Environmental Properties and Analysis of the Euphrates River Within Anbar Governorate in Iraq: A Review

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Abstract

Euphrates River is the primary source of water in Anbar province. It provides the cities that passed with drinking, agricultural and industrial water, in addition to being the downstream of sewage and wastewater after treatment. Anbar province, and consequently the water of the Euphrates River, has been affected by climate and environmental changes resulting from the military operations, which have become an obsession for citizens and decision-makers in the province. This obsession became the motivation for conducting the necessary physical, chemical and biological measurements to identify the environmental characteristics of the Euphrates River due to the presence of many sources of pollution of rivers water and for the purpose of making sure that it is suitable for human uses, since its effects will be serious and direct on humans and the environment. The review article includes a comprehensive study of water quality in Anbar province, as well as a review of previous researches in this field to know and to improve the future of water in the province. As the specialists unanimously agreed that, the future crisis in the region is a water crisis. Also, the review included an analysis of physical, chemical, and biological measurements, and a comparison of results with Iraqi and international standard limits was made. Data were organized and the results were analyzed. Results were of importance, and important environmental recommendations were reached regarding Euphrates River within its flow stream and the time effect on it.

Keywords: Natural water, Euphrates River, Iraqi standards, international standards, Anbar province.

تحليل الخصائص البيئية لنهر الفرات ضمن محافظة الانبار/العراق: استعراض مراجع

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المستخلص

يُعد نهر الفرات المصدر الاول للمياه في محافظة الانبار. فهو يزود المدن التي يمر بها بمياه الشرب والزراعة والصناعة بالإضافة الى كونه المصب لمياه المجاري والصرف الصحي بعد المعالجة. تأثرت المحافظة وبالتالي مياه نهر الفرات بالتغيرات المناخية والبيئية الناجمة عن العمليات العسكرية والتي اصبحت تشكل هاجسا لدى المواطنين واصحاب القرار في المحافظة. أصبح هذا الهاجس هو الدافع لأجراء القياسات الفيزيائية والكيميائية والبيولوجية الضرورية للتعرف على الخصائص البيئية لنهر الفرات بسبب وجود مصادر عديدة لتلوث مياه الأنهار ولغرض التأكد من انها صالحة للاستخدام البشري، لان تأثيراتها ستكون خطيرة ومباشرة على الإنسان والبيئة. تتضمن المراجعة دراسة شاملة لنوعية المياه في محافظة الانبار وكذلك استعراض البحوث السابقة في هذا المجال لمعرفة واستنباط مستقبل المياه في المحافظة. قد تكون الازمة المستقبلية في المنطقة هي ازمة مياه. كما تتضمن المراجعة مناقشة وتحليل القياسات الفيزيائية والقياسات الكيميائية والقياسات الأحيائية ومقارنة النتائج مع الحدود القياسية العراقية والعالمية. تم تنظيم البيانات وتحليل النتائج وقد كانت النتائج ذات اهمية وتم التوصل الى توصيات بيئية مهمة تخص نهر الفرات ضمن مسار جريانه والتأثير الزمني عليه.

الكلمات المفتاحية: مياه طبيعية، نهر الفرات، المواصفات العراقية، المواصفات العالمية، محافظة الانبار.

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Introduction

Water is a source of life, and wherever there is water, life flows and continues. Water is considered as essential element for all living things, so there is no life without water. The earth has arisen since the beginning of creation and will remain forever linked to water. In the past, civilizations arose on the banks of rivers and near their estuaries. Water is the origin of life, as it possesses physical, chemical and biological characteristics that make it necessary for every living organism. Human beings needs it for drinking. Furthermore, water has an essential role in the growth and development of civil life by exploiting it in industry, generating electric power and tourism. It is considered one of the basis of the national wealth, represents an important basis in making life in all its forms, and guarantees its continuity.

Dams reservoirs are used to ward off the dangers of flooding, storage and re-release water for the requirements of agricultural seasons and other needs and to generate electricity (Sayel et al., 2008). Many studies and researches on the future of the middle east have indicated, from the beginning of the twenty-first century up to now. This region population will soon face is the water crisis, and that Iraq is one of the most prominent parts that can be affected by the crisis, given that the sources of the Tigris and Euphrates rivers are outside its lands that extend for long distances in Turkish lands (Al-Tohme, 2018).

Several challenges have accompanied the exacerbation of the water crisis in Iraq, the most prominent of which are lack of coordination with neighboring countries and low water levels flowing from neighboring countries, especially from Turkey, and this has contributed to a decrease in water storage in the Tigris and Euphrates rivers, Climate change and its consequences of sharp drop in rain precipitation within recent years and the backwardness of irrigation methods and the use of primitive methods for irrigating agricultural crops.

The water cycle in nature (the hydrological cycle) means preserving the mass between water reserves with precipitation, seepage and storage, and between evaporation and the flow of ground and surface water to rivers and seas. As for the artificial water cycle, it begins with human intervention (Ahmed, 1996).

For the purpose of using drinking water, it must have characteristics and features that have been approved by the World Health Organization (WHO) as a guide includes standards and determinants of drinking water (WHO, 2011) that followed by the countries of the world. Some countries has its own local standards. In Iraq, the authorities responsible for determining the limits and standards of potable water quality are the Central Organization for Standardization and Quality Control and the Ministry of Health and Environment (IS, 2001). Table 1 shows the local and international standard specifications for drinking water and natural water mg/L.

Criteria and determinants of drinking water validity are divided into three physical, chemical and biological standards. Physical, such as temperature-suspended solid, color, taste and smell. As for the chemical characteristics, such as pH, hardness, turbidity, and undesirable elements. Biological properties are divided into two parts: viral and bacterial indicators. Bacteria are examined only in water because viruses need a living body to multiply and transmit (Abawi, 1995).

Objectives

The study aims to achieve the following objectives:

1. Conducting a comprehensive analytical study of potential

environmental pollution of the Euphrates River in the study area - Anbar province - and observing changes in water quality by comparing with the Iraqi and international standard specifications.

2. Knowing the nature of water and its suitability for human, irrigation and agricultural uses that need this water.
3. Determine the level of pollution of the Euphrates River water in all areas of the province. And finding practical solutions to reduce pollution in water.

Developing a vision or a sound strategy for managing river water and controlling it from pollution in all areas of the province.

Study area

Source Euphrates River and its branches extends in many areas, where there are major cities and urban and rural areas, and it is considered one of the main rivers that have been affected by many human activities represented by domestic, agricultural and industrial activities that directly affected the quality of water. People of Anbar province depend on the river's water greatly in terms of drinking, agriculture and industry. It is noteworthy that Anbar province, which is located to the west and considered as a largest Iraqi province in area (figure 1), suffers from severe desertification, which has become one of the most serious threats facing the province at the present time.

General environmental properties of the Euphrates River water

The hydro chemical properties of river water depend on the source of the water that reaches the reservoir and the geochemical processes that take place below the surface of the earth, which in turn depend on the physical and chemical properties of the rocks, geological processes, salinity and other chemical components of the water. The areas on the right side of the Euphrates River are characterized by a rocky nature of the land, while the areas on the left side are characterized by a sandy nature of the land (Mahmood, 2011).

Previous studies have shown the basic nature of the water of the Euphrates River, the high values of electrical conductivity and dissolved solids, as well as the high salinity ratio (Al-Dahiri et al., 2002; Al-Bassam,1984) as well as the increase in the total hardness values during the period of low river level (Al-Obaidi, 1983). In another study of the river in Anbar province, it was noted that the turbidity, electrical conductivity, and the concentration of calcium, sodium and chloride increased, but it did not exceed the standard limits, as a result of the influence of the wells of Wadi Hajlan, Heet wells and Haditha dam on the quality of the river's water (Al-Zaidani, 2003). In a study of the Euphrates River within the city of Ramadi and lake of Habbaniyah, the results reviled high electrical conductivity values and the high concentration of chloride, sodium and sulfate ions compared with the concentrations of calcium, magnesium and potassium, while the concentration of phosphate, ammonium and nitrate ions in the river were within the standard limits (Al-Dossary, 2006).

Another study of the Euphrates River of samples collected from different sources started from the Syrian city of Deir Ezzor to the Iraqi city of Al-Baghdadi showed that the physical and chemical specifications of the water of the Euphrates are within the permissible limits locally and internationally, with the exception of ammonium and nitrite, which exceeded the permissible limits (Al-Janabi, 2007).

Table 1. local and international standards for drinking water and natural water mg.g^{-1}

No.	Element	WHO WHO (2011)	Europe Mahmood et al., (2016a)	Canada Mahmood et al., (2016a)	USA Mahmood et al., (2016a)	Russia Mahmood et al., (2016a)	Iraq IS (2001)
1	Color TCU	15	20	15	15	-	10
2	TDS (Total dissolved solids)	1000	-	500	500	-	1000
3	TSS	-	-	-	-	-	1000
4	NTU	5	4	5	1 – 5	-	5
5	pH	8.5 – 6.5	8.5 – 6.5	8.5 –6.5	8.5-6.5	-	8.5 – 6.5
6	TH	500	-	-	-	-	500
7	NO_3	-	50	-	-	10	50
8	NO_2	-	0.1	-	-	1	3
9	P	-	5	-	-	-	
10	BOD	-	-	-	-	2	
11	Na	200	175-150	-	-	-	200
12	CI	250	25	250	250	250	250
13	SO_4	400	25	500	250	500	250
14	S	-	-	0.05	-	-	
15	F	1.5	0.7-1.5	1.5	2	1.5	1
16	B	-	1	5	-	-	
17	CN	0.1	-	0.2	-	0.1	0.02
18	Al	0.2	0.2	-	-	-	0.2
19	As	0.05	0.05	0.05	0.05	-	0.01
20	Ba	-	0.1	1	1	-	0.7
21	Cd	0.005	0.005	0.005	0.01	0.001	0.003
22	Cr	0.05	0.005	0.05	0.05	0.5-0.1	0.05
23	Co	-	-	-	-	0.1	
24	Cu	1	1-0.1	1	1	1	1
25	Fe	0.3	0.3	0.3	0.3	0.5	0.3
26	Pb	0.05	0.05	0.05	0.05	0.03	0.01
27	Mn	0.1	0.05	0.05	0.05	-	0.1
28	Hg	0.001	0.001	0.001	0.002	0.0005	0.001
29	Ni	-	0.05	-	-	-	0.02
30	Zn	5	3-0.1	5	5	1	3
31	Oil and Petroleum Products	-	0.01	-	-	0.3	
32	Total Pesticides	-	0.5	0.1	-	-	0.07
33	Individual Pesticides	-	0.1	-	-	-	
34	Phenols	-	0.5	2	-	1	0.002
35	Detergents	-	0.2	-	0.5-12	0.5	

The river water also showed a variation in the values from one region to another in relation to the physical properties, the temperature and suspended solids were within the permissible limits, while the values of electrical conductivity, dissolved solids and turbidity were higher than the permissible limits in some areas. As for the chemical properties, they were within the permissible limits, except for a rise in the concentration of sulfate, bicarbonate and phosphate ions in some areas, which confirms the seriousness

of the river's environmental condition and threatens to reduce its suitability for domestic use. As for the concentrations of trace elements such as copper, nickel, zinc, lead and chromium, they were less than the permissible limits. This means that the water is not contaminated with these elements, but the water is generally suitable for agriculture and irrigation purposes and can only be used for drinking after treatment in all areas of the study (Mahmood, 2010).

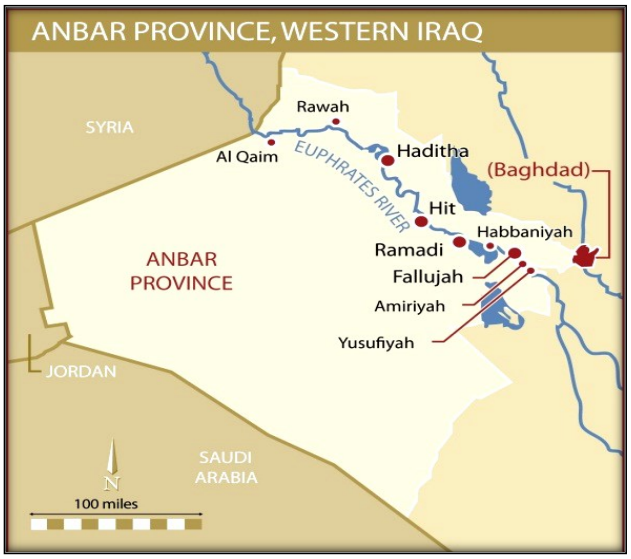

Figure 1. The study area in Anbar province, West of Iraq.

Studies also showed that the values of most of the physical and chemical properties have increased in many sites, and these values may exceed the maximum permissible limits globally, and this confirms the impact of military operations and the destruction they caused, such as the demolition of bridges, buildings, and rubble that are thrown into the river as the level of the water level in the river decreased. The Euphrates River confirms the seriousness of the environmental condition of the river and threatens to reduce its suitability for various uses. The recorded values of drinking water were close to that of the river, and the reason may be due to broken water pipelines and lack of proper treatment by the treatment plants.

The study of the physical properties showed that the rate of turbidity and electrical conductivity exceeded the maximum permissible limits for samples during the period after displacement, while the rate of dissolved solids was high in samples before displacement. The study showed that the river water possesses neutral qualities that tend to low basic properties, and the concentration of bicarbonate ions did not exceed the permissible limits. The dissolved salts, total hardness, calcium, magnesium and sodium ions were high, but they did not exceed the permissible values. The potassium and sulfates were lower than the standard specifications in some study areas. This confirms the impact of military operations and the destruction they caused, such as demolishing bridges, buildings and rubble that are thrown into the river, as military operations are among the most important factors that contribute to environmental pollution in water and land. Moreover, the impact on public health due to the massive

destruction of buildings and infrastructures of residential complexes in cities and rural areas, as well as the direct impact on humans and other living creatures (Mahmood et al., 2018). Euphrates rivers are also a major site for receiving and mitigating water pollutants caused by human action (Al-Khafaf, 1997).

In a study of the waters of the lake of Habbaniyah in Anbar province, it showed that most of the values within the standard specifications, including turbidity, and have low concentrations for suspended solid, but there is an increase in the values of electrical conductivity beyond the permissible limits, which in turn indicates an increase in the percentage of dissolved salts in the lake water as it is considered within standard specifications regarding pH values, chloride and fluoride ion. There was an increase in basicity in some areas. Habbaniyah water has been classified according to the electrical conductivity values as being of medium salinity (Sayel et al., 2008).

The water quality was evaluated through the water quality index (Alsaqqar et al., 2013) which is calculated from several water characteristics. This indicator is considered an effective tool for knowing the quality of water for various uses, determining pollution, managing water quality and making the right decisions in these activities. This indicator was used to find out the suitability of the Euphrates water for drinking. To determine the indicator, ten elements were relied on for the characteristic of the river water measured at the specified stations in Anbar province. The total annual rate of the water quality index was 107.5. This high value of this indicator was due to the concentrations of the elements of magnesium and orthophosphate, which are attributed to human activities on the banks of the river. From this analysis, the quality of the Euphrates water is considered very poor and needs treatment, as it ranges from a very poor type at the front of the river to unsuitable water for drinking at the rear of the river. This study represents an application of the water quality index in assessing and understanding the water quality of the Euphrates River. The water quality index can be considered an effective tool in managing water quality as well as to identify the sources of pollution in surface waters.

In a study (Zaidan et al., 2009) which included the environmental pollution of the Euphrates water in Ramadi and Fallujah cities, as a result of population and human activities, the values of most of the physical and chemical characteristics in the river's waters were high, and the impact of lake of Tharthar, Trocar and various household waste, especially within the city of Fallujah. The concentration of some trace and heavy elements and the level of oils and fats in some of the study sites also showed values higher than the maximum permissible limits worldwide due to the throwing of industrial wastes into the river without treatment. This study also showed that the physical properties such as turbidity and electrical conductivity exceeded the maximum permissible limits, while the rate of suspended solids was high, but within the permissible limits. The chemical measurements showed that the river water possesses neutral properties that tend to weak basic properties, and the dissolved salts and total hardness, calcium and magnesium exceeded the permissible values, while the bicarbonate ion concentration was within the permissible limits. It was noticed that the sodium and potassium values were high, but they did not exceed the permissible values. The iron concentration rate was within the permissible limits. It was also found that the sulfate ion exceeded the permissible values, while the rates for chlorine, fluorine and sulfide ions were within the permissible limits. It was also noted that the concentration of trace elements was within the permissible limits, except for lead,

cadmium and copper, which exceeded the permissible limits in some sites.

Another study showed that the water samples from the Euphrates River in Ramadi were of poor quality. They should not be used by animals or humans directly, but rather need special treatment before it can be used (Saod et al., 2019a).

The study Mahmood et al. (2018) showed a variation in the values from the Iraqi and international standard limits, as there was an increase in the values of electrical conductivity and the concentration of magnesium and sulfate. The rest of the measurements did not exceed the permissible standard values. Also, in this study, the results were statistically analyzed and the linear and inverse correlation coefficients were found. There was direct linear and inverse correlations between the chemical and physical measurements of different water models for all areas of the study using the SPSS statistical program. Biological measurements indicated that all properties (residual chlorine, MPN total coli/100, MPN fecal coliform/100 mL, plate count/1 mL) were all within the permissible standard limits.

In another study Saod (2020) aiming to find out the spatial and temporal variation of the Water Quality Index (WQI) of the Euphrates River in Anbar province. The quality of the river was classified as "poor" in general. The result of the temporal variance analysis shows that the water quality in most of months of the year is poor, except for January and September which were moderate and poor respectively. The spatial variance analysis result also showed the water quality of all sampling stations. The WQI value decreases at the downstream stations and can be attributed to human activities.

The study Al-Battat (2009) showed that Iraq is going through a stage of decline and deterioration related to water quality, as a result of the multiplicity of pollution sources in it, with no strategies for developing and strengthening the foundations for providing clean water. Iraq's water has been polluted, starting with the pollution of drinking water and rivers, and ending with surface and ground water.

Some measurements (turbidity, TSS, TDS, BOD, calcium, sodium and total hardness) in the study Al-Heety (2011a). showed that they exceeded the permissible limits of WHO standards, while other measurements were within the permissible limits.

The study confirmed that there is a severe lack of standards and documentation to maintain the collection of samples and the quality analysis of the Euphrates River water in Iraq. An important factor contributing to these shortcomings is the insufficient scientific culture in this field. No attention has been paid to quality assurance (QA) and quality control (QC) for sample collection, preservation, and analytical procedures. To ensure real results representing the water quality of the Euphrates River in the future. The study concluded that there is a need to follow a specific method in selecting sampling sites, how samples are collected, how to analyze samples, and attention to quality assurance and quality control during sample collection, preservation and analysis procedures.

The study Al-Hamdani et al., (2012) identified the natural hydro-chemical effects within the ecosystem of the Euphrates River and Haditha Lake and their environmental impacts associated with the water system, such as groundwater, sewage and drainage water, which were considered potential sources of pollution in the event of the deterioration of the natural hydrological system resulting from the lack of river water drainage. Among the factors that cause increased pollution are human activities through controlling river drainage and dams or due to the exacerbation of the drought

crisis, such as lack of rain and increased evaporation. This study also confirmed the presence of nitrogen compounds in the waters of the Euphrates River and a Haditha Lake resulting from the decomposition of aquatic plants and lichens and their transformation into organic materials causing the river and lake environment to turn into a stale reductive environment in the area of slowing water velocity and thus the growth and reproduction of micro-organisms that threaten human health when using water for drinking purposes without treatment. The study also found an explanation of the hydrogeochemical phenomena by observing the pattern of fluctuations in the concentrations of trace elements and their relationship to pollution after determining the percentages of their added concentrations in the river and lake waters along the path of the river between Al-Qaim and Al-Baghdadi. In a rapid method for determining the concentration of toxic elements in water by TXRF method in low salinity water, it was found that the concentration of some heavy elements in river water and tap water was high (Mahmood, 2011).

In another study Mahmood (2016b) a successful and economical method was proposed to determine the concentration of lead without preconcentration for very low concentrations using the TXRF method in the concentration range 0.0030-30 mg/L in wastewater, industrial water, drinking water, natural water and for preserving samples water. A technology has been developed to obtain pure nitric acid in laboratory conditions that do not contain impurities of toxic elements.

The literature review Mahmood (2016c) also clarified the advantages and disadvantages of the XRD and XRF methods with TXRF and AAS in measuring some chemical elements of different water types. Special attention is given to the TXRF and AAS speed and efficiency methods, as well as the statistical treatment of the titration process in the analysis of lead ions in different samples of water.

In another technique that has been conducted by Vildanov (2016). The technique involves preparing high-purity nitric acid intended for preserving water samples. This preservation is necessary to prevent some metal ions from being absorbed by the walls of the vessel. When measuring or collecting samples, the concentration was less than 0.1 mg/L. To determine the concentration of lead in drinking water without preconcentration. The TXRF method is much better compared to the other methods because it allows the identification of several toxic elements in the water simultaneously.

The method was developed Mahmood (2016d) for the rapid and economical determination of lead concentration in drinking water and bottled drinking water, which are of the highest purity classes. Based on the data of this work, it can be concluded that the technique described in the work to determine the percentage of lead in drinking and bottled water can control the measurement of lead concentration as well as other toxic elements such as cadmium, nickel and chromium.

In a comprehensive analytical study Mahmood (2020) of the water quality in the district of Khaldiya, which is located on the river within the province of Anbar. The study showed a variation in the values from the Iraqi and international standard limits, where an increase in electrical conductivity and the concentration of magnesium and sulfate were found. As for the rest of the properties, it did not exceed the permissible Iraqi and international standard values. The results were analyzed statistically. Direct linear and inverse correlations were found, as well as a significant correlation between the physical and chemical measurements of various water models for all areas of the study using the SPSS statistical program.

The study of the hydro chemical models of potential pollution in the Euphrates River from Al-Qaim to Fallujah city was demonstrated by observing the system at ten water points. The hydro chemical properties of the water of the Euphrates are determined physically and chemically (Hussien, 2011). The interpretation of the hydro chemical phenomena is according to the statistical results of the polynomial regression statistic, and the computation of the coefficient of variance between the physical and chemical components of the terminated water with 14 models. Monitoring results during 2008 indicated a pollution status by SO_4 and Cd in Ramadi and downstream stations, DS, Mg, Na, Cl, Mn and CO_2 at Ramadi station and TDS, Ca, Na, Cl, Fe at Al-Baghdadi station, Ca, TH in the Al-Qaim station and Mg in the Al-Obaidi station.

Moreover, a daily logging system is recommended for other stations in each city to complete the monitoring system of the type of Euphrates water. There are potential sources of pollution such as municipal sewage pipes and reused water from the mining process for building materials in the first sector of the river that runs between Al-Qaim Dam and Haditha. Groundwater leaks caused pollution of spring water with sewage water. The river's third sector is affected by all causes in the first and second sectors, as well as the effectiveness of agricultural activities through drainage channels and irrigation projects extending between the cities Ramadi and Fallujah.

It was found that the values of turbidity, total dissolved salts and sulfate ion exceeded the permissible limits of the standards of the WHO. The high value of turbidity is due to the effect of drainage water and wastewater, while the rest of the values did not exceed the permissible limits. The data were analyzed statistically to calculate the Pearson correlation coefficient between the physical and chemical parameters. The temporal and spatial change of the physical and chemical parameters of the water of the Euphrates River was measured in Amiriyat Al-Fallujah city (Salah, 2015a).

The hydro chemical characteristics of the Euphrates River were determined using the analysis of physico-chemical variables such as some positive and negative ions, trace elements and acidity, Soluble Solids and Electrical Conductivity. According to the common interpretation between geology, hydrology, metrological and hydrochemical phenomena, which refers to the final results of all environmental and geological efficacy that occur on the rocks and sediments of the hydrological basin (Fayyadh, 2016).

Concentrations of various heavy metals (such as lead, cadmium, copper, nickel, manganese, iron, chromium, and sediments) from the Euphrates River in Iraq were examined based on samples collected from 14 sites (Salah, 2015b). The average concentration of cadmium, copper, nickel, manganese, iron and chromium exceeded the US Environmental Protection Agency's sediment quality guidelines. This indicates that the Euphrates water is polluted.

A multivariate statistical method, including cluster analysis, was used to assess temporal and spatial changes in the water quality of the Euphrates River in Iraq using 16 laboratories in 11 sampling sites (Salah, 2012). Based on the similarities in water quality characteristics, the chronotype shows that April has a higher pollution level compared to other months. This study demonstrates the utility of the cluster analysis method for analyzing and interpreting a surface water dataset for assessing temporal and spatial changes in water quality parameters and improving the water quality sampling network.

This study Rabeea et al., (2020) uses maps of spatial distribution and water level fluctuations to highlight the effect of fish farms on the water quality of the Euphrates.

Physical and chemical properties were estimated before, during and after rainy season. Field and laboratory analyses were performed using multiple spatial distribution maps. The results showed that the increase in NO_3 concentration inside the fish cages site exceeded its normal concentration, but this increase differed from one site to another, while the decrease in dissolved oxygen concentration reached 31%. The effective polluting distance in the direction of the fish farm is more than 60 meters.

The Water Quality Index (WQI) of the Euphrates River was implemented between the cities Heet and Ramadi using 12 different water quality parameters, physically and chemically. Calculating the Water Quality Index (WQI) based on the Canadian Council of Environment Ministers' methodology for the Water Quality Index (CCME WQI). It was found that the water quality of the Euphrates River in the study area was mostly classified as marginal (CCME WQI is 45.17) for all potable water used during the study period. In general, the water quality was marginal - upstream and poor - downstream throughout the study period. The water quality deterioration in the Euphrates water can be attributed to both natural and anthropogenic resources (Al-Heety, 2011b).

Conclusions

The studies showed that the river's water is undergoing a decline, deterioration in its qualitative properties, and an increase in the value of electrical conductivity as a result of high salinity. It was also found that the water is not thermally polluted because the temperature values did not exceed the standard limits. The study also showed that the pH tends to be alkaline, but it did not exceed the standard limits. They also showed that the hardness of water exceeded the standard limits. There was variation in river water quality from one region to another, but in general it is suitable for agricultural and irrigation purposes and it cannot be used for drinking except after treatment in all areas of the study.

The studies showed the clear effect of the sulfur springs in Heet city on the river water in that region due to the drainage of the rural lands on both sides of the Euphrates River into the river. All the sewage sewers of the cities located on the Euphrates River drain into the Euphrates River. Hospitals discharge medical wastes into the Euphrates River. The use of explosive materials by fishermen to catch fish leads to water pollution. The problem of water pollution is one of the most serious problems that countries suffer from, especially with the presence of influences that interfere with the composition of pollution from various sources (such as chemical pollution affected by wars, pollution of industrial wastes, waste, etc. Integrated management of water resources is one of the most successful methods available to improve the conditions of water resources and protect them in terms of quantity and quality. As the amount of water consumed decreases. Recommendations in this review:

1. Conducting field studies to find out the health effect of decreasing or increasing total hardness, calcium and magnesium on humans.
2. Checking constantly what is thrown from the materials into the water, comparing the characteristics and components of water with the relevant local and international standards, and making sure that the filtering stations carry out their duties.
3. Using different alternatives to harmful substances with others less harmful to

humans and environment, such as using biological and non-chemical methods to combat some agricultural diseases and pests, avoiding the use of non-degradable organic pesticides, and reducing the use of agricultural fertilizers except when necessary.

4. Work to reduce soil salinity by working on planting trees and agricultural crops that bear soil salinity and water salinity.
5. Controlling the plains and sulfur springs in Heet city and preventing them from entering the river directly, as well as controlling the drainage of drainage water that is found on both sides of the river, especially in rural areas, as most of these taps are discharged into the river.
6. Get rid of the materials attached to the process of sedation and the possibility of disposing of sulfur materials by physical methods if possible, or by chemical treatments in cases of necessity. And banning the use of explosives by fishermen in fishing, as this leads to pollution of the water.
7. Adopting the technology of photosensitivity to water or smart faucets. As well as the use of modern irrigation techniques, as they are an effective way to legalize the use of water for agricultural purposes, in addition to their contribution to reducing soil salinization.
8. Eliminate all violations of water quotas, whether for agricultural or other uses, domestic, industrial, service, and so on, and hold accountable those responsible for the transgressions.
9. Recycling and using water after being physically or chemically treated to get rid of toxic materials, whether suspended or dissolved in water, so that it can be reused.
10. Developing knowledge about water uses and updating it periodically through continuous monitoring and effective monitoring of the withdrawal or pumping of ground and surface water sources, estimating the quantities of sanitary, industrial and agricultural wastewater, and identifying the sources of pollution.
11. Implementation of laws and instructions in all government agencies regarding water quality to prevent the pollution of water sources with any kind of pollutants. Enacting laws and legislations to protect the quality and quantity of water. Pilot experiments on unconventional methods of water harvesting.
12. Promote cooperation between departments, authorities and organizations working in the field of water, coordinate work among them, and support national efforts in the field of water resources assessment, development and management, through regional programs undertaken by organizations in the water field. And developing environmental curricula for all academic levels and creating university specializations in that, as is the case in the developed countries of the world.
13. Conducting monthly measurements for specific sites within a small geographical area and expanding the current measurements related to the river.

Conducting a statistical analysis using time series methods to predict future results for river quality.

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