النتائج أن معظم مؤشرات الماء تجاوزت الحدود العلاجية لمياه النهر وأظهرت تراكم مبيدات النباتات في مياه الغراف تغييرات فصلية خلال فترة الدراسة.

وتجاوزت الحدود المسموح بها من قبل الممارسات العلاجية للنهر. أما بالنسبة لدراسة العوامل البيولوجية فقد ظهرت نتائج الأعداد الكلية للبكتريا في المحطة الثانية خلال فصل الشتاء 20.15 حيث بلغت 280 خلية/مل، ونسبة المعدلات في المحطة الأولى خلال فصل الصيف 2016 وكانت 320 خلية/100 مل. بينما تراوحت أعداد البكتريا بين E.Coli بين 200 و 270 خلية/100 مل. 17.000 خلية/100 مل.
Introduction

Rivers have always been the most important fresh water resources, and most developmental activities are still dependent upon them. Rivers play a major role in assimilating or carrying industrial and municipal waste water, manure discharge and runoff which are responsible for water river pollution[1] [2]. The degree of pollution is generally assessed by studying physical and chemical characteristics of the water bodies[3]. Iraqi inland waters witness tremendous impacts through discharges of manufacturers, agricultural and domestic sewage [4] [5]. Quite few studies were performed on Tigris River [6] [7] [8], but no work had considered Al-Gharraf canal in Al-Haay City. The present study has taken in consideration the investigation of abiotic conditions in this vital habitat on monthly basis.

2. Material and Methods

2.1. Study area

Al-Gharraf River is one of two branches of the Tigris River at Kut City, 225 km south of Baghdad City (Fig. 1). After branching from the Tigris, the Garaff flows southeast toward Al-Haay City (study area ) within Wasit Province, 220 km southwest of Baghdad City. The river is 230 km in length with a variable depth of 18 m at its branching point from the Tigris to 10 m at its junction with the Euphrates River at the marsh area near Thi Qar Province.

Figure (1) showing map of sampling location in the study area
2.2. Sampling

Samples for physical and chemical variables were performed from three sites during period extended from the December 2015 till November 2016. Water samples were collected for physiochemical analysis using pre-washed polyethylene bottle by water sample twice before filling.

The studied physic-chemical parameters include water temperature (by using precise mercury thermometer), hydrogen ion concentration (by using pH-meter), electrical conductivity (by using EC-meter), turbidity level (by using turbidity-meter), dissolved oxygen (titrimetric methods), biological oxygen demand (Winkler methods), nitrate, reactive phosphate (by using spectrophotometric methods), total hardness and chloride (by using titrimetric methods), were measured according to APHA[9] [10].

Heavy metals in water samples are measured using flame atomic absorption spectrophotometer (Model Pyeunicam SP9) [9].

Water sample for biological analysis E. Coli used multiple fermentation tubes or most probable number (MPN) technique are commonly used for enumeration of the bacteria [9], while total bacterial count (TBC) was carried out using the pour plate technique according to described by APHA [10].

3. Results

Figure (2) and Table (1), shows seasonal changes in air temperature for the three selected stations. Values ranged between 16ºC in a station-1 during winter (2016) to 38º C in station-3 during summer (2016).

Figure (3) and Table (1), however, indicates seasonal variations in water temperature. The lowest value was 11ºC in station-2 during winter (2016) and the highest 31ºC in station-1 during summer (2016). Figure (4) and Table (1), shows seasonal changes in pH. The lowest (7.05) was encountered in autumn (2015) from station-2 and the highest (8.09) was recorded in winter (2016) from station-1, but values in general were slightly alkaline direction.

Figure (5) and Table (1), Shows seasonal changes in values of Electrical conductivity. The lowest (827 μs/cm) was measured from station-3 in spring (2016) and the highest (1558 μs/cm) was observed in autumn (2015) from station-2.

Figure (6) and Table (1), shows seasonal changes in values of water salinity. The lowest (0.54 ppt) was observed in station-3 during spring (2016) and the highest (0.99 ppt) measured from station-2 in autumn (2015).

Figure (7) and Table (1), Shows seasonal changes in values of Turbidity. The lowest (31.0 NTU) was observed in station-1 in summer (2016) and the highest (177.0 NTU) was observed in winter (2016) from station-2.

Figure (8) and Table (1), Reveals seasonal variations in dissolved oxygen in selected stations Values declined during autumn (2015). The lowest (7.04 mg/L) was in summer (2016) from station-2 and the highest (10.38 mg/L) was, in general, in winter (2016) from station-1.
Figure (9) and Table (1), shows seasonal variations in values of biological oxygen demands (BOD$_5$). The lowest (0.90 mg/L) was recorded in spring (2016) from station-1 and the highest (7.0 mg/L) was in autumn (2015) from station-2.

Figure (10) and Table (1), shows seasonal changes in total dissolved solid. The lowest (550.78 mg/L) was encountered in summer (2016) from station-3 and the highest (1108 mg/L) was recorded in autumn (2015) from station-2.

Figure (11) and Table (2), shows seasonal variations in total suspended solid. The lowest (56 mg/L) was observed in summer (2016) from station-1 and the highest (938 mg/L) was observed in winter (2016) from station-2.

Figure (12) and Table (2), Revealed seasonal variations in values of total hardness in the selected locations. Highest value (520 mg/L) was in autumn (2015) and encountered from station-2. The lowest (275 mg/L), however, was in summer (2016) from station-1.

Figure (13) and Table (2), Shows seasonal changes in values of Chloride. The lowest (95.9 mg/L) was measured from station-1 in spring (2016) and the highest (213.7 mg/L) was observed in autumn (2015) from station-2.

Figure (14) and Table (2), Reveals seasonal variations in Nitrate. The lowest (15.4 mg/L) was in summer (2016) from station-1 and the highest (45.00 mg/L) was observed in autumn (2015) from station-2.

Figure (15) and Table (2), Shows seasonal changes in values of Reactive phosphate. The lowest (0.15 mg/L) was observed in autumn (2015) from station-1 and the highest (0.59 mg/L) was observed in autumn (2015) from station-2.

Figure (16) and Table (2), Reveals seasonal changes in values of Cadmium. The lowest (0.002 ppm) was observed in summer (2016) from station-1 and the highest (0.089 mg/L) was observed in autumn (2015) from station-2.

Figure (17) and Table (2), Shows seasonal changes in values of Lead. The lowest (0.031 ppm) was observed in summer (2016) from station-1 and the highest (0.21 ppm) was observed in autumn (2015) from station-2.

Figure (18) and Table (2), Reveals seasonal variations in Total Bacterial Count. The lowest 320 cell /100ml was in summer (2016) from station-1 and the highest 7800 cell /100ml was observed in winter (2016) from station-2.

Figure (19) and Table (2), Shows seasonal changes in values of E.coli were. The lowest 480 cell/10ml was observed in summer (2016) from station-1 and the highest 5200 cell/10ml was observed in winter (2016) from station-2.
<table>
<thead>
<tr>
<th>Time</th>
<th>Station</th>
<th>Air T. C˚</th>
<th>Water T. C˚</th>
<th>PH</th>
<th>E.C µs/cm</th>
<th>Sal. ppt.</th>
<th>Turb. NTU</th>
<th>DO mg/l</th>
<th>DOB5 mg/l</th>
<th>TDS mg/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn 2015</td>
<td>S.1</td>
<td>30</td>
<td>24</td>
<td>7.38</td>
<td>1335</td>
<td>0.87</td>
<td>78</td>
<td>8.22</td>
<td>1.89</td>
<td>946</td>
</tr>
<tr>
<td></td>
<td>S.2</td>
<td>30</td>
<td>26</td>
<td>7.05</td>
<td>1558</td>
<td>0.99</td>
<td>121</td>
<td>7.04</td>
<td>7.0</td>
<td>1108</td>
</tr>
<tr>
<td></td>
<td>S.3</td>
<td>32</td>
<td>25</td>
<td>7.34</td>
<td>1339</td>
<td>0.87</td>
<td>74</td>
<td>7.61</td>
<td>4.01</td>
<td>928</td>
</tr>
<tr>
<td>Winter 2016</td>
<td>S.1</td>
<td>16</td>
<td>11.5</td>
<td>8.09</td>
<td>1075</td>
<td>0.69</td>
<td>161.0</td>
<td>10.38</td>
<td>2.0</td>
<td>715.9</td>
</tr>
<tr>
<td></td>
<td>S.2</td>
<td>16</td>
<td>11</td>
<td>7.98</td>
<td>1078</td>
<td>0.70</td>
<td>177.0</td>
<td>8.36</td>
<td>5.5</td>
<td>717.9</td>
</tr>
<tr>
<td></td>
<td>S.3</td>
<td>16</td>
<td>12.5</td>
<td>7.77</td>
<td>1062.5</td>
<td>0.69</td>
<td>163.5</td>
<td>9.57</td>
<td>2.5</td>
<td>707.7</td>
</tr>
<tr>
<td>Spring 2016</td>
<td>S.1</td>
<td>28</td>
<td>24</td>
<td>7.8</td>
<td>855</td>
<td>0.56</td>
<td>35</td>
<td>8.0</td>
<td>0.90</td>
<td>569.43</td>
</tr>
<tr>
<td></td>
<td>S.2</td>
<td>29</td>
<td>23</td>
<td>7.5</td>
<td>888</td>
<td>0.58</td>
<td>67</td>
<td>7.5</td>
<td>4.5</td>
<td>591.40</td>
</tr>
<tr>
<td></td>
<td>S.3</td>
<td>30</td>
<td>23</td>
<td>7.8</td>
<td>827</td>
<td>0.54</td>
<td>43</td>
<td>8.1</td>
<td>2.1</td>
<td>550.78</td>
</tr>
<tr>
<td>Summer 2016</td>
<td>S.1</td>
<td>37</td>
<td>31</td>
<td>7.8</td>
<td>1018</td>
<td>0.65</td>
<td>33</td>
<td>8.1</td>
<td>1.9</td>
<td>677.99</td>
</tr>
<tr>
<td></td>
<td>S.2</td>
<td>37</td>
<td>29</td>
<td>7.3</td>
<td>1029</td>
<td>0.66</td>
<td>52</td>
<td>7.2</td>
<td>5.2</td>
<td>685.32</td>
</tr>
<tr>
<td></td>
<td>S.3</td>
<td>38</td>
<td>30</td>
<td>7.2</td>
<td>1014</td>
<td>0.65</td>
<td>37</td>
<td>7.9</td>
<td>2.9</td>
<td>675.32</td>
</tr>
</tbody>
</table>
Table (2): seasonal variation of physic-chemical and biological characters of Al-Gharraf river through period study 2015 – 2016

<table>
<thead>
<tr>
<th>Time</th>
<th>Station</th>
<th>TSS mg/l</th>
<th>T.H mg/l</th>
<th>Cl− mg/l</th>
<th>NO3− mg/l</th>
<th>PO4−3 mg/l</th>
<th>Cd ppm</th>
<th>Pb ppm</th>
<th>T.B.C Cell/100ml</th>
<th>E.coli Cell/10ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autumn 2015</td>
<td>S.1</td>
<td>738</td>
<td>430</td>
<td>159.4</td>
<td>31.09</td>
<td>0.15</td>
<td>0.023</td>
<td>0.09</td>
<td>1400</td>
<td>2900</td>
</tr>
<tr>
<td></td>
<td>S.2</td>
<td>890</td>
<td>520</td>
<td>213.7</td>
<td>45.00</td>
<td>0.59</td>
<td>0.089</td>
<td>0.21</td>
<td>2150</td>
<td>3600</td>
</tr>
<tr>
<td></td>
<td>S.3</td>
<td>820</td>
<td>437.5</td>
<td>193.6</td>
<td>35.69</td>
<td>0.31</td>
<td>0.081</td>
<td>0.19</td>
<td>3200</td>
<td>2500</td>
</tr>
<tr>
<td>Winter 2016</td>
<td>S.1</td>
<td>887</td>
<td>314</td>
<td>154.9</td>
<td>20.12</td>
<td>0.19</td>
<td>0.009</td>
<td>0.073</td>
<td>2700</td>
<td>3400</td>
</tr>
<tr>
<td></td>
<td>S.2</td>
<td>938</td>
<td>412</td>
<td>198.5</td>
<td>32.45</td>
<td>0.23</td>
<td>0.013</td>
<td>0.096</td>
<td>7800</td>
<td>5200</td>
</tr>
<tr>
<td></td>
<td>S.3</td>
<td>908</td>
<td>392</td>
<td>180.7</td>
<td>25.62</td>
<td>0.2</td>
<td>0.011</td>
<td>0.089</td>
<td>1350</td>
<td>3800</td>
</tr>
<tr>
<td>Spring 2016</td>
<td>S.1</td>
<td>165</td>
<td>310.4</td>
<td>89.02</td>
<td>16.1</td>
<td>0.32</td>
<td>0.004</td>
<td>0.033</td>
<td>1500</td>
<td>2300</td>
</tr>
<tr>
<td></td>
<td>S.2</td>
<td>196</td>
<td>388</td>
<td>153</td>
<td>20.0</td>
<td>0.43</td>
<td>0.007</td>
<td>0.041</td>
<td>3900</td>
<td>-4200</td>
</tr>
<tr>
<td></td>
<td>S.3</td>
<td>185</td>
<td>329.8</td>
<td>111.5</td>
<td>16.0</td>
<td>0.38</td>
<td>0.005</td>
<td>0.039</td>
<td>2800</td>
<td>2100</td>
</tr>
<tr>
<td>Summer 2016</td>
<td>S.1</td>
<td>56</td>
<td>275</td>
<td>95.9</td>
<td>15.4</td>
<td>0.33</td>
<td>0.002</td>
<td>0.031</td>
<td>320</td>
<td>480</td>
</tr>
<tr>
<td></td>
<td>S.2</td>
<td>86</td>
<td>335</td>
<td>138</td>
<td>28.2</td>
<td>0.45</td>
<td>0.006</td>
<td>0.037</td>
<td>1500</td>
<td>2600</td>
</tr>
<tr>
<td></td>
<td>S.3</td>
<td>87</td>
<td>360</td>
<td>105</td>
<td>21.7</td>
<td>0.38</td>
<td>0.005</td>
<td>0.035</td>
<td>980</td>
<td>1400</td>
</tr>
<tr>
<td>Summer 2016</td>
<td>S.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>S.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table (3): Comparison between some water quality parameters of Al-Gharraf river with the Iraqi and International standards.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.5-8.5</td>
<td>6.5-8.5</td>
<td>6.5-8.5</td>
</tr>
<tr>
<td>TDS mg/L</td>
<td>500-1500</td>
<td>500-1500</td>
<td>1000</td>
</tr>
<tr>
<td>Turbidity NTU</td>
<td>0-50</td>
<td>0-25</td>
<td>25</td>
</tr>
<tr>
<td>DO mg/L</td>
<td>&gt;5</td>
<td>&gt;5</td>
<td>&gt;5</td>
</tr>
<tr>
<td>BOD5 mg/L</td>
<td>&gt;3</td>
<td>&gt;5</td>
<td>&gt;3</td>
</tr>
<tr>
<td>T.H mg/L</td>
<td>100-500</td>
<td>100-500</td>
<td>-</td>
</tr>
<tr>
<td>Cl− mg/L</td>
<td>200</td>
<td>200-600</td>
<td>200</td>
</tr>
<tr>
<td>NO3− mg/L</td>
<td>0-45</td>
<td>0-40</td>
<td>25-50</td>
</tr>
<tr>
<td>Cd ppm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pb ppm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(Fig. 2) Seasonal changes in Air Temperature °C in three selected stations.

(Fig. 3) Seasonal changes in Water Temperature °C in three selected stations.

(Fig. 4) Seasonal changes in pH in three selected stations.

(Fig. 5) Seasonal changes in EC ms/cm in three selected stations.

(Fig. 6) Seasonal changes in Salinity ppt in three selected stations.

(Fig. 7) Seasonal changes in Turbidity NTU in three selected stations.
(Fig. 8) Seasonal changes in DO mg/l in three selected stations

(Fig. 9) Seasonal changes in BODS mg/l in three selected stations

(Fig. 10) Seasonal changes in TDS mg/l in three selected stations

(Fig. 11) Seasonal changes in TSS mg/l in three selected stations

(Fig. 12) Seasonal changes in total hardness mg/l in three selected stations

(Fig. 13) Seasonal changes in Cl- mg/l in three selected stations
(Fig.14) Seasonal changes in NO3 mg/l in three selected stations

(Fig.15) Seasonal changes in PO4 mg/l in three selected stations

(Fig.16) Seasonal changes in Cd mg/l in three selected stations

(Fig.17) Seasonal changes in Pb mg/l in three selected stations

(Fig.18) Seasonal changes in T.B.C cell/100 ml in three selected stations

(Fig.19) Seasonal changes in E.Coli cell/10 ml in three selected stations
4. Discussion

Air and water temperature is an important factor in any aquatic environments affecting on biological processes, in this study it was ranged between 16 to 38 °C and 11 to 31 °C respectively. This result was similar to previous studies done by [11] [12].

The pH value of AL-Gharraf River in study sites during of most studied period was alkaline side above 7, and this result agreed with [13], they reported that Iraqi inland water is regarded to be on the alkaline side of neutrality, reflecting geological formations of the area and the results are agree with the finding that recorded by [14] [15]. Electrical conductivity used as an indicator of water quality based on total dissolved salts [16]. The increase of EC values at station two reflects the strong effect of domestic sewage effluent discharge at this area. Also, EC values recorded in the present work is coincided with findings of [17] [18]. The study also revealed monthly changes in salinity, with notable increase during summer months due to evaporation [19]. The presence of agricultural drainage systems namely, Kut, Al-Muafakiah and AL-Haay may contribute in rising salinity as well[20]. Water turbidity is caused by suspended matter such as clay, silt and planktons also turbidity degree of River water is an approximate measure of the intensity of the pollution [20]. This result was similar to previous studies done by [21] [22]. Oxygen content of water is one of the important factors, and it is very necessary for all living organisms [23]. The study finding coincided with other authors [24] [25] [26] on Iraqi inland waters mainly Tigris. Low concentration of DO recorded from station-2 may relate to organic wastes discharged from Al-Haay City. Generally, the DO at most stations of canal water was within normal guideline values cited by [27] for the protection of aquatic life.

The biological oxygen demand is defined as the quantity of DO which is able to oxidize the organic components in the water with the assistance of microorganisms under defined experimental conditions [28]. Generally, results indicate increasing levels of BOD, in particular at station-2 during the November and October, this may be due to decomposition of organic matters run directly to the river with domestic sewage. These results were slightly higher than that reported by [29] [30] at the same river. Values of total hardness in the selected stations exceeded 520 mg/L as CaCO3. This indicates that waters are very hard according to [31]. Increase in hardness values was found to coincide with rise in salinity [32] [33]. The results of total hardness are agreed with those of [34] [35]. Chloride is a natural substance present in all portable water as well as sewage effluents as metallic salt. Generally high concentration of chloride indicates to organic pollution in the water [36]. This result was similar to previous studies done by [37] [38]. Total dissolved solids (TDS) is the term used to describe the inorganic salts and small amounts of organic matter present in solution in water [39]. These results were slightly lower than that reported by [40] [41] at the same river. Total suspended solids are considered to be one of the major pollutants that contributes to the deterioration of water quality, contributing to higher costs for water treatment, decreases in fish resources, and the general aesthetics of the water [42]. TSS values recorded in the present work is coincided with findings of [43] [44]. Nitrate is the stable form of combined nitrogen and it is an important factor which might limit growth of phytoplankton [45]. The results of nitrate are agreed with those of [46] [47]. Phosphorus is essential to the growth of algae and other biological organisms. The reactive phosphate concentration in studied river was ranged between 0.15 to 0.5 mg/l. The high concentration of phosphate may be due to sewage water
effluent and fertilizer application in surrounding agricultural area. This result was close to that reported by [48]. Cd can enter the environment from various anthropogenic sources such as by-products from zinc refining, coal combustion, mine waste, electroplating processes, iron and steel production, and pesticides[49]. The increase of the concentration of Cd during autumn season and decrease during summer due to increased discharge of domestic sewage especially at station 2 and using of fertilizer and pesticides that is added to agricultural lands [50]. Lead is one of the very toxic heavy metals that not only accumulate in individual but also have the ability to affect the entire food chain and disrupt the health system of human beings, animals and phytoplankton [51]. The recorded concentrations of Pb in Al-Gharraf River in all the stations as a result of the passage of the river through agricultural lands that used different chemicals that contains Pb [52]. The total bacterial includes all of the bacterial species that are capable of growing in or on a nutrient rich solid agar medium [53]. High numbers of bacterial level of the Al-Gharraf River due to receiving the large amounts of sewage especially in Al-Haay city, as well as increase the agricultural activities have led to increase bacteria number in the waters of the river [54]. The presence of E.coli bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals[55]. In this study fecal indicator bacteria abundance were measured in samples collected in river located in Al-Haay city. Results showed that this river which flowing through urban areas was more contaminated than those rivers which flowing through agricultural areas [37].

5. Conclusions

The results of the study revealed that the river is not suitable for use as drinking water without elaborate treatment, poor for aquatic life protection and fair for irrigation. Also the results revealed that most water quality parameters were excess the Iraqi standards, and WHO standards for the raw water. The shortage of water in the river and runoff of the domestic sewage impacted negatively on the quality of water.

6. References


8. Al-Rubaee, M. A. J. (1997) Ecological study to Ethem river and its impact on Tigris. MSc thesis; Baghdad University. (in Arabic)


