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An Environmental Assessment of the Qualitative Characteristics of Surface Water in Al-Mishkhab District, Al-Najaf Governorate

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Abstract

This research study proposes solutions for addressing pollution and degradation of surface water in a specific study area. The researcher identifies major problems and suggests a range of measures to tackle them. The proposed solutions include raising awareness among residents about the economic, social, and cultural value of water, creating alternative locations for agricultural land and informal settlements, constructing a new solid waste treatment plant, regulating the use of chemical fertilizers and pesticides, and enforcing penalties for violators of water networks. Other recommendations involve avoiding the use of polluted sites for human activities and ensuring optimal utilization of surface water resources.

Keywords: *Surface water pollution, degradation, awareness raising, solid waste treatment, chemical fertilizers, pesticides, water resource management.*

Introduction

Water is an important resource for humans, used in various administrative, industrial, and civil fields. Allah, the Almighty, made this blessing the foundation of the creation of living beings, as He said in His Noble Book, "And We made from water every living thing." Water is mentioned in several verses of the Quran, where Allah says, "And We sent down from the sky water, so that We may bring forth thereby fruits as provision for you [1-2]."

Water distinguishes itself from other natural resources by being a finite quantity on Earth, and there is a great need to protect it. In recent times, there has been significant degradation of the natural environment, especially in the aquatic environment. It can be said that each individual directly or indirectly contributes to the deterioration of the quality characteristics of surface water through certain practices and behaviors. Water has become in a lamentable state, especially rivers, in our present time. It is known that water covers more than three-quarters of the Earth; however, the portion suitable for use remains limited and scarce due to the agricultural, industrial, and civil waste dumped into it. The continuous pollution of water, if left untreated and poorly managed, poses a danger to humans and other living organisms.

Soil is a complex natural formation that occurs through complex natural and chemical processes. Everything on the Earth's surface and everything beneath it to a shallow depth, whether plant, animal, solid, liquid, or gaseous, shares a common connection. The significance of soil as a natural resource is closely related to other resources, especially water, and it plays a

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role in its pollution.

Our study focuses on analyzing the chemical and physical characteristics of water and comparing them to international and local standards for most human uses (drinking, agriculture, industry, and livestock livelihood) [3-6].

1-The Study Problem

1- What are the natural factors influencing the qualitative characteristics of surface water in the district of Al-Mashkhab?
2- Do human factors affect the qualitative characteristics of surface water in the district of Al-Mashkhab?
3- What is the geographic extent of surface water in the district of Al-Mashkhab?
4- Do the qualitative characteristics of surface water vary in the district of Al-Mashkhab?

2- The Hypothesis of the Study

1- Natural factors have an impact on the qualitative characteristics of surface water in the district of Al-Mashkhab, including surface features, climate, soil, and natural vegetation.
2- Human factors have a clear influence on the qualitative characteristics of surface water in the district of Al-Mashkhab, including population size, residential units, and cultivated areas with different crops.
3- Surface water in the district of Al-Mashkhab flows from north to south and branches into fourteen tributaries.
4- There is variation in the qualitative characteristics of water in the study area, including physical and chemical properties.

3- Objectives of the Study

The study aims to identify the natural and human factors that influence the qualitative characteristics of surface water in the district of Al-Mashkhab, while understanding its geographic extent in order to determine its physical, chemical, and biological characteristics. The objective is to identify the problems facing surface water in the district of Al-Mashkhab and propose solutions for their remediation.

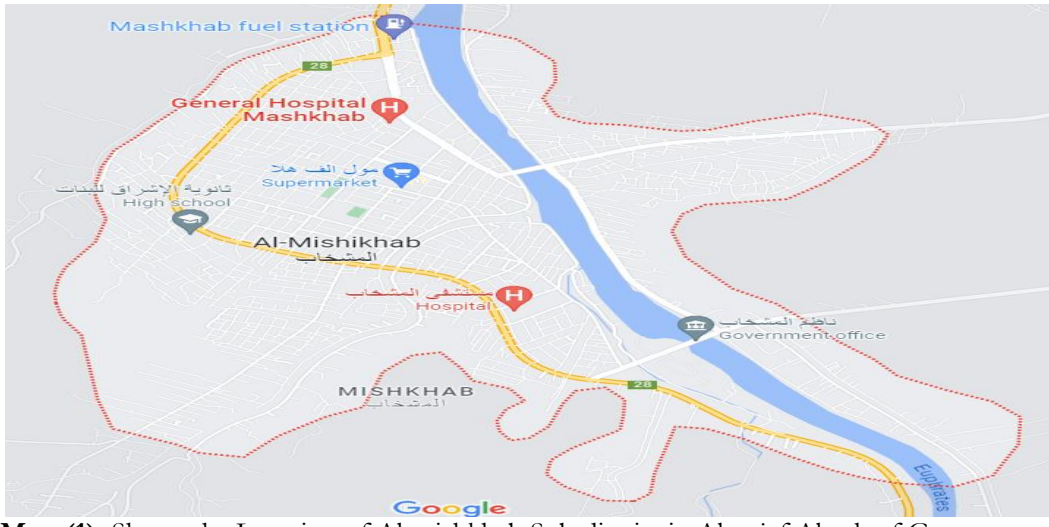
4- The Boundaries of the Study Area

The spatial boundaries of the study area are defined by the administrative boundaries of Al-Mishkhab district in Al-Najaf Al-Ashraf Governorate, which is located in the southeastern part of Al-Najaf Al-Ashraf Governorate. Its geographical coordinates are between the longitudinal lines of 44.00°E and 41.20°E, and between the latitudinal lines of 32.00°N and 31.48°N. The study area is bordered by Al-Najaf Al-Ashraf district to the north, northeast, northwest, west, and southwest, and by Al-Munathirah district to the northeast. The southern and southeastern boundaries are formed by Al-Qadisiyyah sub-district.

The temporal boundaries of the study are based on the data used, which include climatic, hydrological, population, agricultural, poetic, and map data from 1986 to 2016. Additionally, the study duration started in 2019 and ended in 2018.

Regarding the objective boundaries, they are represented by conducting a spatial analysis of the qualitative characteristics within the study area. This involves studying and analyzing the characteristics of natural and human factors that impact water deterioration, as well as studying their qualitative properties (physical and chemical). The evaluation of the suitability of various

uses is also conducted based on global and local criteria. Furthermore, models of surface water samples were analyzed to conduct the necessary analyses and determine their qualitative properties and the extent of their impact on surface water pollution.



Map (1): Shows the Location of Al-mishkhab Sub-district in Al-najaf Al-ashraf Governorate.

5-Study Structure

The Research Is Divided into Four Axes, which Are:

1. Natural extension of surface water: This axis focuses on studying the natural distribution and extension of surface water within the study area.
2. Environmental assessment of the qualitative characteristics of the study area's water: This axis involves evaluating the environmental aspects related to the qualitative properties of water in the study area.
3. Findings of the study: This axis presents the results and conclusions derived from the study.
4. Recommendations of the study: This axis outlines the proposals and recommendations derived from the study.

Firstly: The Natural Extension of Surface Water

Surface water is the primary water resource in the study area. The Euphrates River and its associated tributaries play a significant role in supplying surface water to the region, particularly in the alluvial plain where the study area is located. Despite the arid climate, the water from the Euphrates River flows into Al-Kufa Canal, passing through Al-Mishkhab district after traversing Abi Sukhair district and exiting towards Al-Qadisiyyah sub-district.

The length of Al-Mishkhab Canal within the district is approximately 18,200 km. The canal branches into two main channels, the right and left sides. Al-Mishkhab district ranks first in terms of the number of main and secondary canals, totaling 52 canals with an average discharge rate of 2.8 m^3/s. The total length of these canals reaches 220 km, with 13 main canals, including the important ones such as Hajat, Al-Azamia, Al-Jabawi, Al-Dubainia, Al-Eila, Abu Al-Raba, Al-Sawariya Al-Ra'isah, Al-Shaweilah, and Abu Safsafa. There are also 26 secondary canals, including Al-Arba'a, Barihi, Al-Tayara, Al-Hawr, Al-Shatam, Tabr, Aysh, and Kta'a Al-Zarfat [1-2].

The irrigated areas by the canals reached 72,555 hectares. Al-Mishkhab Canal, the main watercourse, divides at a certain point towards the north, towards Al-Qadisiyyah sub-district, by approximately one kilometer into two branches: Shatt Al-Ya'ou and Abu Ashrah [3]. As shown in Table (1), the water in the study area, originating from the main watercourse, irrigates main canals. The longest main canal is Shatt Ajihat, with a length of approximately 18 km and the highest discharge rate of about 33 m^3/s. The shortest main canal in length is Jaddul Al-Janabiyah, which is 1,500 km long, and the lowest discharge rate is for the canals Al-Mujayhila, Kta'a Al-Zarfat, and Kta'a Al-Murashidah, with a discharge rate of around 1.5 m^3/s.

Subsidiary canals also emerge from the main watercourse of Al-Mishkhab Canal. The largest discharge rate is in Al-Azamia Canal, with approximately 3 m^3/s, and the longest canal is also Al-Azamia Canal. The smallest discharge rate is in Al-Muhanna Canal (0.20 m^3/s), and the shortest canal in length is Al-Muhanna Canal.

Table (1): Provides the Lengths and Discharge Rates of the Canals in Al-MISHKHAB District.

Site Name	Discharge (m^2/s)	Length (km)
(Al-Mishkhab Canal)	750	12
Juhat Canal	33	18
Al-Mujayhila Canal	1,5	3,250
Al-Dubainia Canal	15	3
Al-Sawariya Canal	15	3
Al-Janabiyah Al-Yamaniyah Canal	8	1,500
Kta'a Al-Zarfat Canal	1,5	2,500
Kta'a Al-Murashidah Canal	1,5	2,500
Al-Janabiyah Al-Yasirah Canal	10	2
Tabr Adham Canal	1	3
Tabr Sayyid 'Alwan Canal	0,5	2
Tabr Al-Mawlawani Canal	0,5	2,500
Aysh Canal	0,5	3
Tabr Mahdi Al-'Asal Canal	5	4
Al-Hajimi Canal	0,5	2
Al-Azamia Canal	3	9
Asiwd Canal	3	2,750
Abu 'Anab Canal	0,5	3
Al-Jabawi Canal	1	4
Al-Ya'ni Canal	0,5	1,200
Al-Shati Al-Mushtarak Canal	0,25	1,800
Al-'Eila Canal	2	5
Al-Sawariya Al-Far'iyah Canal	1	5
Tabr Sayyid Muhammad Canal	1,5	5,500
Al-'Adl Canal	0,25	1,300
Al-Shaweilah Canal	0,5	2
Abu Safsafa Canal	1	5,500
Al-Kawwah Canal	0,25	2,500
Al-Muhanna Canal	0,25	1
Al-Fallal Canal	0,25	1,200
Al-Kim Canal	0,5	3
Barihi Canal	2,5	5
Tabr Sayyid Nour Canal	5	7
Al-Shursh Canal	1,5	3
Tabr Al-Sada Canal	1	3,500
Al-'Adl Canal	0,25	1,800
Al-Tayara Canal	0,25	2
Abu 'Aakula Canal	0,25	2,500
Al-Wusataniyat Canal	0,25	2,500
Al-Shati Canal	0,5	3,500
Al-Thayliyah Canal	0,25	1,500

Qualitative Characteristics of Water in Some Canals of Al-Mishkhab Canal in the Study Area:

1. From Table (2), it is evident that the pH values varied temporally and spatially. The pH values observed at the studied site (Al-Janabiyah Al-Yasirah) were within the permissible range (6.5-8.5) globally and locally, as shown in Table (3). However, it was noted that the suitability of the irrigation sites (Al-Mujayhila, Al-Dubainia, Shalal, Juhat, Al-Sawariyah) for drinking water was compromised due to exceeding the permissible limits globally and locally. When comparing the water values in Al-Mishkhab according to the FAO (Food and Agriculture Organization) and Iraqi standards (Table 4), it is observed that the water at the Al-Janabiyah Al-Yasirah site is suitable for drinking water as it did not exceed the permissible limits according to the FAO standard (pH range of 5-9) and the Iraqi standard (pH range of 6.5-8.5). However, the water in the studied sites (Al-Dubainia, Juhat, Al-Mujayhila, Al-Sawariyah, Shalal) was deemed unsuitable for exceeding the aforementioned criteria (Table 4).
2. As shown in Table (2), the electrical conductivity (EC) concentrations within the studied sites ranged from 1.465 to 2.44 decisiemens per meter (dS/m). This can be attributed to the reduced water availability in the canals due to the expansion of cultivated areas, leading to a decrease in the amount of water supplied and subsequently an increase in salinity concentrations. This increase in salinity is a result of the expansion of summer crops and, consequently, an increase in agricultural drainage.

Based on the EC concentrations of the water and comparing them to the WHO (World Health Organization) and Iraqi standards (Table 3), it is observed that the canals (Al-Dubainia, Al-Sawariyah, Al-Janabiyah Al-Yasirah, Juhat) are suitable for drinking water as they did not exceed the permissible limits of 2 dS/m. However, the canals (Shalal, Al-Mujayhila) are not suitable for drinking water as they exceeded the permissible limit of 2 dS/m. Nevertheless, they are deemed suitable for irrigation according to the FAO standard and the Iraqi standard, as they did not exceed the permissible limits of 300 dS/m and 2 dS/m, respectively, in parallel (Table 4).

Table (2): Qualitative Characteristics of Water in Al-mishkhab Canal in the Study Area for the Year 2022.

No.	Concentration	Al-Dubainia	Shalal	Al-Sawariyah	Al-Mujayhila	Al-Janabiyah Al-Yasirah	Ajhat
1	PH	8,21	8,86	8,91	8,87	7,63	8,37
2	Ec dS/m	1.504	2,25	1,503	2,44	1,482	1,465
3	T.D.S mg/L	1436	803	1840	1740	1465	1960
4	Mg mg/L	26,34	89,79	56,34	22,38	88,54	88,56
5	Na mg/L	153,9	90,6	156,4	114,3	136,7	111,1
6	Ca mg/L	8	7	12	15	7	8
7	So4 mg/L	108	113	112	106	111	102
8	No3 mg/L	0,145	0170	0,190	0,139	0,143	0,136
9	Fe mg/L	0,082	0,115	5,111	0,099	0,106	0,113
10	Cu mg/L	160	173	170	57	158	157
11	K mg/L	51,4	65,8	54,3	60,1	54,3	51,4
12	TurbidityNTu	1,94	2,04	3,10	2,45	1,184	1,190
13	T.H mg/L	750,45	734,4	605,4	560,60	605,5	431,9
14	CL mg/L	155	160	120	180	900	850

Table (3): Permissible Limits for Drinking Water Quality According to the World Health Organization (Who) and Iraqi Standards.

No.	Property	Unit of measurement measurement	WHO	Iraqi specifications
1	Temperature	The Celsius degree	5 Less than 35	5- Less than 35
2	Color, taste, and odor	--------	Normal and acceptable	None
3	Turbidity (N.T.U)	mg/L	5-25	5-25
4	Oxygen	mg/L	More than 4	More than 5
5	Biochemical Oxygen Demand (BOD)	Dessmann	Less than 4	Less than 5
6	Electrical Conductivity	Dessmann	2	2
7	pH (hydronium-ion concentration)	-------	6.5-8.5	8,5 -6,5
8	Total Hardness (TH)	mg/L	500	500
9	Total Dissolved Solids (TDS)	mg/L	1200	1000
10	Calcium (CA)	mg/L	75-200	150
11	Magnesium (MG)	mg/L	30-150	100
12	Sodium (NA)	mg/L	20-200	200
13	Potassium (K)	mg/L	15-12	15
14	Phosphate (PO4)	mg/L	0.4	0,4
15	Chlorine (CL)	mg/L	200-300	350
16	Sulfate (SO4)	mg/L	10-200	400
17	Bicarbonate (HCO3)	mg/L	170	200
18	Nitrate (NO3)	mg/L	50	50
19	Cadmium (CD)	mg/L	0.003	0,003
20	Iron (Fe)	mg/L	0.3	0,5
21	Copper (Cu)	mg/L	2	1
22	Nickel (Ni)	mg/L	0.07	0,02
23	Lead (Pb)	mg/L	0.001	0,01
24	Aluminum (Al)	mg/L	0.1-0.2	0,02
25	Zinc (Zn)	mg/L	0.1	3
26	Total Coliform Bacteria Count	Cell/1 millimeter	None	Not available
27	Fecal Coliform Bacteria Count (Escherichia coli or E. coli)	Cell/1 millimeter	Not available	Not available

Who, Guidelines for Drinking – Water – Quality -4th Edition ,2017 [7].

Iraq, Drinking Water Standers, Cent Al Orgaization for Standardiztion and Quality, Contril Min, Of Planning,2014 [8].

Table (4): Permissible Limits for Water Validity for Irrigation Purposes According to the Standards of the Food and Agriculture Organization (Fao) and the Iraqi Standards.

No.	Property	Unit of measurement	Allowed limits according to FAO:	Allowed limits according to Iraqi standards:
1	Temperature	The Celsius degree	Less than 35	Less than 35
2	Electrical Conductivity	Decibels/meter	5-3	2
3	Total Dissolved Solids (T.D.S)	mg/L	0	- -
4	Calcium (CA)	mg/L	0-400	0-400
5	Magnesium (MG)	mg/L	0-150	0-150
6	Sodium (NA)	mg/L	0-920	520
7	Potassium (K)	mg/L	78.0	80
8	Carbonates (HCO3)	mg/L	610.0	520
9	Sulfates (SO3)	mg/L	0-500	500
10	Chloride (CI)	mg/L	0-250	350
11	Nitrate (NO3)	mg/L	0-10	16
12	pH	----	5-9	6.5-8.5
13	Calcium (CA)	mg/L	0.01	0.01
14	Lead (PB)	mg/L	0.01	1
15	Copper (CU)	mg/L	0.2	0.2
16	Iron (FE)	mg/L	5	5
17	Nickel (NI)	mg/L	0.2	- -
18	Zinc (ZN)	mg/L	20	- -
19	Aluminum (AL)	mg/L	4	- -
20	Biological Oxygen Demand (BOD)	mg/L	Less than 3	Less than 3
21	Total Coliform Bacteria	Cell/millimeter	1000	1000
22	Fecal Coliform and E.COLI	Cell/millimeter	0.20	- -

FAO, guidelines for irrigation water quality, ministry of environment human resource development of environment U.S.A .1999 [9].

Concentration of Total Dissolved Solids (TDS) shows a clear variation, ranging from 1960 to 1436 mg/L. According to Table 2, all the studied sites (Dubainiya, Al-Mujayhila, Al-Junabiya Al-Yasra, Jihat, Shalal) recorded higher concentrations compared to the standards set by the World Health Organization (WHO) and the Iraqi standard (Table 3). We observe that all the studied sites are not suitable for drinking water as they exceed the permissible limits according to the WHO standard of 1200 mg/L and the Iraqi standard of 1000 mg/L. Furthermore, it is noticed that the irrigation water is also unfit due to exceeding the permissible limits set by the Food and Agriculture Organization (FAO). Total Dissolved Solids (TDS) concentrations represent water hardness (TH), which showed low concentrations in all the studied sites, ranging from 431.9 to 750.45 mg/L. Thus, the sites (Dubainiya, Shalal, Al-Sawariyah, Al-Mujayhila, Al-Junabiya Al-Yasra) are not suitable for drinking water as they exceed the limits allowed according to the WHO standard of 35-500 mg/L. Only Jihat is considered suitable for drinking water as it does not exceed the permissible limit (Table 3).

Regarding the positive ions concentrations (MG++, K+1, CA+2, NA+1) in the lake waters, it varied spatially and temporally. Comparing the concentrations to the WHO and Iraqi drinking water standards (Table 3), it is observed that all the studied sites are suitable for drinking water as they do not exceed the permissible limits for the concentrations of CA+2 and NA+1, which are 20-200 and 75-200 mg/L, respectively, according to the WHO standard. However, based on the Iraqi standard, it is noted that the drinking water is not suitable due to exceeding the limits for K+1 concentrations, which are 15-12 mg/L. Additionally, it is observed that the drinking water is suitable according to the concentrations of CA+2 and NA+1 according to the Iraqi standard, as they do not exceed the permissible limits (20-200 and 75-200 mg/L, respectively). Moreover, the drinking water is suitable based on the concentrations of Mg++ in all the sites, as it does not exceed the WHO standard of 30-150 mg/L but exceeds the Iraqi standard of 100 mg/L (Table 3).

Regarding irrigation, it is observed that the water in the studied sites is suitable according to the concentrations of K+1, Mg++, and NA+1 based on the FAO standard (Table 4). None of these concentrations exceed the permissible limits, which are 0-920, 0-150, and 78 mg/L, respectively. Additionally, it is noted that the lake sites (Dubainiya, Shalal, Al-Sawariyah, Al-Junabiya Al-Yasra, Jihat, Al-Mujayhila) are suitable for irrigation based on the concentrations of CA+2 according to the FAO standard. These concentrations do not exceed the permissible limit of 0-400 mg/L (Table 4).

Negative ions (MO3-1-CL3-1) may vary spatially and temporally.

We observe a decrease in the concentrations of the location table (2), which is attributed to the limited area planted with summer crops according to the (WHO) and the Iraqi standard for drinking water suitability. We also notice the unsuitability of drinking water according to the (SO4) concentrations in all the studied locations, as the water is suitable for drinking as it does not exceed the allowed limit according to the (WHO) and the Iraqi standard of (10-200) mg/L, while the Iraqi standard is (400) for exceeding the allowed limit. Table (3).

Regarding the (NO3+1) concentrations, we notice that the water is suitable for drinking as it does not exceed the allowed limit according to the (WHO) in all the studied locations, as shown in table (3). As for irrigation, according to the (FAO) organization, all the studied locations are suitable for irrigation, as they do not exceed the allowed limit of (0-10) according to table (4).

Based on the (CL) concentrations, we note that the water is suitable for drinking in all the studied locations according to the (WHO) standard in table (3), as it does not exceed the

allowed limit of (200-300) mg/L. However, we observe the unsuitability of drinking water (Al-Janabiya Al-Yusra-Jihat) according to the Iraqi standard which is (250) mg/L for exceeding the allowed limit. As for irrigation, we notice the suitability of water according to the (SO4) concentrations in all the studied locations, as it does not exceed the allowed limit according to the (FAO) and the Iraqi standard of (500) mg/L. Table (4). The water is suitable for drinking according to the (NO3) concentrations as it does not exceed the allowed limit according to the (FAO) and the Iraqi standard of (16) mg/L for each. Table (4). However, regarding the (CL) concentrations, we notice the unsuitability of irrigation water in the studied locations (Al-Janabiya Al-Yusra-Jihat) according to the (FAO) standard and the Iraqi standard of (350) mg/L for exceeding the allowed limit.

The concentrations of the heavy element (CA) in the water of the ponds show temporal and spatial variation according to table (2). We observe that the water is suitable for drinking in all the studied locations according to the (WHO) standard, as it does not exceed the allowed limit of (75-200) mg/L. Table (3).

Through the above information and after identifying the specific characteristics of the water in some ponds in the study area, it is evident that they are not suitable for most uses due to exceeding international and local standards, especially in terms of the concentrations of most chemical and physical elements, especially electrical conductivity and heavy elements that exceed the global and local limits for drinking and irrigation [10-14].

Results

The study has proven through laboratory analysis results from (6) locations that there is temporal and spatial variation in the concentrations of chemical and physical pollutants in the water. There is variation from one location to another, with higher concentrations observed in the location affected by human, civil, industrial, and agricultural waste. Temporally, the variations occur between seasons, as follows:

1. The study has shown through laboratory analysis results that the water's quality properties fluctuate as it moves towards the pond areas due to the influence of human waste and increased pollutant concentration. The water was found to be unsuitable based on the concentrations of certain elements at the initial branching points before entering the study area. This variation affects its usability for most human activities such as drinking, agriculture, and aquatic life.
2. Laboratory analysis results have shown that the water is suitable for drinking in all the studied locations according to the concentrations of temperature, magnesium, bicarbonates, and nitrates, based on the WHO and Iraqi standard. However, the water has been found to be unsuitable for drinking in all the locations based on the concentrations and properties of electrical conductivity, total dissolved solids, sodium, potassium, and phosphates, according to the standards of WHO and the Iraqi standard. This indicates the varying usability of the water for drinking purposes from one location to another.
3. The study has proven that surface water in the study area is suitable for the purpose of understanding aquatic life in all the studied locations based on the concentration of pH. However, it is considered unsuitable based on the concentrations of phosphates, lead, and calcium, revealing the limited usability of these elements for human purposes both temporally and spatially.

Proposed Solutions

Considering the researcher's awareness of most of the problems faced in the study area, the researcher has proposed a set of solutions that can contribute to addressing and eliminating the pollution and degradation of surface water in the study area, if implemented.

1. It is necessary to consider water as an economic commodity with significant monetary value so that residents in the study area recognize its economic, social, and cultural importance. This can be achieved by enhancing religious and cultural awareness among the population through environmental awareness programs.
2. The Ministry of Housing and Public Works should provide alternative locations for agricultural land and informal settlements within the basic design of the city and its inhabitants. Measures should be taken against those who encroach on such areas, especially those located on the banks of rivers. Additionally, the municipality of Al-Mashkhab district should monitor and hold accountable the owners of restaurants and cafes along the Mashkhab Corniche, advising them against disposing waste into waterways.
3. The municipality of Al-Mashkhab district should expedite the construction of a new solid waste treatment plant with sufficient capacity to accommodate all waste and identify a suitable location away from river streams for the disposal of solid waste. Measures should also be taken to prevent residents from disposing household waste and wastewater into water bodies.
4. The Ministry of Agriculture and all its institutions in the region, in cooperation with the Irrigation and Drainage Directorate in Najaf Al-Ashraf Governorate, should regulate irrigation and drainage networks to prevent farmers from discharging agricultural waste into water bodies. This should be incorporated into the comprehensive plan for sedimentary plain drainage, connecting the study area to the main drainage outlet or redirecting drainage water towards the lower area of the Sea of Najaf after establishing a wastewater treatment plant.
5. Optimal use of chemical fertilizers and pesticides should be practiced based on the needs of agricultural crops, with regulated schedules for their application. Moreover, sewage water should not be used for irrigation or fertilization. Training courses should be conducted by experts to educate farmers on these practices.
6. Relevant authorities should hold accountable those who violate water networks by imposing financial fines and other legal penalties as deterrents against anyone attempting to discharge liquid or solid waste into water networks or tamper with them.
7. Sites with pollution concentrations exceeding the permitted levels for human activities should not be used for tourism or washing purposes, particularly sites with high concentrations of harmful heavy elements.
8. The relevant water resource management authorities, especially the Directorate of Agriculture, Directorate of Water Resources, and Irrigation and Drainage Directorate in Najaf Al-Ashraf Governorate, should monitor the unutilized surface water to prevent wastage and ensure its proper utilization in economic activities.

Conclusions

In conclusion, the proposed solutions outlined in this research study offer a comprehensive approach to addressing surface water pollution and degradation. Implementing these measures, along with continuous monitoring and evaluation, will contribute to the long-term protection and sustainable management of surface water resources in the specific study area.

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