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# Study of the quality and validity of the water of the River Tigris (Al-Gharraf stream) within the city of Nasiriya- Iraq

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**Abstract:**

**Despite the importance of water for life, drinking, irrigation, power generation and industrial use. This study concerns the study of the quality and validity of water by applying the arithmetic weight index (AWI) for the water quality of irrigation , where the selection of the eleven variables acidity (PH), Total Dissolved Solid (T.D.S), Alkalinity(ALK), Electrical Conductivity (E.C), Calcium(Ca), Chloride (CL), Sodium (Na), Sulfate (SO4), Potassium (k), Total suspended solids (T.S.S), Total hardness (TH) to show the water quality of the study area. The water samples collected from the river were examined and numbered 17 for two seasons. The study reveals that the water quality index has increased along the stream which indicates the water is completely unfit for irrigation use(arithmetic weight rating almost stations were between poor and very poor water). civilizations around this stream are probably lead to degrading water quality, which could be a menace to the public.**

**Keywords:** Weight arithmetic index, Water quality index, Al-Gharraf River, Weight arithmetic index, WQI, Water **pollution**

## [1]Introduction:

Water pollution is to spoil the quality of river water and the water of agricultural banks, seas and oceans, making this water unusable.Water is contaminated by human, plant, animal, mineral, industrial, agricultural or chemical residues that run into water sources. Assessment of water quality can be defined as the analysis of physical, chemical and Biological characteristics of water. In recent years we have noticed that the quality of the Tigris and Euphrates rivers, which are the main sources of water in Iraq, began to deteriorate at a high and rapid rate during its course and up to the mouth of the Shatt al-Arab in the Arabian Gulf [1]. Water quality indices are such approaches which minimize the data volume to a great extent and simplify the expression of water quality status. The water quality index can be evaluated on the basis of various physical, chemical and bacteriological parameters. Numerous water quality indices have been formulated all over the world which can easily judge out the overall water quality within a particular area promptly and efficiently [2]. The Index of arithmetic weight Water Quality (AW-WQI) method is used to indicate the impact of selected pollutants resulting from human and industrial activities of Nasiriya city on Tigris River (al-Garraf). Categorization of water quality started in the mid-twentieth century by Horton in 1965[3].

## [2] MATERIALS AND METHODS

## [2.1]STUDY AREA

Nasiriya is located between latitude (30˚36´00˝ _ 32˚00´00˝ N) and longitude (45˚36´00˝ _ 47˚12´00˝ E) as showing Figure (1). Kut dam was established on the Tigris River between (1934 and 1939), with the aim of controlling the Tigris River for agricultural purposes .The Tigris River branch after the Kut to two branches the first province of Maysan and the second extends towards the city of Thi-Qar, called Garraf River, which is located in the southeastern part of Iraq. Enter Nasiriya and passes ALfagr, Qala'at Sikar, Al Rifai and Al Nasr and the (168 km) distance from the beginning branches of the river into two branches Shatt Al bdai, which ends in the marsh leading to Hammar, while the second section is the Shatt al-Shatra, which passes in Shatrah, Garraf and ends in the marshes leading to Hammar also, a total length of (230) km from its starting point to its outlet in the marshes of Nasiriya. The level of water at the top of the Garraf is (17.4) m, and the Al bdai regulates ten meters and for the purpose of maintaining this rise in the water level, four systems were established on the Gharraf River.

## [2.2]Field work and laboratory work

The Natural and chemical properties of water are considered as a fundamental criterion to evaluate the validity and quality of that water. In the present study, the hydro chemical characteristics are included (17) site, distributed on the al-Garraf stream from the beginning of its entry to the city of al-fagr and the end of al-Gharraf as shown in Figure (1). Table (1) and (2) illustrates the site's name, their latitudes and longitudes and Concentrations of Physical, Cation and Anion elements in the research area, where they were examined models taken from seventeen for a period of month 04/FEB/2017 and 11/MAY/2017. These concentrations reach to the lowest level at entering Thi Qar city for two seasons. This gives an indication of the extent of the effect of pollutants brought by the water of al-hay as the last part of Kut city.

## [2.3]Water quality and validity of use

The influence of water for different uses is determined by the physical, Cation and Anion characteristics. The quality of water depends on the concentrations of physical contaminants, which includes elements such as (PH, Ec, TDS, and TSS), the group of Cation elements such as (Ca, TH, Na and K) and Anion characteristics such as (Cl, So4 and ALK) [4]. Worldwide multi-specifications were developed for irrigation and drinking water, including the limits of concentrations of positive and negative ions in the water. The main specifications that use in this study are Iraqi standard for irrigation as shown in Table (3). These specifications are depended on the concentration of each individual ion and its effect and do not base on the presence within the group. The most important use AW-WQI in this study to determine the general indicator of water quality [5].

### [2.3.1]Calculations of the WQI

Water quality index (WQI) is one of the best effective tools to communicate evidence on the quality of water to policy makers and the concerned citizens as it is a significant parameter for the management and assessment of surface water [6]. To calculate the WQI, the following steps were used: In the first step, unit weight ($W_i$) for various parameters is the following formula pro-posed by Tiwari and Mishra [7].

$$w_i = \frac{k}{(Vstandard)} \ldots\ldots\ldots\ldots\ldots\ldots \text{ (1)}$$

Where:

*K* = proportionality constant.

*V Standard* = The Iraqi standard permissible.

The constant of proportionality *K* in the above equation can be determined from the following conditions.

$$k\sum \frac{1}{(Vstandard)} \ldots\ldots\ldots\ldots\ldots\ldots \text{ (2) } = w_i\sum$$

Where:
$Wi$ = Relative unit weight of $n^{th}$ Parameter.
$Si$= Standard permissible value for $n^{th}$ Parameter.
K= Proportionality constant.

In the second step, Quality rating (*Qi*) is calculated as

Qi= (Vactual -Videal)/ (Vstandard -Videal)*100 ……. (3)

Where:

Qi = Quality rating of $i^{th}$ Parameter for a total of n water quality parameters.

Vactual = Actual value of the water quality parameter obtained from laboratory analysis.
Videal= Ideal value of that water quality parameter can be obtained from the standard tables.
V ideal for pH = 7 and for other parameters, it is equal to zero.

Then, the overall WQI was calculated using the formula

$$WQI=\sum_{i=1}^{i=n} Qi * Wi$$

Based on the calculated WQI, the classification of water quality types is given according to [7] as shown in Table (4).

**[2.3.2]Quality Rating and Weighting**

Quality rating or sub index (Qi) was calculated using The 'standards' for the irrigation water, recommended by the Iraqi standard and unit weights are given in Tables (5) and (6).

The variation of (AW-WQI) with the sample location is shown in Figure (2). It is observed that the value of (AW-WQI) increases with the progress of Gharraf stream from location 1 to 17, then the variation becomes turbulently reaching to the maximum value in location 15 for date:4/FEB/2017,while the variation of (AW-WQI) with the sample location is shown in Figure (3). It is observed that the value of (AW-WQI) increases with the progress of Gharraf stream from location 1 to 17, then the variation becomes turbulently reaching to the maximum value in location 12 for date:11/MAY/2017.

**[2.4]Results and Discussion**

These results gave a guide of the deterioration of water quality during the flow of the Gharraf stream within the city of Nasiriya due to factors resulting from two major kinds, point source, and non-point source pollution. In (date: 04/FEB/2017) was observed that all the parameters under study almost follow the same developmental curve except pH (Water alkalinity is evidence of the lack of available carbon dioxide), so4 (due to the impact of sewage, soil drainage and the industrial waste water), and T.S.S (are made up of inorganic materials include anything drifting or floating in the water, from sediment, silt, and sand to plankton and algae. In addition, Organic particles from decomposing materials can also contribute to the TSS concentration), which recorded irregular high concentration at various stations. In (date: 11/MAY/2017) was observed that all the parameters under study almost follow the same developmental curve except T.H (is formed by the presence of calcium and magnesium ions and is formed by bicarbonate or sulfate), and so4 (low water levels divorced), which recorded irregular high concentration at various stations.

Based on the index values of the quality of water of the Gharraf stream it is found that there is an increase in the values of the index along the river from its entry of alfagr to the end of it. This increase in arithmetic weight index mean that water quality was decreased due to several reasons; such as, the influence of irrigation water, Sanitation without treatment, impact of soil components where rainwater works on the cliff of parts of the soil to the river, thus increasing the concentrations of variables, and reducing the quality of water, impact of factories scattered widely along the river and low water levels divorced.

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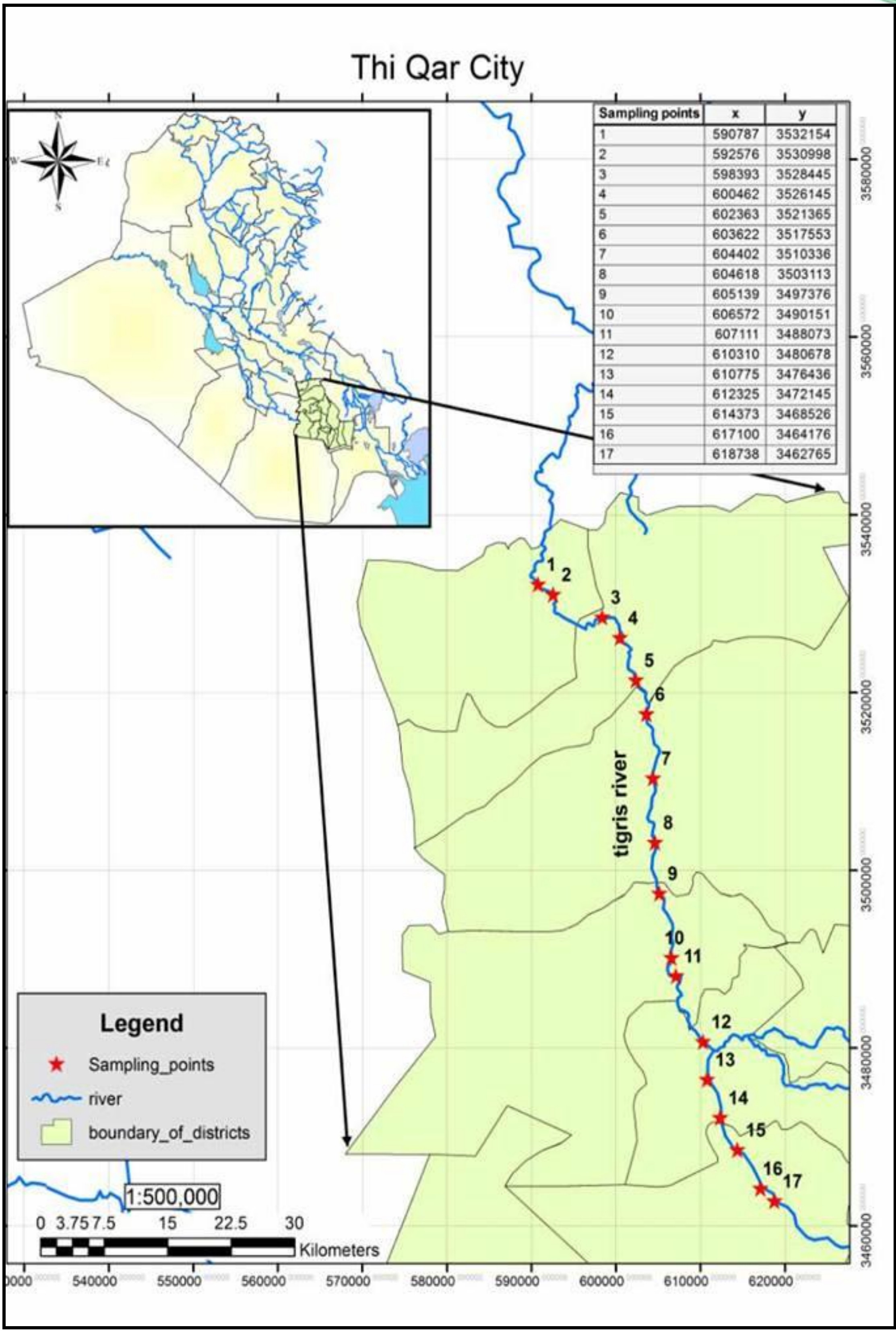


**Figure (1):** Location of the study area (Al- Gharraf stream)

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| | Name | Location | | Physical Properties | | | | CatIon (mg/l) | | | | Anion (mg/l) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | E | N | Ph | EC(μs/cm) | TSS | TDS | Ca | TH | Na | K | Cl | So4 | ALK |
| **Loc_01** | ALfagr | 590787 | 3532154 | 7.85 | 1494 | 60 | 1016 | 121 | 486 | 142.8 | 4.0 | 153 | 413 | 128 |
| **Loc_02** | ALfagr | 592576 | 3530998 | 8.01 | 1568 | 44 | 1022 | 127 | 508 | 146.0 | 4.4 | 148 | 281 | 136 |
| **Loc_03** | ALfagr | 598393 | 3528445 | 8.18 | 1471 | 30 | 1018 | 120 | 482 | 143.2 | 4.0 | 146 | 405 | 128 |
| **Loc_04** | Gala sgar | 600462 | 3526145 | 8.24 | 1477 | 58 | 1020 | 120 | 482 | 142.4 | 4.0 | 148 | 408 | 128 |
| **Loc_05** | Gala sgar | 602363 | 3521365 | 8.25 | 1476 | 60 | 1026 | 120 | 482 | 145.2 | 4.0 | 140 | 386 | 128 |
| **Loc_06** | Gala sgar | 603622 | 3517553 | 8.31 | 1474 | 36 | 1030 | 120 | 482 | 146.4 | 4.0 | 143 | 395 | 128 |
| **Loc_07** | Al-Rifai | 604402 | 3510336 | 8.31 | 1472 | 70 | 1032 | 120 | 482 | 144.8 | 4.0 | 144 | 392 | 126 |
| **Loc_08** | Al-Rifai | 604618 | 3503113 | 8.39 | 1467 | 42 | 1036 | 120 | 482 | 145.2 | 4.0 | 146 | 497 | 126 |
| **Loc_09** | Al-Rifai | 605139 | 3497376 | 8.43 | 1497 | 22 | 1026 | 121 | 486 | 142.0 | 4.0 | 144 | 397 | 128 |
| **Loc_10** | Alnsar | 606572 | 3490151 | 8.40 | 1480 | 56 | 1030 | 121 | 486 | 145.2 | 4.0 | 140 | 374 | 128 |
| **Loc_11** | Alnsar | 607111 | 3488073 | 8.42 | 1480 | 72 | 1028 | 121 | 486 | 143.2 | 4.0 | 143 | 404 | 128 |
| **Loc_12** | Albdai | 610310 | 3480678 | 8.42 | 1478 | 66 | 1024 | 120 | 482 | 144.4 | 4.0 | 144 | 408 | 128 |
| **Loc_13** | Alshatra | 610775 | 3476436 | 8.43 | 1481 | 28 | 1022 | 120 | 482 | 145.2 | 4.0 | 153 | 408 | 128 |
| **Loc_14** | Alshatra | 612325 | 3472145 | 8.58 | 1485 | 36 | 1018 | 120 | 482 | 144.8 | 4.0 | 149 | 413 | 128 |
| **Loc_15** | Alshatra | 614373 | 3468526 | 8.80 | 1484 | 28 | 1022 | 120 | 482 | 145.6 | 4.0 | 144 | 394 | 128 |
| **Loc_16** | Algarraf | 617100 | 3464176 | 8.67 | 1502 | 40 | 1036 | 121 | 486 | 145.2 | 4.0 | 149 | 398 | 130 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Loc_17** | Algarraf | 618738 | 3462765 | 8.34 | 1532 | 56 | 1040 | 122 | 490 | 146.8 | 4.4 | 137 | 402 | 132 |
| Max. | | | | 8.8 | 1568 | 72 | 1040 | 127 | 508 | 146.8 | 4.4 | 153 | 497 | 136 |
| Min. | | | | 7.85 | 1467 | 22 | 1016 | 120 | 482 | 142 | 4 | 137 | 281 | 126 |
| Mean | | | | 8.355 | 1489.294 | 47.294 | 1026.2353 | 120.8 | 485.2 | 144.6 | 4.047 | 145.4 | 398.5 | 128.6 |
| SD | | | | 0.224 | 25.45772 | 15.999 | 6.9957971 | 1.704 | 6.366 | 1.408 | 0.133 | 4.358 | 39.62 | 2.32 |

**Table (1):** Test results using (ph-meter &oakton pcs testr 35) devices and Test results conducted in the Department of the Environment Water / Najaf Governorate **(**date**:** 4/FEB/2017).

| | | Location | Physical Properties | CatIon (mg/l) | Anion (mg/l) |
|---|---|---|---|---|---|

| | Name | E | N | Ph | EC(µs/cm) | TSS | TDS | Ca | TH | Na | K | Cl | So4 | ALK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Loc_01** | ALfagr | 590787 | 3532154 | 8.4 | 828 | 34 | 564 | 73 | 294 | 74.7 | 2.4 | 90 | 181 | 74 |
| **Loc_02** | ALfagr | 592576 | 3530998 | 8.4 | 790 | 58 | 446 | 72 | 290 | 73.5 | 2.1 | 88 | 186 | 72 |
| **Loc_03** | ALfagr | 598393 | 3528445 | 8.3 | 808 | 34 | 482 | 73 | 294 | 75.6 | 1.8 | 89 | 171 | 72 |
| **Loc_04** | Gala sgar | 600462 | 3526145 | 8.3 | 808 | 24 | 598 | 73 | 294 | 74.7 | 2.4 | 89 | 181 | 72 |
| **Loc_05** | Gala sgar | 602363 | 3521365 | 8.3 | 818 | 48 | 560 | 73 | 294 | 75.6 | 2.4 | 88 | 171 | 74 |
| **Loc_06** | Gala sgar | 603622 | 3517553 | 8.4 | 816 | 56 | 486 | 73 | 294 | 76.2 | 2.4 | 88 | 176 | 74 |
| **Loc_07** | Al-Rifai | 604402 | 3510336 | 8.5 | 836 | 52 | 598 | 76 | 304 | 77.7 | 2.4 | 98 | 217 | 76 |
| **Loc_08** | Al-Rifai | 604618 | 3503113 | 8.4 | 816 | 60 | 562 | 73 | 294 | 77.4 | 2.4 | 89 | 202 | 74 |
| **Loc_09** | Al-Rifai | 605139 | 3497376 | 8.4 | 816 | 38 | 556 | 73 | 294 | 76.8 | 2.4 | 89 | 204 | 74 |
| **Loc_10** | Alnsar | 606572 | 3490151 | 8.4 | 827 | 42 | 494 | 73 | 294 | 76.5 | 2.1 | 90 | 182 | 76 |
| **Loc_11** | Alnsar | 607111 | 3488073 | 8.3 | 851 | 68 | 488 | 76 | 304 | 78.0 | 2.1 | 94 | 208 | 76 |
| **Loc_12** | Albdai | 610310 | 3480678 | 8.6 | 848 | 38 | 680 | 76 | 304 | 79.5 | 2.4 | 92 | 246 | 76 |
| **Loc_13** | Alshatra | 610775 | 3476436 | 8.4 | 846 | 36 | 450 | 76 | 304 | 75.9 | 2.4 | 93 | 205 | 76 |
| **Loc_14** | Alshatra | 612325 | 3472145 | 8.4 | 855 | 40 | 646 | 76 | 304 | 76.5 | 2.4 | 94 | 214 | 76 |
| **Loc_15** | Alshatra | 614373 | 3468526 | 8.6 | 881 | 36 | 602 | 77 | 308 | 89.7 | 3.9 | 98 | 208 | 78 |
| **Loc_16** | Algarraf | 617100 | 3464176 | 8.5 | 866 | 54 | 526 | 77 | 308 | 79.2 | 2.4 | 100 | 214 | 78 |
| **Loc_17** | Algarraf | 618738 | 3462765 | 8.5 | 872 | 16 | 628 | 77 | 308 | 76.5 | 2.4 | 102 | 220 | 78 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Max. | 8.6 | 881 | 68 | 680 | 77 | 308 | 89.7 | 3.9 | 102 | 246 | 78 |
| Min. | 8.3 | 790 | 16 | 446 | 72 | 290 | 73.5 | 1.8 | 88 | 171 | 72 |
| Mean | 8.418 | 834.2353 | 43.176 | 550.94118 | 74.53 | 299.2 | 77.29 | 2.4 | 92.41 | 199.2 | 75.06 |
| SD | 0.095 | 25.43504 | 13.566 | 69.401432 | 1.841 | 6.366 | 3.553 | 0.424 | 4.57 | 20.7 | 2.015 |

**Table (2):** Test results using (ph-meter &oakton pcs testr 35) devices and Test results conducted in the Department of the Environment Water / Najaf Governorate **(**date**:** 11/MAY/2017).

**Table (3):** Irrigation water Iraqi standards

| Water quality parameters | Standards |
|---|---|
| PH | 4-8.6 |
| Total Dissolved Solid (T.D.S) mg/l | 2500 |
| Alkalinity (ALK) mg/l | 200 |
| Electrical Conductivity (E.C) mg/l | 2250 |
| Calcium(Ca)mg/l | 450 |
| Chloride (Cl) mg/l | 250 |
| Sulfate (SO4) mg/l | 200 |
| Potassium (k) mg/l | 100 |
| Total suspended solids (T.S.S) mg/l | 60 |
| Total hardness (TH) mg/l | 300 |
| Sodium (Na) mg/l | 250 |

**Table (4):** Water quality index scale.

| WQI | Water quality |
|---|---|
| 0-25 | Excellent |
| 26-50 | Good |
| 51-75 | Poor |
| 76-100 | Very poor |
| >100 | Unsuitedable |

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**Table (5):** Arithmetic weight index calculation for 04/FEB/2017

| No | Sites | par. | Ph | EC | TDS | TSS | ALK | TH | Ca | Na | K | Cl | SO4 | WQI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Wi** | **0.694** | **0.002** | **0.019** | **0.023** | **0.029** | **0.002** | **0.013** | **0.059** | **0.099** | **0.023** | **0.029** | |
| **1** | **Loc_01** | | 53.12 | 66.40 | 40.64 | 100.0 | 64 | 162.00 | 26.88 | 57.12 | 4.0 | 61.20 | 206.5 | 61.879 |
| **2** | **Loc_02** | | 63.12 | 69.68 | 40.88 | 73.33 | 68 | 169.33 | 28.22 | 58.40 | 4.4 | 59.20 | 140.2 | 64.499 |
| **3** | **Loc_03** | | 73.75 | 65.37 | 40.72 | 50.00 | 64 | 160.66 | 26.66 | 57.28 | 4.0 | 58.40 | 202.5 | 71.016 |
| **4** | **Loc_04** | | 77.50 | 65.64 | 40.80 | 96.66 | 64 | 160.66 | 26.66 | 56.96 | 4.0 | 59.20 | 204.0 | 78.327 |
| **5** | **Loc_05** | | 78.12 | 65.60 | 41.04 | 100.0 | 64 | 160.66 | 26.66 | 58.08 | 4.0 | 56.00 | 193.0 | 78.713 |
| **6** | **Loc_06** | | 81.87 | 65.51 | 41.20 | 60.00 | 64 | 160.66 | 26.66 | 58.56 | 4.0 | 57.20 | 197.5 | 77.511 |
| **7** | **Loc_07** | | 81.87 | 65.42 | 41.28 | 116.6 | 63 | 160.66 | 26.66 | 57.92 | 4.0 | 57.60 | 196.0 | 83.075 |
| **8** | **Loc_08** | | 86.87 | 65.20 | 41.44 | 70.00 | 63 | 160.66 | 26.66 | 58.08 | 4.0 | 58.08 | 248.5 | 83.493 |
| **9** | **Loc_09** | | 89.37 | 66.53 | 41.04 | 36.66 | 64 | 162.00 | 26.88 | 56.80 | 4.0 | 57.60 | 198.5 | 80.428 |
| **10** | **Loc_10** | | 87.50 | 65.77 | 41.20 | 93.33 | 64 | 162.00 | 26.88 | 58.08 | 4.0 | 56.00 | 187.0 | 84.416 |
| **11** | **Loc_11** | | 88.75 | 65.77 | 41.12 | 120.0 | 64 | 162.00 | 26.88 | 57.28 | 4.0 | 57.20 | 202.0 | 88.398 |
| **12** | **Loc_12** | | 88.75 | 65.68 | 40.96 | 110.0 | 64 | 160.66 | 26.66 | 57.76 | 4.0 | 57.60 | 204.0 | 87.433 |
| **13** | **Loc_13** | | 89.37 | 65.82 | 40.88 | 46.66 | 64 | 160.66 | 26.66 | 58.08 | 4.0 | 61.20 | 204.0 | 81.673 |
| **14** | **Loc_14** | | 98.75 | 66.00 | 40.72 | 60.00 | 64 | 160.66 | 26.66 | 57.92 | 4.0 | 59.60 | 206.5 | 89.548 |
| **15** | **Loc_15** | | 112.5 | 65.95 | 40.08 | 46.66 | 64 | 160.66 | 26.66 | 58.24 | 4.0 | 57.60 | 197.0 | 97.451 |
| **16** | **Loc_16** | | 104.3 | 66.75 | 41.44 | 66.66 | 65 | 162.00 | 26.88 | 58.08 | 4.0 | 59.60 | 199.0 | 93.963 |
| **17** | **Loc_17** | | 83.75 | 68.08 | 41.60 | 93.33 | 66 | 163.33 | 27.11 | 58.72 | 4.4 | 54.80 | 201.0 | 82.336 |

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**Table (6):** Arithmetic weight index calculation for 11/MAY/2017

| No | Sites | par. | Ph | EC | TDS | TSS | ALK | TH | Ca | Na | K | Cl | SO4 | WQI |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Wi** | **0.694** | **0.002** | **0.019** | **0.023** | **0.029** | **0.002** | **0.013** | **0.059** | **0.099** | **0.023** | **0.029** | |
| **1** | **Loc_01** | | 87.50 | 36.80 | 22.56 | 56.66 | 37 | 98.00 | 16.22 | 29.88 | 2.4 | 36.0 | 90.50 | 74.28 |
| **2** | **Loc_02** | | 87.50 | 35.11 | 17.84 | 96.66 | 36 | 96.66 | 16.00 | 29.40 | 2.1 | 35.2 | 93.00 | 78.22 |
| **3** | **Loc_03** | | 81.25 | 35.91 | 19.28 | 56.66 | 36 | 98.00 | 16.22 | 30.24 | 1.8 | 35.6 | 85.50 | 69.72 |
| **4** | **Loc_04** | | 81.25 | 35.91 | 23.92 | 40.00 | 36 | 98.00 | 16.22 | 29.88 | 2.4 | 35.6 | 90.50 | 68.24 |
| **5** | **Loc_05** | | 81.25 | 36.35 | 22.40 | 80.00 | 37 | 98.00 | 16.22 | 30.24 | 2.4 | 35.2 | 85.50 | 72.10 |
| **6** | **Loc_06** | | 87.50 | 36.26 | 19.44 | 93.33 | 37 | 98.00 | 16.22 | 30.48 | 2.4 | 35.2 | 88.00 | 77.80 |
| **7** | **Loc_07** | | 93.75 | 37.15 | 23.92 | 86.66 | 38 | 101.3 | 16.88 | 31.08 | 2.4 | 39.2 | 108.5 | 82.37 |
| **8** | **Loc_08** | | 87.50 | 36.26 | 22.48 | 100.0 | 37 | 98.00 | 16.22 | 30.96 | 2.4 | 35.6 | 101.0 | 78.93 |
| **9** | **Loc_09** | | 87.50 | 36.26 | 22.24 | 63.33 | 37 | 98.00 | 16.22 | 30.72 | 2.4 | 35.6 | 102.0 | 75.30 |
| **10** | **Loc_10** | | 87.50 | 36.75 | 19.76 | 70.00 | 38 | 98.00 | 16.22 | 30.60 | 2.1 | 36.0 | 91.00 | 75.65 |
| **11** | **Loc_11** | | 81.25 | 37.82 | 19.52 | 113.3 | 38 | 101.3 | 16.88 | 31.20 | 2.1 | 37.6 | 104.0 | 76.14 |
| **12** | **Loc_12** | | 100.0 | 37.68 | 27.20 | 63.33 | 38 | 101.3 | 16.88 | 31.80 | 2.4 | 36.8 | 123.0 | 84.79 |
| **13** | **Loc_13** | | 87.50 | 37.60 | 18.00 | 60.00 | 38 | 101.3 | 16.88 | 30.36 | 2.4 | 37.2 | 102.5 | 75.11 |
| **14** | **Loc_14** | | 87.50 | 38.00 | 25.84 | 66.66 | 38 | 101.3 | 16.88 | 30.60 | 2.4 | 37.6 | 107.0 | 75.94 |
| **15** | **Loc_15** | | 100.0 | 39.15 | 24.08 | 60.00 | 39 | 102.6 | 17.11 | 35.88 | 3.9 | 39.2 | 104.0 | 84.19 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **16** | **Loc_16** | 93.75 | 38.48 | 21.04 | 90.00 | 39 | 102.6 | 17.11 | 31.68 | 2.4 | 40.0 | 107.0 | 82.74 |
| **17** | **Loc_17** | 93.75 | 38.75 | 25.12 | 26.66 | 39 | 102.6 | 17.11 | 30.60 | 2.4 | 40.8 | 110.0 | 76.53 |

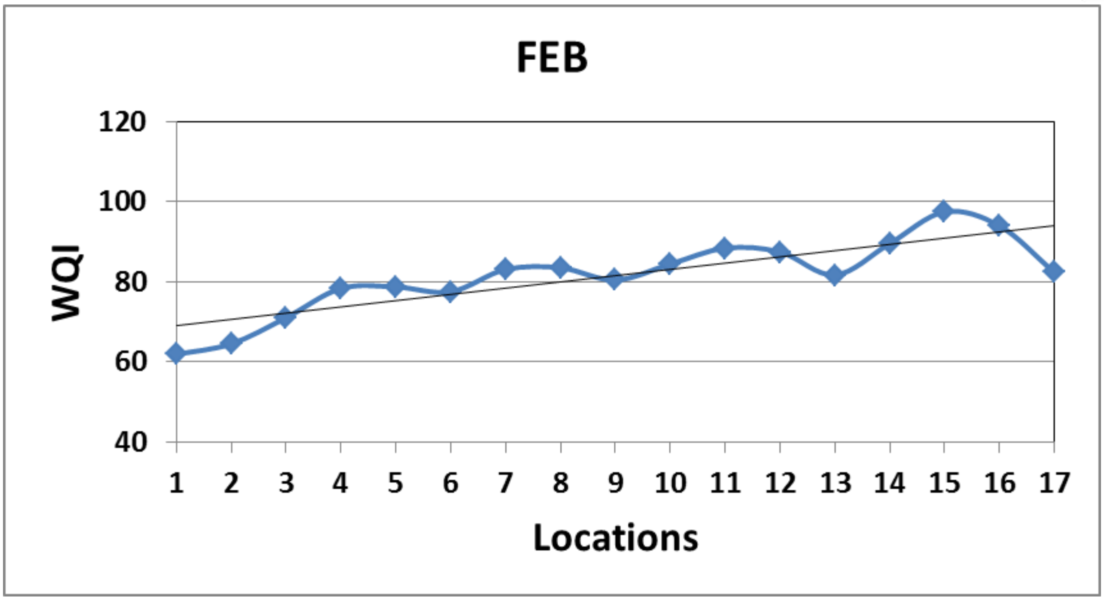


Figure (2): Variation of AW-WQI with Sample Location for 04/FEB/2017

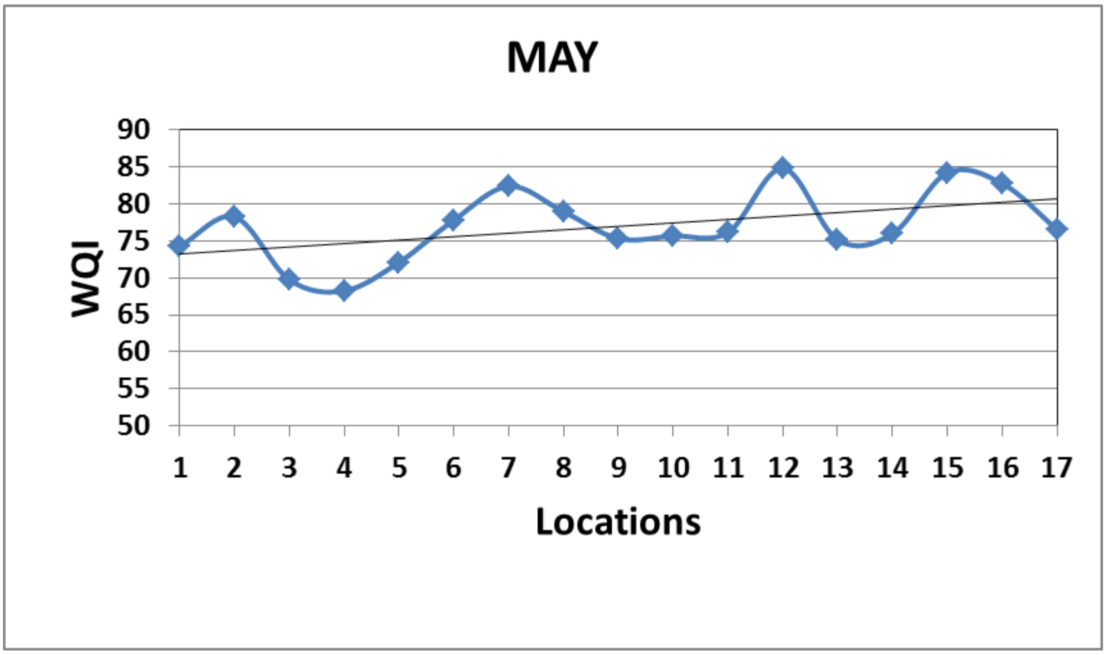


Figure (3): Variation of AW-WQI with Sample Location for 11/MAY/2017

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