Qualitative Assessment and Classification of Aji Chai River Using Water Quality Index (WQI)

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Abstract: Aji Chai River (11490 km²) is composed of four hydrologic units. This is a Qualitative study about the main branch of Aji Chai. For accessing the extent of pollution changes, some physiochemical parameters of the river’s water in 8 different stations has been measured. The results of the measurements showed that this river is affected by some emission sources on the route. In this study, water quality index (WQI) was used for classification. WQI is divided Aji Chai river into two groups. The best quality is devoted to the station No. 1 situated in the Boyuk Chai, close to the city of Sarab which is in the first place of the region to be studied. And the worst quality belongs to the station No. 5 due to receiving human and industrial sewage which is situated under the International Bridge of Tabriz-Marand.

Key words: Water Quality Assessment %Classification %East Azerbaijan %Iran

INTRODUCTION

Aji Chai River is one of the important rivers of East Azerbaijan. It gathers the vast majority of the surface waters of Tabriz, Sarab and Bostan-abad and then runs into the Urmia Lake. This river is situated in the valley and runs from east to west. On the north it is close to the West-Arasbaran, Goshe Dagh and Sabalan and on the south is close to the Bozgush and Sahand Mountains [1].

River’s length to the Urmia Lake’s Delta is about 276 km and its drainage basin is about 13853 km². The most important cities of this basin are Tabriz, Sarab, Bostan-abad, Haris and Osku [2].

This basin is one of the sub basins of Urmia Lake and is situated at 40°45’ to 54°47’ E and 34°37’ to 30°38’ N [3].

This river is composed of different branches such as: Aghimon Chai, Taj yar, Razlig Chai, Vanag Chai, Mehraban, Duzduzan, Zarnag Chai, Ojan Chai, Varzagan Chai, Nahand Chai, Saeid Chai, Mehran rud, Sard rud and Onsor rud in four hydrologic units [4]. In this study, the qualitative evaluation of the main branch of Aji Chai has been under consideration.

Rivers are of the most important renewable and vital resources of fresh water consumed for agricultural, industrial and drinking purposes [5]. Water quality indices are one of methods used in water qualitative management which can be used as a powerful management instrument for related decision-makings [6].

Since different industrial and residential centers are built in the plains, they cause the pollution of Aji Chai River directly or indirectly. Because most of the factories with industrial and urban emission sources are situated in Tabriz plain, they are more observable and important than the agricultural emission sources [2].

Therefore, this research was conducted to study the mentioned situations and in order to be aware of the qualitative condition of the river water to control the emission sources. One of the most common methods used to evaluate the pollution and the quality of river water is the water quality index (WQI) [7]. WQI has been used for evaluating and categorizing of Aji Chai.

MATERIALS AND METHODS

In the entire basin study, physiochemical and microbiological parameters were considered from the river origination to river mouth in eight different stations. In selecting the stations of sampling and measurement some features such as: effective factors in water’s quality, small branches and their join spots to the main branch, human
and environmental factors and the probability of pollution by emission sources has been considered. These stations are:

Station No.1: Situated on the Boyuk Chai in Sarcheshmeh and Sarab city.

Station No.2: Situated on the Aghmien Chai 5 km far from Sarab regarding its neighboring to the food stuff companies,

Station No.3: Situated on the Boyuk Chai where the Aghmien Chai is joining the Boyuk Chai,

Station No.4: Situated on the Vanjar Bridge in Ahar-Tabriz road where Aji Chai flows into the chalky and salt-affected lands after passing Sarab;

Station No.5: situated under the International Bridge of Tabriz-Marand where Mehran Rud is joining to and Tabriz human and industrial sewages draining to the river,

Station No.6 because of establishing industries such as: color- mixing units – leather-making units and refinery,

Station No.7: situated on the Aji Chai river after Sinik Cahi is linking to it and

Station No.8: situated in where urban sewages is running into.

In the determined stations, physiochemical parameters including acidity, dissolved oxygen, water temperature, water turbidity, electric conductivity and required oxygen for biological purposes, the entire dissolved substances, phosphate, nitrate and gastrointestinal coliforms have been measured by sampling in four seasons of the year in 2008 from stations and their transmission to the labs by standard methods of 2005. Then the quality index of each station was calculated by WQI Calculator.

Generally, Water Quality Index (WQI) is used for estimating the river’s pollution and shows the composite effect of physiochemical and biological parameters [8].

Its equation is: \( WQI = EW_iQi \)

In this Equation:

\[ WQI = \text{Water quality index which its quantity differs from 0 to 100.} \]

\[ E_i = \text{Weight or factor’s precedence degree from 0 to 1. (Table 1)} \]

\[ Q_i = \text{parameter’s quality from 0 to 100. (Table 2)} \]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dissolved oxygen</td>
<td>%</td>
<td>0.17</td>
</tr>
<tr>
<td>Gastrointestinal coliform</td>
<td>Mg/l</td>
<td>0.16</td>
</tr>
<tr>
<td>Acidity</td>
<td>Unit</td>
<td>0.11</td>
</tr>
<tr>
<td>Required oxygen for biological purposes</td>
<td>Mg/l</td>
<td>0.11</td>
</tr>
<tr>
<td>Temperature</td>
<td>°C</td>
<td>0.10</td>
</tr>
<tr>
<td>Phosphate</td>
<td>Mg/l</td>
<td>0.10</td>
</tr>
<tr>
<td>Nitrate</td>
<td>Mg/l</td>
<td>0.10</td>
</tr>
<tr>
<td>Turbidity</td>
<td>NTU</td>
<td>0.08</td>
</tr>
<tr>
<td>Entire solids</td>
<td>Mg/l</td>
<td>0.07</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

In Table 1 & 2, the obtained information by this software considering the weight or precedence degree of each parameter and the derivational information from standard curves related to them, have been combined and showed.

The water quality index system needs unconditional relation between different amounts of each lab feature and the quality level which by its variations we can attribute to the water. Using multivariate statistical techniques is useful in assessing water quality, determining the amount of pollutants and determining pollution sources [9-11]. Whereas, water is an indefinite factor, the above mentioned relation needs a kind of qualitative inference [10].

The mechanism of determination of these relations is by using curves and criteria tables. By quality index we can evaluate one station on one river for many times, compare the water quality in different stations on one river or compare the water quality of different rivers.

C Water Quality Index

RESULTS AND DISCUSSION

The average measured amounts for physicochemical and microbial parameters which are needed in determining the water quality index is shown in Table 3.

With regards to the obtained results from parameters’ average in different stations, the water quality index of each station has been estimated and is shown in Table 4.
Table 3: The average parameters in selected stations of the region under investigation

<table>
<thead>
<tr>
<th>Station</th>
<th>Temperature</th>
<th>PH</th>
<th>T.Po (mg/l)</th>
<th>T.No (mg/l)</th>
<th>BOD (mg/l)</th>
<th>DO (mg/l)</th>
<th>T.D.S (mg/l)</th>
<th>Turbi (NTU)</th>
<th>Faecal coliform (MPN in 100 cc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.1</td>
<td>7.96</td>
<td>1.06</td>
<td>1.72</td>
<td>2.66</td>
<td>10.5</td>
<td>350</td>
<td>12</td>
<td>582</td>
</tr>
<tr>
<td>2</td>
<td>7.7</td>
<td>8.13</td>
<td>1.26</td>
<td>3.31</td>
<td>21.64</td>
<td>9.25</td>
<td>602</td>
<td>16</td>
<td>590</td>
</tr>
<tr>
<td>3</td>
<td>11.07</td>
<td>7.8</td>
<td>2.66</td>
<td>1.99</td>
<td>28.3</td>
<td>4</td>
<td>1400</td>
<td>22</td>
<td>619</td>
</tr>
<tr>
<td>4</td>
<td>9.93</td>
<td>8.3</td>
<td>0.53</td>
<td>2.26</td>
<td>3.66</td>
<td>10</td>
<td>4760</td>
<td>31</td>
<td>574</td>
</tr>
<tr>
<td>5</td>
<td>13.5</td>
<td>8.13</td>
<td>2.26</td>
<td>2.52</td>
<td>27.63</td>
<td>7</td>
<td>5560</td>
<td>32</td>
<td>601</td>
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<tr>
<td>6</td>
<td>15.2</td>
<td>8.13</td>
<td>1.46</td>
<td>2.3</td>
<td>8.65</td>
<td>8.37</td>
<td>583</td>
<td>35</td>
<td>599</td>
</tr>
<tr>
<td>7</td>
<td>12.33</td>
<td>8.3</td>
<td>1.35</td>
<td>2.39</td>
<td>12.98</td>
<td>7.25</td>
<td>6250</td>
<td>38</td>
<td>600</td>
</tr>
<tr>
<td>8</td>
<td>11.2</td>
<td>8.13</td>
<td>2.5</td>
<td>3.59</td>
<td>33.35</td>
<td>7.25</td>
<td>453</td>
<td>28</td>
<td>582</td>
</tr>
</tbody>
</table>

Table 4: Amounts of obtained Q value for parameters by diagrams

<table>
<thead>
<tr>
<th>Station</th>
<th>Temperature</th>
<th>PH</th>
<th>T.Po</th>
<th>T.No</th>
<th>BOD</th>
<th>DO</th>
<th>T.D.S</th>
<th>Turbi</th>
<th>Coliform</th>
<th>WQI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9.3</td>
<td>9.35</td>
<td>3.9</td>
<td>9.5</td>
<td>10.56</td>
<td>1.19</td>
<td>3.71</td>
<td>5.76</td>
<td>4.32</td>
<td>55</td>
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<tr>
<td>2</td>
<td>9.1</td>
<td>8.69</td>
<td>3.5</td>
<td>8.4</td>
<td>1.1</td>
<td>1.19</td>
<td>1.19</td>
<td>4.72</td>
<td>4.32</td>
<td>41</td>
</tr>
<tr>
<td>3</td>
<td>7.7</td>
<td>9.9</td>
<td>2.3</td>
<td>9.5</td>
<td>0.66</td>
<td>0.68</td>
<td>1.4</td>
<td>4.16</td>
<td>4.32</td>
<td>40</td>
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<tr>
<td>4</td>
<td>8.2</td>
<td>8.03</td>
<td>5.9</td>
<td>9.4</td>
<td>6.93</td>
<td>1.19</td>
<td>1.4</td>
<td>4.16</td>
<td>4.32</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>6.5</td>
<td>8.69</td>
<td>2.5</td>
<td>9.2</td>
<td>0.66</td>
<td>1.02</td>
<td>1.4</td>
<td>4.08</td>
<td>4.32</td>
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<tr>
<td>6</td>
<td>5.5</td>
<td>8.69</td>
<td>3.2</td>
<td>9.4</td>
<td>4.29</td>
<td>1.02</td>
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<tr>
<td>7</td>
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<td>3.3</td>
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<td>3.76</td>
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<td>8</td>
<td>7.7</td>
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<td>7.8</td>
<td>3.74</td>
<td>1.02</td>
<td>2.73</td>
<td>4.4</td>
<td>4.32</td>
<td>43</td>
</tr>
</tbody>
</table>

Calculations of water quality index in Table-4 shows that the best quality is devoted to the station No.1 situated in the Boyuk Chai, close to the Sarab city, which is in the first place of the mentioned river. And the worst quality is devoted to the station No.5 situated under the International Bridge of Tabriz-Marand. Sewages of human, slaughter houses and other industrial units are draining into the Mehran Rood which runs inside the Tabriz city and because of joining to Aji Chai River, it causes more pollution of this river; moreover, because of the following reasons station number 2, 3, 4, 6, 7 and 8 have different water quality:

- Station No.2 because of draining of food stuff companies’ sewage into its water and station No.3 because of joining Aghimun Chai which is polluted to Boyuk Chai don’t have a good quality.
- Station No.4 which is situated on the Vanyar Bridge in Ahar-Tabriz road, after station No.1 has the highest quality among others, because there is no main emission source in its environment.
- Station No.6 which is situated next to the Khosro shahr-Tabriz road has also low quality. Because most of the industries such as: ink industries, leather craft suppliers and refineries are situated in the west of Tabriz and drain their sewages into Aji Chai River.
- Station No.7 is situated on Aji Chai River after Sinikh Cah in joining it. Because of draining of urban sewages into Aji Chai River, in comparison with station No.6 it has lower water quality and higher pollution.

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Station No.8 is the last station. Considering that all the urban sewages have been drained into the river before, after station No.5, this station is the most polluted among others.

After this station, no more pollution is added to the river water. In other words, the final pollution of the river is characterizing in here and thereafter because of self-purification of the river, its quality may increase and its pollution may decline. Considering the location of the stations over Aji Chai River and obtained results from parameters analysis using WQI Calculator, we can summarize the most important features of Aji Chai water’s quality in four groups:

**Reduction of Dissolved Oxygen (DO):** After running into the city of Tabriz, the Aji chai’s dissolved oxygen is reducing. The amount of the least calculations which is almost zero shows that after draining of the urban and industry sewages into it, the whole biological life has been destroyed. In other words, in downstream of the Vanyar dam, gradually Aji Chai becomes a dead river in which there is no life; while in upstream of the river and first branches of Aji Chai, there are different species of fish such as Capoeta. Also in upstream small dams some species of fish are breeding.

Before running of the Aji Chai into the city of Tabriz, the amount of biochemical oxygen demand (BOD) is about zero; But after passing it the amount of BOD increases and in the last station (western Khosroshahr) its amount...
increases to 10 mg/l; it is because of draining sewages including organic material such as: urban sewages, slaughterhouses and milk pasteurization plants’ sewages in the city of Tabriz.

The average amount of chemical oxygen demand (COD) in the western Tabriz reaches to the highest level in the entire river’s route and the concentration of industries and huge factories in this region is the main reason for it.

**Total Suspended Solids (T.S.S) and Total Dissolved Solids (T.D.S):** Running in the city of Tabriz, the average Total Suspended Solids and Total Dissolved Solids increases and in the station No.5.

The joining spot of Mehran rood), in the exit rout of Tabriz, reaches to the highest level of 187 mg/l and 5560 mg/l. The cause of increase in amount of T.S.S and T.D.S in station No.7 is that it has been situated near the irrigation and drainage network of Tabriz plain and its minerals and soil particles enter the river.

**Suggestions:**

- Construction and commissioning of refineries for industrial and urban sewages which lack it. Supervising the sewages infiltration in standard level and using agricultural purposes.
- Managing surface water sources in entire drainage basin of Aji Chai in order for good quality water to be used in Tabriz.
- Promoting, educating and increasing public knowledge in order to protect waters and introducing modern irrigation methods for improving agricultural lands and rationalization using pesticides and fertilizer in order for preventing the river’s pollution.

**REFERENCES**