Develop and Apply Water Quality Index to Evaluate Water Quality of Shatt-Al-Hilla River

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Abstract:

This study is an attempt to develop Shatt-Al-Hilla river water quality index (WQI) which can be applied to evaluate the general water quality of the main Iraqi rivers or streams in its entire stretch for public uses. The index proposed in this work is composed of seven measurable parameters: Total hardness (TH), Electrical conductivity(EC),Acidity (PH), Total dissolved solids (TDS), Sulphate(SO_4), Calcium(Ca). Chloride(CL). WQI is a mean to summarize large amount of water quality data into simple terms (e.g., good or poor) for reporting to authorities management and the public in a consistent manner. Visual Basic can be effectively used to evaluate the variations of surface water quality in any rivers or stream in Iraq.

In the present study, surface water samples were gathered (monthly two samples) from differentfive regions located at Shatt Al-Hillariver during culturing period from October 2014 to September ,2015.

Sodium absorption ratio(SAR), permeability(PI)and magnesium hazard(MH) were calculated to evaluate the water quality depending on arithmetic method of (WQI) and Iraqi standard No.417 for 2004.

Values of WQI ranged from (45.789 -37.234)at Hilla city and rated good according to the classification of Iraq Standard ,2004 and WHO ,2004. These values belong to high water electrical conductivity and chloride of the studied wells comparable with other parameters. Also, correlation coefficient support this interpretation where there are strong positively correlation between WQI values and both electrical conductivity and chloride values (0.987, 0.909 respectively).As a compared with SAR for all five stations ,there values are (S_2) with(12-18), and sodium (%) (35-54),it means permissible type according to specification of Na%. These values associated with both EC and Cl^- in a strong negatively correlation (0.990, 0.912 respectively).

Application program can be considered as a good and fast tool to evaluate (WQI) for every river or stream in Iraq.

Keywords: Surface water quality -water quality- WQI.

الخلاصة:

تهدف هذه الدراسة لتطوير برنامج لحساب قيمة معامل نوعية المياه لشط الحلة (WQI) والذي يمكن تطبيقه لتقييم نوعية المياه والذي يمكن تطبيقه لاي نهر في العراق لتقييم نوعية المياه للاستخدامات المختلفة.

معامل نوعية المياه تم حسابه من خلال سبع محددات مقاسة : العسرة الكلية، التوصيلية الكهربائية، الحامضية، الاملاح الذائبة الكلية، الكبريتات، الكالسيوم،الكلوريدات. معامل نوعية المياه هو حاصل جمع قيم البيانات للنماذج المأخوذه بدلالة مصطلح بسيط (مثل جيد ، ردئ) لاعطاء تقرير الى الادارة والمجتمع بطريقة متماسكة. تطبيق برنامج (الفيجوال بيسك) يعتبر اداة فعالة لتقييم الاختلاف في نوعية المياه السطحية لمختلف الانهار في العراق.

في هذه الدراسة تم جمع العينات (نموذجين شهريا) من مياه شط الحلة من خمسة مناطق موزعة على طول النهر من دخوله لمدينة الحلة خلال الفترة من تشرين الاول 2014 ولغاية ايلول 2015.

تم حساب (نسبة امتصاص الصوديوم، نسبة النفاذية ، قيمةالمغنيسوم الخطير، قيمة النفاذية) وذلك لأهميتها في تقييم نوعية المياه بالاعتماد على الطريقة الحسابية في استخراج (WQI) وبالاعتماد على المواصفات القياسية العراقية رقم 417 لسنة 2004 .

تراوحت قيم معامل نوعية المياه بين(37.234− 45.789) في مدينة الحلة وحسب المواصفات العراقية رقم 417 لسنة 2004 ومواصفات منظمة الصحة العالمية 2004، وتعتبر جيدة والسبب يعود لكون قيم التوصيلية عالية مع قيم الكلورايد وهذا ما اثبتته علاقة الارتباط الخطي بين قيم المحددات الكلية وبين قيم معامل نوعية المياه اذ اثبت انه اعلى قيم تكون للتوصيلية الكهربائية والكلورايد (0.909, 0.987) على التوالي. وبمقارنة قيم امتزاز الصوديوم للمواقع الخمسة المختارة على شط الحلة ، تعتبر من ضمن تصنيف(S_2) بقيم (18−12) لكافة المواقع ونسبة الصوديوم (54−35) % وهذا يدل على ان المياه جيدة نوعا ما للاستخدامات المختلفة . وهذا ما اثبته تحليل لارتباط الخطي باعلى قيم بين معامل نوعية المياه وبين كل من التوصيلية الكهربائية والكلورايد (0.912−, 0.990) على التوالي.

اما التطبيق البرمجي فيعتبر خطوة سريعة وجيدة لتطبيق البرنامج على اي نهر في العراق وايجاد قيم معامل نوعية المياه لها.

الكلمات المفتاحية : نوعية المياه السطحية ، نوعية المياه، معامل نوعية المياه.

Introduction

The availability of water in terms of both quality and quantity is essential for the very existence of mankind. Water, though indispensable and plays a pivotal role in our lives, is one of the most badly abused resources. Lack of awareness and civic sense, use of inefficient methods and technology lead to more than 50% of water wastage in the domestic, agriculture & industrial sectors. Water pollution is rendering much of the available water unsafe for consumption. There is heavy extraction of water for domestic, industrial and agricultural purpose. Age-old customs and habits of community, cattle bathing and washing in rivers are responsible for rampant pollution of river water. The release of domestic waste water, agricultural runoff water & industrial effluents promote excessive growth of algae in water bodies, results in their eutrophication.

In Iraq, Water resources, 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 , Halihan,2010),(Jones*,et.al*., 2008). It is not surprising that, due to the above factors, studying water quality is so much important to be carried out in order to keep our awareness and understanding of our environment. Also, accurate information on the condition and trends of water resources quantity and quality is required as a basis for economic and social development, and for the development and maintenance of environmental quality.

Water quality index is one of the most effective tools to communicate information on the quality of water to the concerned citizens and policy makers. It, thus, becomes an important parameter for the assessment and management of surface water, and is widely used in multiple scientific publications related to the necessities of sustainable management (Parparov *et.al*., 2006). Water quality in an aquatic ecosystem is determined by many physical, chemical and biological factors (Sargaonkar, Deshpande; 2003). Therefore, particular problem in the case of water Quality monitoring is the complexity associated with analyzing the large number of measured variables (Boyacioglu, 2006) and High variability due to anthropogenic and naturalinfluences (Simeonov *et.al*., 2002).

There is a number of methods to analyze water quality data that vary depending on informational goals, the type of samples, and the size of the sampling area. Research in this area has been extensive, as indicated by the number of methods proposed or developed for classification, modeling and interpretations of monitoring data (Simeonov *et.al.,* 2002 and Boyacioglu, 2006). One of the most effective ways to communicate information on water quality trends is by use of the suitable indices (Dwivedi & Pathak,2007). Indices are based on the values of various physico-chemical and biological parameters in a water sample. The use of indices in monitoring programs to assess ecosystem health has the potential to inform the general public and decision-makers about the state of the ecosystem (Nasirian ,2007 , Simoes*,et. al*., 2008)

Water Quality Index (WQI)

A Water Quality Index (WQI) is defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water (Deininger, Maciunas, 1971; Harkins, 1974 , Tiwari , Manzoor, 1988). The objective

of water quality index is to turn complex water quality data into information that is understandable and usable by the public. A single number cannot tell the whole story of water quality; there are other water quality parameters that are not included in the index. However, a water quality index based on some very importantparameters can provide a simple indicator of water quality. In general, water quality indices indicator data from multiple water quality parameters into a mathematical equation that rates the health of a water body with number.

The concept in of indices to represent gradation in water quality was first proposed by Horton (Horton, 1965). It indicates the quality by an index number, which represents the overall quality of water for any intended use. Water Quality Index (WQI) method has been applied in many countries to assess the overall status of their water bodies, such as Canada (Khan, *et.al*.,2003), (Sisodia,and Moundiotiya2006); India (Dwivedi& Pathak ,2007)(Chaturvedi, and Bassin2010).

The present study aims at calculating the Water Quality Index (WQI) of the Shatt Al-Hilla river in order to assess the suitability of its water for drinking and irrigation uses.

Materials and method

Description of the Study Area

The area study (Shatt Al-Hilla) lies in the Hilla city, about 100 Km from the Baghdad city within Babylon governorate (Figure1). Five positions can divide the river to meet all the activates of the population increase and quite different industrial activities taken place as shown in Figure(1).

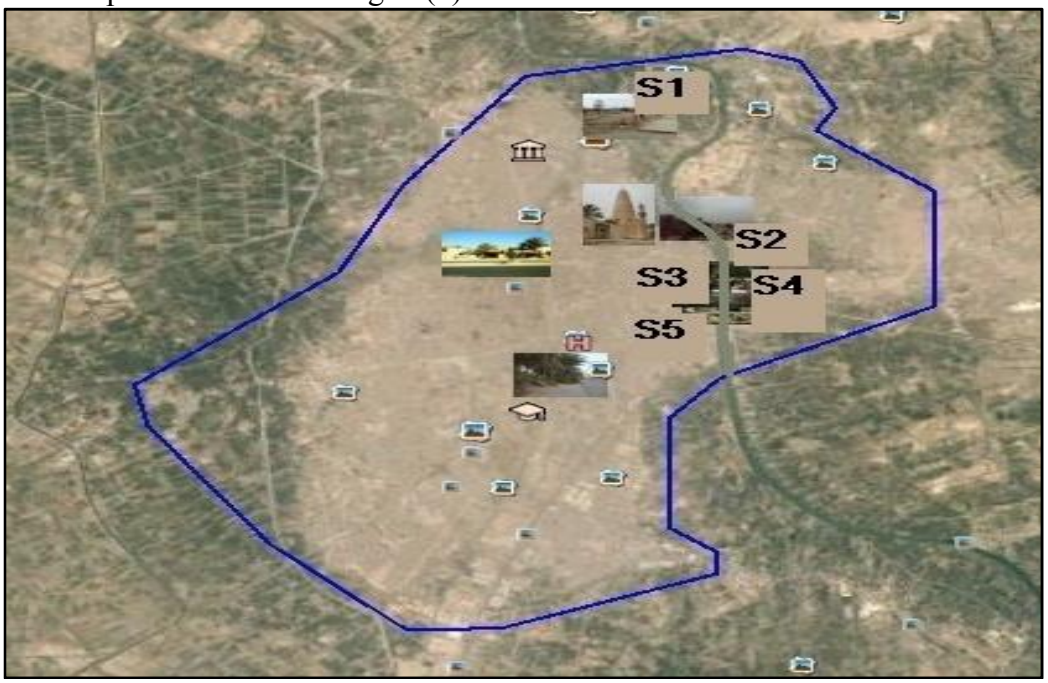

Figure1: location of samples in Shattt Al-Hilla river.

Sample Collection and Analysis

Water quality data for (Shatt Al-Hilla) were collected (monthly two samples) from October 2014 to September ,2015.(The water samples were then analyzed for seven parameters: pH, Electrical Conductivity, Hardness, Total Dissolve Soluble , Calcium ,Chloride, Sulphate.

Calculation of the WQI

The Water Quality Index (WQI) was calculated using the Weighted Arithmetic Index method .The calculation and formulation of the WQI involved the following steps:(parparov 2006)

1- In the first step, Relative weight (Wi) for each parameter was calculated by a value inversely proportional to the recommended standard (Si) of the corresponding parameter:

$$Wi = 1 / Vs \quad \ldots\ldots(1)$$

Where:

Wi : Relative weight

Vs : recommended standard value for each parameter.

2- In the second step, quality rating scale (Qi) for all the parameter was calculated by using this expression:

$$\text{Quality rating, } Qi = 100\,[(Vn - V_i) / (Vs - V_i)] \quad \ldots\ldots(2)$$

Where:

Vn: actual amount of nth parameter

Vi: the ideal value of this parameter (Vi = 0, except for pH = 7.0)

Vs: recommended WHO standard of corresponding parameter

Finally, the water quality index was calculated by using this expression:

$$\text{Water Quality Index (WQI)} = \sum Qi\,Wi / \sum Wi \quad \ldots\ldots(3)$$

The index equation generates a number between 10 and 100, with 10 being the poorest and 100 indicating the excellent water quality. Within this range designations, present study have been set to classify water quality as illustrated in (Table 1) into five classes of water quality as very poor, poor, fair, good, very good and excellent.

Table (1):- Classification scheme for water quality index scores.(Brown et al.,1970).

WQI Range	Statement
0-25	Excellent
26-50	Good
51-75	Poor
76-100	Very Poor
>100	Unsuitable for Drinking

Results and Discussion:

The water quality index was designed to permit comparison of water quality among different stretches along the same river or between different Iraqi rivers.

After applying arithmetic mean to calculate (WQI) ,Table 2 presents the result of WQI for all five stations with range values (45.789 -37.234) ,this means water is good for use.

As compared toSAR for all five stations ,their values are (S2) with(12-18), and sodium (%) (35-54),it means permissible type according to specification of Na% as shown in tables (3 and 4) respectively.

Table 2: Calculation of WQI for five stations

No. station	WQI
1	37.921
2	37.234
3	45.789
4	44.762
5	40.791

Table3: classification of water based on SAR value.(Rahi,2010)

SI.No.	Types of water and SAR value	Quality	Suitability of irrigation
1	Low sodium water (S1)SAR value :0-10	Excellent	Sutable for all types of crops and all types of soils,except for those crops,which are sensetive to sodium
2	Medium sodium water (S2)SAR value :10-18	Good	Sutable for coarse textured or organic soil with good permeability,relatively unsuitable in fine textured soils
3	High sodium water (S3)SAR value :18-26	Fair	Harmful for almost all types of soil:Requires good drainage ,high leaching gypsum addition.
4	Very high sodium water (S4)SAR value :above 26	Pooor	Nsuitable for irrigation

Table 4 : Sodium percent water class..(Rahi,2010)

Sodium(%)	**Water class**
<20	Excellent
20-40	Good
40-60	Permissible
60-80	Doubtful
>80	Unsuitable

Application of Visual Basic Program

Visual Basic is a third-generationevent-driven programming language and it integrated development environment (IDE) from Microsoft for its COM programming model first released in 1991 and declared legally in 2008. Microsoft intended Visual Basic to be relatively easy to learn and use. Visual Basic was derived from BASIC and enables the rapid application development (RAD) of graphical user interface (GUI) applications, so, it can be applied in the research for that reason. **(**Plant, Robert T,2007).as its shown in Figure 2 and Figure 3.

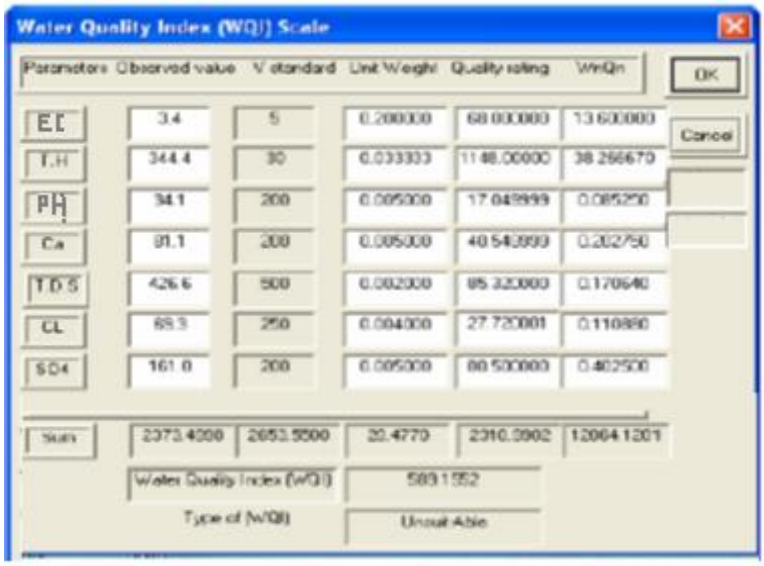

Figure 2: Water Quality Index (WQI) values

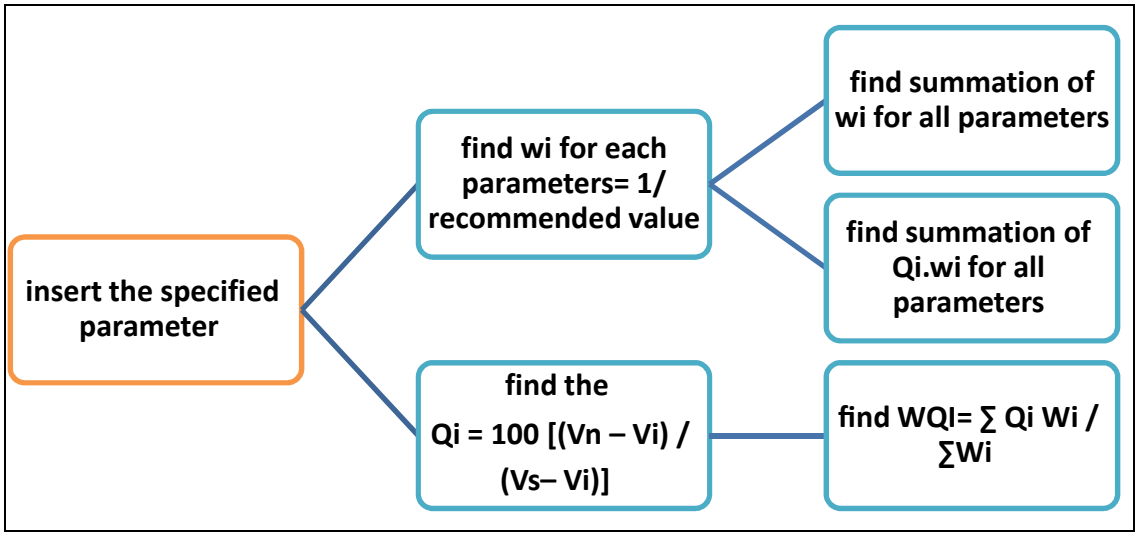

Figure3: Flowchart of calculating WQI value.

Conclusions

Values of WQI ranged from (45.789 -37.234)at Hilla city and rated good according to the classification of Iraq Standard ,2004 and WHO ,2004. These values belong to high water electrical conductivity and chloride of the studied wells comparable with other parameters. Also, correlation coefficient supports this interpretation where there are strong positive correlation between WQI values and both electrical conductivity and chloride values (0.987, 0.909 respectively).As compared with SAR for all five stations ,their values are (S_2) with(12-18), and sodium (%) (35-54),this indicates a permissible type according to specification of Na% as shown in tables (3 and 4) respectively. These values associated with both EC and Cl^- in a strong negative correlation (0.990, -0.912 respectively).

From all the above result , it can be shown that the WQI type is good for use and suitable for coarse texture or organic soil with good permeability ,relatively unsuitable in fine texture soils with class S_2, and permissible according to Na%.

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