

PAPER • OPEN ACCESS

Water Quality Index for Surface Water Assessment by Using Gis Techniques, Alnajaf, Kufa, Iraq

To cite this article: Ali Kadhim Hussein *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **928** 072023

View the [article online](#) for updates and enhancements.

You may also like

- [Determination of long-lived gamma emitters in some vegetarian products in Al-Najaf governorate using NaI\(Tl\)](#)
Ali Saeed jassim, Adnan Hassoon Oraibi, Ali Abid Abojassim et al.
- [Futurity scenario of water resources management in Bahr An-Najaf basin in Iraq](#)
Hassan Ali Omran, Mohammed Sh Mahmood and Ali Abbas Kadhem
- [Measuring The Water Pollution Of selected Sites In Al- Najaf Covenarate\(TSS\) And Using Remote Sensing Data](#)
Zeena Yaseen Mahdy and Hussain Mihyi Ali



ECS
The
Electrochemical
Society
Advancing solid state &
electrochemical science & technology

DISCOVER
how sustainability
intersects with
electrochemistry & solid
state science research

WATER QUALITY INDEX FOR SURFACE WATER ASSESSMENT BY USING GIS TECHNIQUES, AL-NAJAF, KUFA, IRAQ

Ali Kadhim Hussein¹, Nabeel Abbood Kadhim², Adil Shnawa Jaber² and Ali Abid Abojassim^{3*}

Basic science Department, College of Dentistry, University of Kufa, Kufa, Najaf, Iraq¹.

Ministry of education, Najaf education office, Najaf, Iraq²

Physics Department, Faculty of Science, University of Kufa, Najaf, Iraq³

ali.alhameedawi@uokufa.edu.iq

ABSTRACT

Our study achieved in AL-Najaf province within kufa district which are consist of stream network, in dry season (2016), there are thirteen samples collected and six physicochemical parameter analyzed in laboratory of environment in surface water and agriculture directorate in AL-Najaf Province. Six physicochemical parameter like Ec (mmho/cm), TDS(mg/liter), Ca+2(mg/liter), Cl-(mg/liter), So4-2(mg/liter), and PH. For irrigation purpose Standards Iraq were used and inverse distance waited(IDW) interpolation has been used to make of six parameters spatial distribution map above. Raster calculator of Arc map GIS 10.2 software presented water quality index for surface water samples ranged between 53.5092 - 87.5235.

Key word: Water quality index , GIS, physicochemical parameters

1. INTRODUCTION

Water quality index (WQI) is indicated the feature of water in conditions of index number for any intended use. It defines as an evaluation reflecting the compound influence of different water quality parameters were taken for computation of water quality index [1]. WQIs have been frequently used in estimation of potable water; very restricted study has been carried out to evaluate the water for agriculture purpose [2]. WQI is the mechanism for submitting a cumulatively derived numerical exposure defining a sure degree over of water quality [3]. In other words, WQI summarizes huge quantities of water quality data of easy terms (e.g., excellent, good, bad, etc.) because reporting in imitation of administration and the community between a regular behaviour [4]. Most of the job over the WQI has been devoted to surface water such as streams with sake concerning classifying the water for aquatic and agriculture uses. During this study, an effort has been made to implement a review of important indices which used for the surface water quality assessment in steam network of kufa was placed within sedimentary flat east of Al-Najaf city. The salts



aside from affecting the increase of plants also affect the soil structure, permeability and aeration which indirectly have an effect on plant growth. Higher salt substance in water of irrigation leads to a raise in the soil solution osmotic pressure [5,6]. It has been defined GIS as a technique to capture, retrieve, store, analyses and predict [7]. The incorporation of WQIs with GIS provides the comprehensive, rapid and dependable information for decision makes to adopt or realize strategies related to water pollution and scarcity [8]. In this study six parameters have been chosen which are (electrical conductivity (EC), total dissolved solids (TDS), Ca^{+2} , Cl^- , SO_4^{2-} , and, pH). The mentioned parameters in this method were selected irrigation water according to Iraq standard [9]. The results are appeared in spatial distribution maps by using Arc GIS software. The classified resulted of WQI values into three classes (good, moderate, and poor water). Thirteen samples have been collected and navigated by GPS GARMIN 72H. we are used GIS version 10.2 for Geo-reference and map of the digitize irrigation which are collected from directorate of water resources in AL-Najaf province.

2. METHODOLOGY

2.1 STUDY AREA

Kufa district center is located about (8.99) km eastern of AL-Najaf district center see Figure (1), is geographically located $44^{\circ}20'0''$ - $44^{\circ}37'30''$ E and $31^{\circ}58'30''$ - $32^{\circ}12'30''$ N. AL-Najaf province is located in south-west part of Iraq, covering an area of (185788.72) donums, the sub districts are located within of AL-Kufa district center are Al-Abbassiya sub district and Al-Huriya sub district[10] .

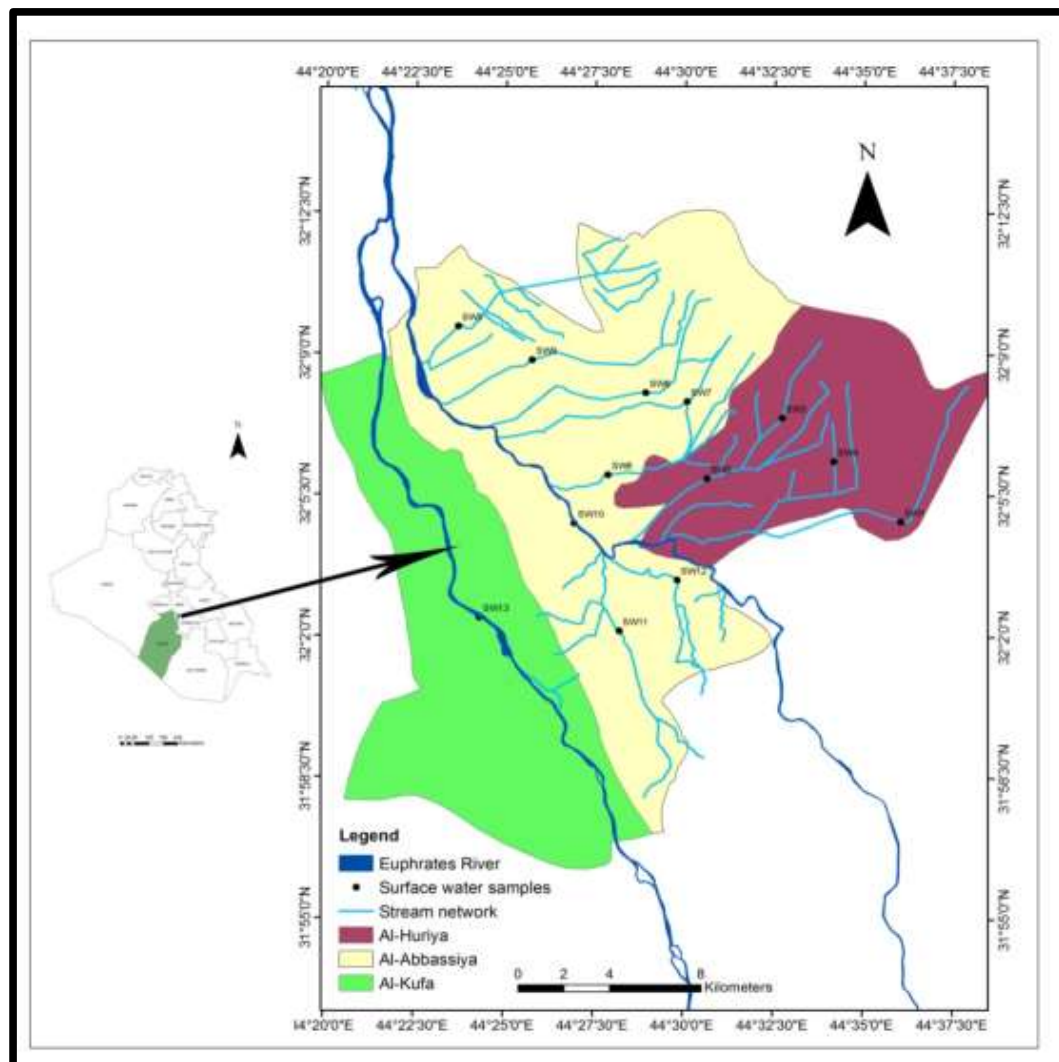


Fig.(1): Study area location.

Table (1): Parameters Analysis of Surface water in AL-Kufa District Center.

SW	Sample site	Location	Eastin g \m	Northi ng \m	EC mmho/ cm	PH	Ca mg/lite r	So4 mg/lite r	Cl mg/lite r	TDS mg/lite r
SW1	Alhma si alfryaa	Al-Huriya	46229 4	35494 56	1.6	7.06	171.8	548.2	153	1247
SW2	ALzya di	Al-Huriya	45366 3	35513 50	1.3	7.02	141	402.4	136	915
SW3	Algaza li	Al-Huriya	45694 4	35540 37	1.4	7.01	124	396.1	120	977

SW4	Abo hlan	Al-Huriya	460023	3553918	1.5	6.94	144	527	153.5	1216
SW5	Alhdar i	Al-Abbas siya	442798	3558174	1.3	6.8	137	478	128	1118
SW6	Alama a	Al-Abbas siya	449389	3551644	1.3	6.89	149	509	134	1112
SW7	Alarya n	Al-Abbas siya	452953	3554996	1.7	7.03	138	526	154	1211
SW8	Abogr ab	Al-Abbas siya	451117	3555345	1.2	7.28	120	416.19	150	991
SW9	Wahha bi	Al-Abbas siya	446147	3556966	1.3	7.5	133	514.3	159	1235
SW10	Abbas siya River	Al-Abbas siya	447942	3549420	1.3	8.7	130.7	341	133	987
SW11	Tobar saed jowad	Al-Abbas siya	449965	3544509	1.2	7.4	127	363	122	918
SW12	Abo hora	Al-Abbas siya	452537	3546854	1.2	8.8	124.7	354	124	943
SW13	Kufa River	Al-kufa	443803	3545125	1.3	6.91	128	361	119	863

2.2 COLLECTION OF SURFACE WATER SAMPLES AND PHYSICOCHEMICAL ANALYZED

Through the dry season(2016) **the GPS GARMIN72H** has been applied to navigate of GCPS of 13 random samples in kufa district by using stream networks , the parameters have been selected, Electrical Conductivity(EC), Chloride(Cl-),Calcium(Ca²⁺), Sulphate (So₄²⁻), Hydrogen Ion Concentration (pH) and total dissolves sold(TDS). The inverse distance weighted (IDW) interpolation has been used to generate six parameters spatial distribution map see figure (2). Table (1), shows these parameters and their samples site, location, easting and northing.

3.2 WATER QUALITY INDEX CALCULATION

The WQI is calculated from different diverse physicochemical parameters. To compute WQI, four steps are followed [11]. In the first step, the quality rating scale is assigned to the parameter which is also weighed according to its relation importance in the quality of water for irrigation uses. These weights have been ranged from 1 to 5. The most weight assigned to parameter that has chief importance in water quality assessment, while the least weight assigned to that parameter that may not be harmful. The standards for irrigation water as

recommended by Iraq Standards and relative weight of physicochemical parameters are given in Table (2).

The relative weight (Rw_i) was computed utilizing the following Equation (1) [12] [13].

$$RW_i = \frac{W_i}{\sum_i^n W_i} \dots \dots \dots (1)$$

where (RW_i) is the relative weight, (W) is the limited weight for each parameter and n is the parameters number. The relative weight(WR) values of each parameter have been given in Table(2). In the third step, a quality grading scale(q_i) for each water parameter is computed by dividing its concentration by its typical consistent with the guidelines of [14] and then multiplied by 100:

$$q_i = \left(\frac{C_i}{S_i} \right) \times 100 \dots \dots \dots (2)$$

$$q_i = \left(\frac{C_0 - C_i}{C_s - C_l} \right) \times 100 \dots \dots \dots (3)$$

C_0 and C_i were represented the observed and ideal values respectively. C_s is the Iraq irrigation water standard of each chemical parameter consistent with the guidelines of Table (2) [9]. In most cases C_i is equal to zero except in certain parameters such as pH, dissolved oxygen etc.

Table (2): Relative weight of Physicochemical parameters.

Parameters	Iraq Standards for irrigation purpose 2012	Weight (Wi)	Relative weight(Wi)
EC (mmho/cm)	2.5	5	0.2778
TDS(mg/liter)	2500	4	0.2222
Ca ⁺² (mg/liter)	450	1	0.0556
Cl ⁻ (mg/liter)	250	3	0.1667
So4 ⁻² (mg/liter)	200	2	0.1111
PH	4-8.6	3	0.1667

$$SI_i = W_i \times q_i \dots \dots \dots (4)$$

Finally, WQI is computed by adding together each sub index values of each water samples as follows:

$$WQI = \sum_{i=1}^n SI_i \dots \dots \dots (5)$$

The values of WQI have usually been classified into three categories good water, moderate water, and poor water for irrigation uses [15] as shown in Table (3). In this paper, the WQI values range computed are ranging from 53.5092 to 87.5235 so that , we can be classified

into three types “good water” to “poor water for irrigation uses”. Table(3) display the percentage of water samples that falls under different quality.

3. RESULTS AND DISCUSSION

3.1 WATER QUALITY INDEX

The computed WQI values range from 53.5092- 87.5235 and therefore, can be categorized into three types “good, moderate, and poor water”, see Table(3).

Table (3) : Water quality classification based on WQI values.

WQI	Water quality	Color in Map	Percentage of water samples
<64	Good water	Green	20.174312
64-71	Moderate water	yellow	67.136037
>71	Poor water	Red	12.689651

The GIS software were used for drawing the WQI map of The obtained WQI values as seen in figure (3). Concerning the Table (3) it is clear that the good type appears the dominated water quality in the study area. Figure (3) detects the spatial distribution of the different water qualities according to WQI values, where the yellow part appear the locations of the best available water quality in the study area then the green parts which represent the good type while the poor type was exhibited in red color..

3.2 PHYSICOCHEMICAL PROPERTIES OF SURFACE WATER

The quality of surface water is varied from site to site depending up on surface characteristics. The variations of water quality have been discussed below.

- **HYDROGEN ION CONCENTRATION (PH)**

Acidic water involves a pH value less than 7 and basic water involves a value greater than 7. According to Table(1) the PH of the surface water samples varies from **6.80 to 8.8** with an average is **7.39** that is refer to the water is slightly alkaline, where in sample sites (**sw10,sw12**), which is exceeding the acceptable limit has been given by SOI (**8.6**) that were unfit for the irrigation uses while other of sample sites were within the permissible limit given by SOI (**8.6**).

- **ELECTRICAL CONDUCTIVITY (EC)**

Electrical conductivity is measured of the capability of water for carrying an electrical current. This capacity involves the total amount of solids dissolved in the water. Thus water with high ions content **material** tends to have higher conductivity, who is an indicator of high solid concentration dissolved within the water. For all the sample sites EC is located between **1.2 to 1.7 mmho\cm** with an average of **1.36 m\cm** which is listed within the permissible limit given by SOI (**2.5 mmho\cm**).

- **TOTAL DISSOLVES SOLID (TDS)**

Total dissolves solid has a range from **863 to 1247 mg\liter** with the average about **1056.2 mg\liter**, which is located within the permissible limit has been given by SOI (**2000mg\liter**), that is suitable for the irrigation uses. From noticed that increased concentration of TDS in dry season due to increase of temperatures and decreased level

of water in stream network as especially in samples of (sw1,sw2,sw3,sw4,sw5,sw6,sw7,sw9).

- **CALCIUM (CA^{+2})**

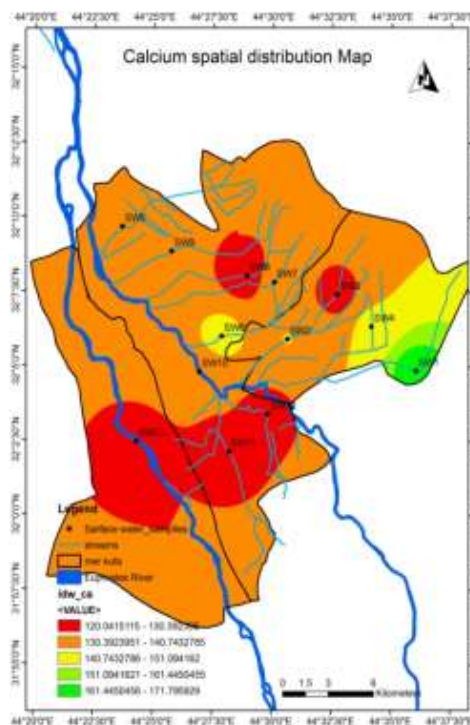
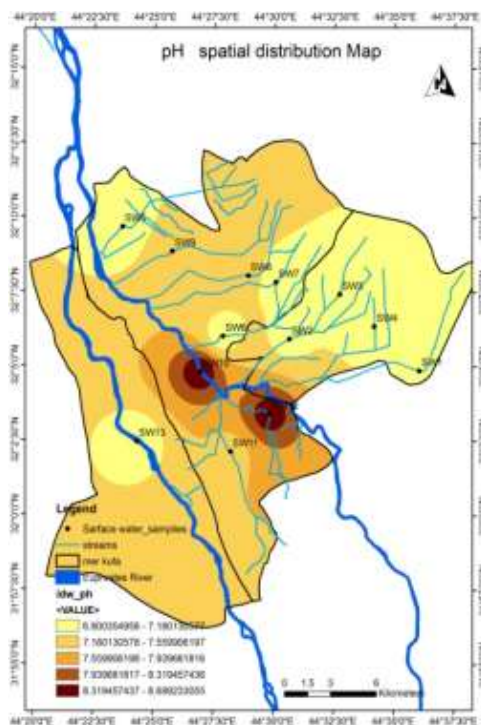
Calcium in surface water samples varies from **120 to 171.8** mg\liter with an average of **137.33** mg\liter, for all the samples it is within the permissible limit given by SOI (**450** mg\liter), that it is suitable for the irrigation uses. From noted that the increased concentration of Calcium in the samples locations of (sw1,sw2,sw3,sw4,sw5,sw6,sw7).

- **CHLORIDE (CL^{-})**

Chloride in surface water samples varies from **119 to 159** mg\liter with an average of **137.33** mg\liter, for all samples it is within the permissible limit given by SOI (**250** mg\liter), that it is suitable for the irrigation uses. From noted that the increased concentration of Chlorid in the samples locations of (sw1, sw2, sw4, sw6, sw7, sw8, sw9).

- **SULPHATE (SO_4^{-2})**

Suphate in surface water samples varies from **341 to 548.2** mg\liter with an average of **441.69** mg\liter, for all the samples it does not within the permissible limit given by SOI (**200** mg\liter) that is unfit for the irrigation uses. From noticed that the increased concentration of sulphate in the samples locations of (sw1, sw2, sw4, sw6, sw7,sw8,sw9).



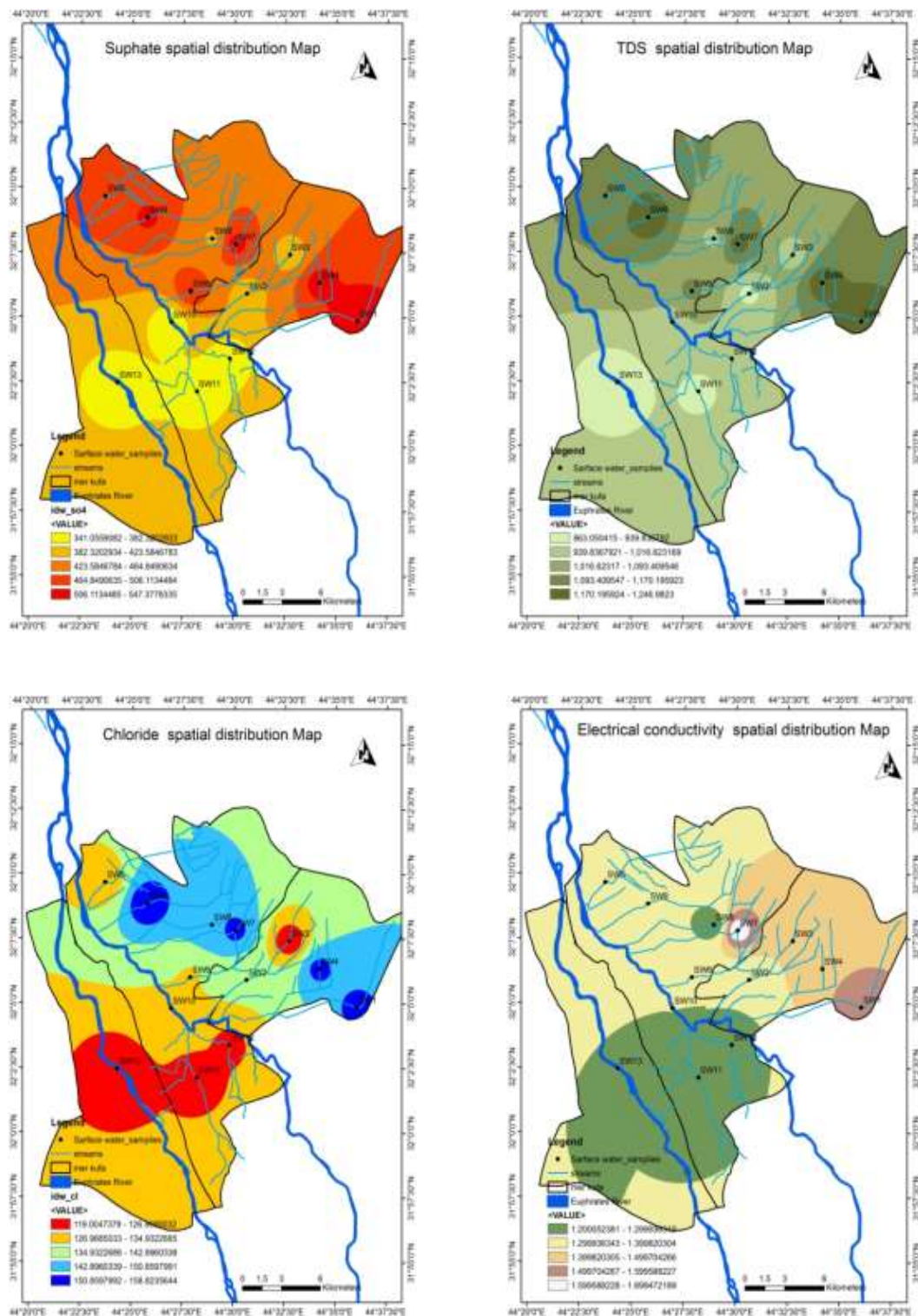


Fig.(2): Spatial distribution Map of six Parameters.

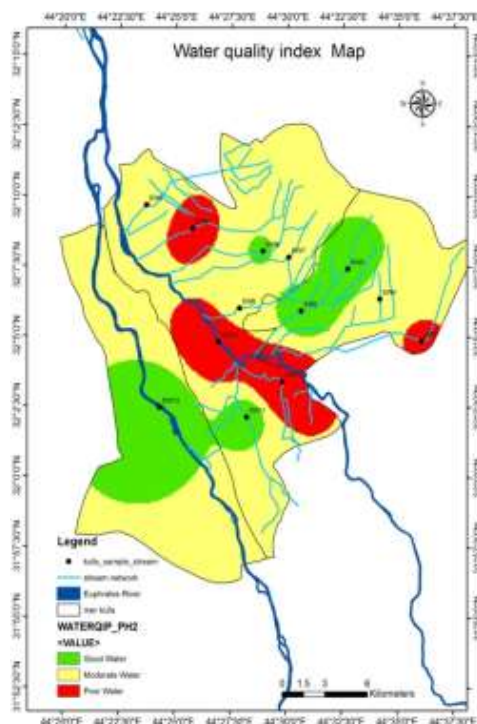


Fig. (3): Water quality index Map of the study area.

4. CONCLUSIONS

The Arc GIS software is powerful tool to create the spatial distribution maps of physicochemical parameters. The value of Water Quality Index ranges from 53.5092-87.5235 and for the study area. The resulting WQI values can be classified into three types (good, moderate, and poor water). The poor water for irrigation purpose according to Iraq standards appeared in the north eastern, middle and the north western parts covers 12.689651%, while the good and moderate water have been covered about 20.174312-67.136037% of the study area.

5. REFERENCES

- [1] Rao, C.S., Rao, B. S., Hariharan, A.V.L.N.S.H. and Bharathi, N.M. (2010). Determination of water quality index of some areas in Guntur district Andhra Pradesh. *International Journal of Applied Biology and Pharmaceutical Technology*, 1: Issue-1, 79-86.
- [2] Singh, S.K., Srivastava, P.K., Singh, D., Han, D., Gautam, S.K., & Pandey, A.C. (2015). Modeling groundwater quality over a humid subtropical region using numerical indices, earth observation datasets, and X-ray diffraction technique: A case study of Allahabad district, India. *Environmental Geochemistry and Health*, 37(1), 157–180. doi:10.1007/s10653-014-9638-z.
- [3] A.A. Bordalo, R. Teixeira, W.J. Wiebe, W. J., (2006), A water quality index applied to an international shared river basin: The case of the Douro River, *Environ Manag.* 38 (2006) 910–920.

- [4] N. Bharti, D. Katyal (2011) Water quality indices used for surface water vulnerability assessment. *Int. J. Environ Sci.* 2(1) (2011) 154-173.
- [5] Shaki, A.A., & Adeloje, A.J. (2006). Evaluation of quantity and quality of irrigation water at Gadowa irrigation project in Murzuq basin, southwest Libya. *Agricultural Water Management*, 84, 193–201.
- [6] Thorne, D.W., & Peterson, H.B. (1954). *Irrigated soils*. London: Constable and Company.
- [7] Gajbhiye, S., Meshram, C., Singh, S.K., Srivastava, P.K., & Islam, T. (2016). Precipitation trend analysis of Sindh River basin, India, from 102-year record (1901-2002). *Atmospheric Science Letters*, 17, 71–77.
- [8] Singh, S.K., Srivastava, P.K., Pandey, A.C., & Gautam, S.K. (2013b). Integrated assessment of groundwater influenced by a confluence river system: Concurrence with remote sensing and geochemical modelling. *Water Resources Management*, 27 (12), 4291–4313. doi: 10.1007/s11269-013-0408-y
- [9] Dheyaa W. Abbood, Karim R. Gubashi, Hanan H. Abbood, (2014), "Evaluation of Water Quality Index in the Main Drain River in Iraq by Application of CCME Water Quality", ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online), Vol.6, No.8.
- [10] Agriculture directorate in AL- Najaf province.
- [11] Gebrehiwot, A.B., Tadesse, N. and Jigar, E. (2011) Application of Water Quality Index to Assess Suitability of Groundwater Quality for Drinking Purposes in Hantebet Watershed, Tigray, Northern Ethiopia. *ISABB Journal of Food and Agriculture Science*, 1, 22-30.
- [12] Brown, R.M., McClelland, N.J., Deininger, R.A. and O'Connor, M.F. (1972) A Water Quality Index—Crossing the Psychological Barrier. *Proceedings of the. International Conference on Water Pollution Research*, Jerusalem, 18-24 June 1972, 787-797.
- [13] Tiwari, J.N. and Manzoor, A. (1988) Water Quality Index for Indian Rivers. In: Trivedy, R.K., Ed., *Ecology and Pollution of Indian Rivers*, Aashish Publishing House, New Delhi, 271-286.
- [14] WHO (2004) *Guidelines for Drinking Water Quality*. 3rd Edition, World Health Organization, Geneva
- [15] Hazim Kareem Manhi, (2012), *Groundwater Contamination Study of the Upper Part of the Dibdibba Aquifer in Safwan Area (Southern Iraq)*, Master Thesis, College of science, University of Baghdad.