

# The Concentration of Pollutants and the Shortage of Water Supply in the Euphrates River in the City of Samawah, and Ways to Address it

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**Abstract:** This research addressed the relationship between the increased concentration of pollutants in the Euphrates River in the city of Samawah and the shortage of water supplies. The research relied on field visits after collecting water samples taken from several locations along the course of the Euphrates River and then analyzing them according to specific indicators, while studying the biological, chemical, and physical characteristics across the seasons. The results showed an increase in the concentration of pollutants due to the decrease in water levels, and an increase as well in electrical conductivity, turbidity, and dissolved elements. The decrease in water discharge led to an increase in bacteriological indicators, with the river unable to mitigate this pollution due to climate change, increased drought, and the shortage of water resources feeding the Euphrates River. Human activities showed that sewage and agricultural runoff represent the main source of this pollution. The study recommended the necessity of improving the water quality of the Euphrates River through integrated measures such as improving infrastructure, activating environmental laws, and developing sustainable management of the Euphrates River to ensure its protection and the continuation of its vital role.

**Keywords:** Euphrates River; Water Pollution; Water Scarcity; Samawah; Environmental Analysis; Water Quality.

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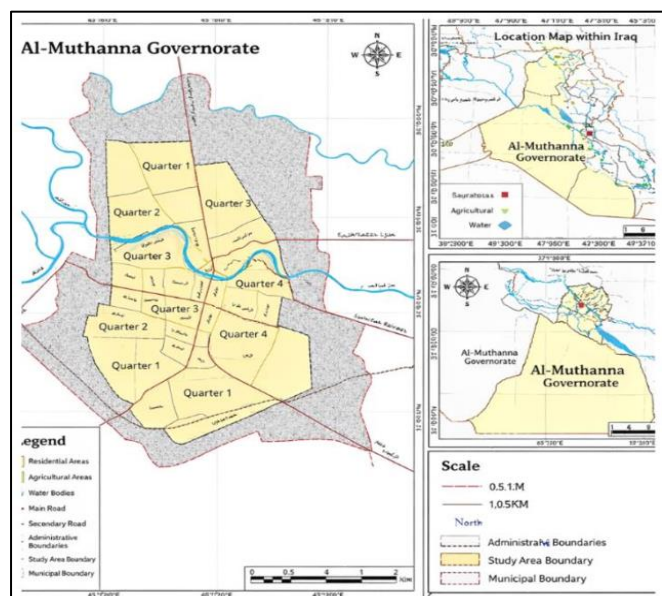
## I. INTRODUCTION

The Euphrates River in the city of Samawah is considered the lifeblood that supplies it with water, as it depends on it completely and directly in various economic and life activities. In light of growing and accelerating climatic and environmental changes, the Euphrates River is no longer a pure resource, with the simultaneous rise in concentrations of pollutants and a noticeable decline in the quantities of water feeding it. This has led to an exacerbation of pollutants and risks that threaten human health and created a worrying situation, in addition to the environmental and health challenges that have been negatively reflected in all aspects of life, from public health to agricultural activities. Therefore, this combination of high levels of pollutants in the waters of the Euphrates River and the corresponding decrease in water supplies represents a real problem that requires a precise scientific study that seeks to find effective solutions to ensure its protection, improve the quality and sustainability of its waters, as well as its vital role as a resource for our current and future generations.

## II. RESEARCH FRAMEWORK

### ➤ Research Problem

- What is the level of pollutant concentration in the waters of the Euphrates River as it passes through the city of Samawah in recent years?
- What are the main factors that led to the increased concentration of pollutants in the river water?
- To what extent has the shortage of water supply contributed to the further deterioration of water quality?
- What is the relationship between declining water releases, increased salinity, and the deterioration of the physical and chemical properties of river water?
- What are the health, environmental, and agricultural impacts resulting from the (pollutant concentration – water shortage) syndrome?
- How effective are current governmental and local measures in controlling pollution and improving water quality?
- What treatments and strategies can be adopted to reduce the worsening of this syndrome in the city of Samawah?



Map 1 Location of Al-Muthanna Governorate in Iraq

#### ➤ Research Objectives

- Measuring the concentration of pollutants in the Euphrates River water in the city of Samawah and comparing it to approved environmental standards.
- Identifying the main sources of pollution affecting water quality.
- Analysis of the impact of reduced water supply on the degree of water pollution and changes in its properties.
- Clarifying the complementary relationship between decreased water releases and increased pollution.
- Assessing the health, environmental, and agricultural damage resulting from the deterioration of water quality.
- Evaluating the effectiveness of current pollution reduction measures.
- Proposing practical solutions and treatments that can be applied in the short, medium, and long term.

#### ➤ Importance of the Research

- It highlights one of the most serious environmental crises facing the city of Samawah.
- It provides a scientific database that helps relevant authorities make decisions related to water resource management.
- It reveals the relationship between pollution and water scarcity, helping to understand the mechanisms of river degradation.
- It contributes to protecting public health and the agricultural sector from the effects of polluted water.
- It provides scientifically sound proposals that can be adopted to develop realistic and sustainable treatment plans.

#### ➤ Research Hypotheses

- There is a clear increase in the concentration of pollutants in the Euphrates River waters in the city of Samawah, resulting from human, agricultural, and industrial sources.

- Reduced water inflow directly contributed to increased pollutant concentration due to the river's decreased self-mitigation capacity.
- The deterioration in water quality has negatively impacted public health, agriculture, and the local environment.
- Current measures to address pollution are insufficient to meet the scale of the problem.

#### ➤ Research Boundaries

##### • Spatial Boundaries

The study covers Samawah City, Al-Muthanna Governorate, specifically the sections of the Euphrates River passing within the city limits. The city is located within longitudes 45°17' East and latitudes 31°19' North. The study focuses only on the course passing through the administrative boundaries of Samawah, specifying monitoring points such as river entry points into the city, main sewer outlet points, and city exit points. Rural areas, swamps, and branches of the Euphrates River located outside the city's administrative boundaries are excluded unless they represent a direct source of pollution or water shortage affecting the city.

### III. METHODOLOGY

#### ➤ Field Study – Spatial Boundaries of Sampling Sites

- Reference station above the city: Sample taken from  $\geq 500$ –1000 m above the first urban impact point to ensure an unaffected reference condition.
- Stations within the city: Distributed to cover the urban area well, with approximately 300–800 meters between stations depending on the river's length within the city.
- At drainage outlets (municipal/industrial): Two samples are collected for each outlet – a direct sample from the drain outlet and a sample mixed with river water at 10–30 meters from the outlet.
- City exit station: Located 200–1000 meters beyond the last exit within the city to monitor urban impact.
- Station below the city: Chosen  $\geq 2$ –5 km after the city end to assess the extended impact.
- Backup sites: Two alternative sites documented at 100–300 meters from each station in case main sites cannot be accessed.

#### ➤ Vertical Boundaries and Sampling Type

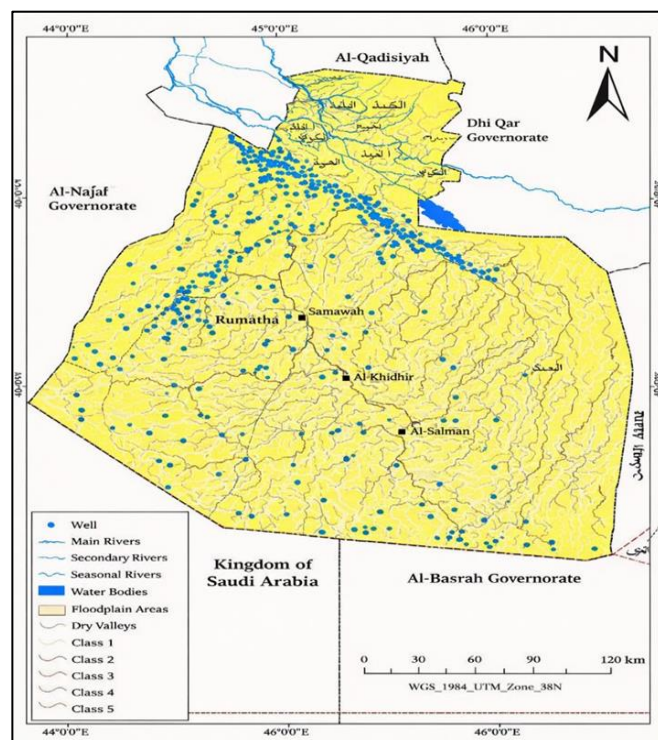
- Surface water samples: Collected from a depth of 0.3–0.5 meters below the surface at locations with natural runoff.
- Composite samples: Collected when there are changing currents, across the depth or width of the river (3–5 merged point samples).
- Sediment: Taken from the surface layer (0–5 cm) for analysis of heavy metals or pollutant accumulation.
- Stagnant layers or calm pools: Require sampling from both the surface and the bottom to assess differences.

➤ *Sampling Frequency and Timing*

- Minimum frequency: At least monthly samples to track seasonal variations.
- Seasonal coverage: At least one sample per season if monthly sampling is not possible.
- During emergency events: Samples should be taken immediately during or after heavy rain, emergency drainage, or industrial accidents.
- Standardized timing: Field measurements preferably collected between 08:00 and 11:00 am during repeated tours.

➤ *Sample Sizes and Preservation Methods*

A minimum of 1–2 liters per site is collected for multi-indicator analysis. Sterile glass containers are used for organic indicators (BOD/COD and pesticides), and special plastic containers for inorganic indicators. Metal samples are fixed by adding acids to adjust pH to < 2. Bacterial samples must be analyzed within 6 hours, or a maximum of 24 hours in exceptional cases; samples are instantly cooled to 4°C using an ice pack.



Map 2 Water Resources Network in Al-Muthanna Governorate

Table 1 Sampling Plan for the Euphrates River in Samawah

Description of the Proposed Site	Goal / Reason	Suggested Sample Type / Depth	Station Code
Before the Euphrates waters enter the city (reference station)	Measuring water quality before the city's impact	Surface water, depth 0.3–0.5 m	S1
City entrance – first river entry point into the urban area	Monitoring the change upon entering the city	Surface water, depth 0.3–0.5 m	S2
City Center – near the Central Bridge	Assessing urban impact at city center	Surface water, depth 0.3–0.5 m	S3
Point near an industrial wastewater outlet	Monitoring the impact of industrial discharges	Surface water near drain outlet, depth 0.3–0.5 m	S4
Municipal drainage outlet 1 within the city	Assessment of first municipal drainage impact	Surface water BOD/COD, surface depth	S5
Municipal drainage outlet 2 or wastewater collection point	Comparing impact of different drainage sources	Surface water near the outlet	S6
Agricultural drainage or pesticides point (if available)	Measuring nitrates and phosphates from agriculture	Surface water for organic/pesticide analysis	S7
River exit point from the city	Water quality after passing through the city	Surface water, depth 0.3–0.5 m	S8
Sedimentation area or swamp within the city	Understanding sedimentation and accumulation	Surface water + sediments (0–5 cm)	S9
After the river has passed a set distance below the city	Measuring pollutant movement below the city	Surface water, depth 0.3–0.5 m	S10

Source: From the Researcher's Work Based on the Field Study.

**IV. RESULTS AND DISCUSSION**

➤ *Physical and Chemical Indicators*

The results indicate significant variations in physical, chemical, and bacteriological characteristics across different months during the study period. Temperature variations were observed due to seasonal changes and the diversity of studied sites, ranging between 8°C and 40°C. The temperature difference between winter (Station 1: 7°C) and summer

(Station 4: 39°C) reached 32°C. Electrical conductivity values varied between 885–989 μS/cm, measured in spring and summer at stations three and four. Turbidity values ranged between 45 and 56 NTU during the summer and spring seasons at stations one and four, while pH rates were between 8.0 and 8.2 over the four seasons.

For nitrite, values ranged between 1.1 and 2.2 μmol/L during the autumn and spring seasons at station one. The

lowest nitrate value was recorded in the autumn season at station one, at 47 µmol/L, while the highest value was 57 µmol/L during the spring season at the same station. Phosphate ranged from 1.8 mg/L during the autumn season at station two to 3.1 mg/L during the spring season at station three. Hardness values ranged between 677–690 mg/L, calcium between 312–353 mg/L, and magnesium between 75.26–81.31 mg/L across the four seasons and four stations.

➤ *Bacteriological Indicators*

In bacteriological examinations, the total bacterial count ranged from 41 × 10<sup>3</sup> cells per 100 ml during the summer

season at stations 1 and 3, to 49 × 10<sup>3</sup> cells per 100 ml during the spring season at station 2. Total coliform count values ranged from 100 to 142 cells per 100 ml during the winter and summer seasons at stations 3 and 4. The lowest counts for thermotolerant fecal bacteria and E. coli were 63 cells per 100 ml in the winter season at station one, while the highest value was 84 cells per 100 ml in the summer season at station four. Fecal streptococcal bacteria values ranged between 51 cells per 100 ml in the winter season at station one and 77 cells per 100 ml in the summer season at stations three and four, as shown in Table 2.

Table 2 Drinking Water Quality and Concentrations of Substances in the Euphrates River, Samawah

Season	St n.	Temp (°C)	EC (µS/cm)	Turbidity (NTU)	pH	NO <sub>2</sub> (µmol/L)	NO <sub>3</sub> (µmol/L)	PO <sub>4</sub> (mg/L)	Hardness (mg/L)	Ca (mg/L)	Mg (mg/L)	Alk. (mg/L)	DO (mg/L)	BOD (mg/L)
Autumn	1	25±0	945±0.01	50±0.06	8.0±0.01	1.1±0.02	47±0.1	2.0±0.07	675±0.9	312±0.6	81.31±0.1	218±0.02	4.7±0.08	1.8±0.03
Autumn	2	26±0	945±0.08	51±0.01	8.0±0.01	1.1±0.02	48±0.04	1.8±0.01	677±0.04	317±0.04	80.64±0.07	222±0.05	4.5±0.02	1.7±0.04
Autumn	3	27±0	951±0.01	51±0.02	8.0±0.02	1.4±0.03	48±0.09	2.1±0.1	678±0.6	320±0.03	80.19±0.02	224±0.06	4.7±0.06	1.9±0.07
Autumn	4	28±0	957±0.02	52±0.02	8.1±0.04	1.3±0.01	48±0.2	2.0±0.05	677±0.14	322±0.01	79.52±0.6	227±0.06	4.8±0.07	1.8±0.03
Winter	1	7±0	910±0.06	48±0.05	8.0±0.03	2.0±0.04	50±0.07	2.7±0.09	682±0.08	341±0.01	76.38±0.01	236±0.01	5.1±0.03	2.0±0.04
Winter	2	8±0	918±0.02	48±0.03	8.1±0.01	1.8±0.02	50±0.09	2.8±0.08	687±0.04	345±0.08	76.60±0.04	237±0.07	5.2±0.05	2.2±0.08
Winter	3	8±0	920±0.09	49±0.02	8.1±0.01	2.1±0.02	51±0.03	2.8±0.07	688±0.06	347±0.07	76.38±0.05	240±0.09	5.1±0.02	2.0±0.06
Winter	4	9±0	921±0.03	50±0.01	8.1±0.03	2.0±0.03	52±0.07	2.9±0.01	685±0.01	346±0.08	75.93±0.02	242±0.02	5.1±0.09	2.0±0.03
Spring	1	16±0	885±0.03	52±0.07	8.0±0.01	2.2±0.04	57±0.08	3.1±0.09	691±0.02	344±0.06	77.73±0.4	255±0.07	5.5±0.07	2.3±0.05
Spring	2	18±0	887±0.02	53±0.05	8.1±0.02	2.1±0.02	58±0.1	3.0±0.07	690±0.09	348±0.07	76.60±0.01	257±0.06	5.7±0.06	2.4±0.03
Spring	3	19±0	883±0.01	53±0.04	8.2±0.01	2.1±0.03	58±0.05	3.1±0.3	690±0.02	351±0.02	75.93±0.03	257±0.03	5.6±0.09	2.3±0.01
Spring	4	19±0	886±0.08	54±0.02	8.1±0.05	2.2±0.01	57±0.01	2.8±0.08	689±0.03	353±0.02	75.26±0.07	259±0.01	5.6±0.01	2.5±0.01
Summer	1	37±0	980±0.07	44±0.03	8.1±0.01	1.5±0.02	55±0.06	2.9±0.03	697±0.08	337±0.09	80.64±0.9	241±0.07	5.0±0.01	2.1±0.06
Summer	2	37±0	987±0.07	45±0.02	8.1±0.04	1.6±0.04	54±0.07	2.8±0.02	698±0.08	341±0.01	79.96±0.02	244±0.08	5.1±0.03	2.3±0.1
Summer	3	38±0	986±0.03	45±0.04	8.1±0.01	1.7±0.03	55±0.03	2.9±0.05	695±0.01	342±0.05	79.07±0.03	247±0.05	5.2±0.02	2.2±0.09
Summer	4	39±0	987±0.05	46±0.06	8.0±0.01	1.7±0.01	57±0.04	2.9±0.05	696±0.7	344±0.02	78.84±0.08	248±0.04	5.1±0.07	2.2±0.04

Source: From the Researcher's Work Based on WHO Guidelines for Drinking Water Quality.

➤ *Discussion*

This study reveals significant changes in the water quality of the Euphrates River due to seasonal variations and surrounding environmental factors. Fluctuations in water temperature between seasons were observed as a result of seasonal climatic variations, reflecting the role of these changes in affecting water properties. An increase in electrical conductivity values was observed, attributable to

the river flowing through agricultural lands where salts reach the river from irrigation water; high temperatures lead to increased evaporation, which further raises the concentration of ions in the water.

Variations in turbidity were particularly noted in spring, attributed to snowmelt and waste dumping into the river, which increases the proportion of suspended solids. pH

showed a tendency toward alkalinity in all studied areas due to the water's alkaline nature. Calcium concentrations were consistently higher than magnesium concentrations across all sites and seasons because carbon dioxide reacts with calcium to a greater extent than with magnesium, producing soluble bicarbonate.

Regarding nitrite and nitrate concentrations, a clear variation was observed, possibly due to the area being located within agricultural and residential lands containing residues of agricultural chemical fertilizers that reach water sources through drainage or rainwater. High phosphorus levels are primarily due to the dumping of household waste and the use of phosphate fertilizers. Dissolved oxygen levels rose during winter and spring due to lower temperatures, increased photosynthetic activity, and higher current speeds, while low oxygen levels appeared at the end of summer and during autumn due to high temperatures, reduced photosynthesis, and decomposition of organic matter. The total bacterial count increases in spring and decreases in summer, being influenced by climate and corresponding fluctuations in water levels.

Table 3 Relative Size and Length of the Euphrates River Basin by Country

Location	River Length (km)	River Length (%)	Basin Area (km <sup>2</sup> )	Basin Area (%)
Turkey	1,170	39.8	125,000	28.1
Syria	610	20.8	76,000	17.1
Iraq	1,160	39.4	177,000	39.9
Saudi Arabia	–	–	66,000	14.9
Total	2,940	100	444,000	100

Source: From the Researcher's Work, Calculated by Dividing River Length and Basin Area Proportionally by Country.

From Table 3, it is noted that Iraq contains the largest area of the Euphrates River basin (39.9%), yet its annual discharge is very low compared to Turkey and Syria. This is due to the absence of tributaries that support the river as it passes through Iraq, and the river's passage through dry desert lands that increase evaporation rates. Turkey has leveraged approximately 90% of the Euphrates River's water originating in its territory through major dam projects, controlling water flow to downstream countries. The Euphrates River's flow peaks at the end of winter and during spring and decreases in summer.

#### ➤ Quantitative Data on Water Supply

##### • River Discharge

The average discharge at the city of Samawah is estimated at approximately 356 m<sup>3</sup>/s. The flow varies depending on location and time, ranging from a minimum of 58 m<sup>3</sup>/s to a maximum of 2,514 m<sup>3</sup>/s depending on flood seasons and dam management. Long-term estimates indicate the total annual discharge was approximately 30 billion m<sup>3</sup>/year before the implementation of major upstream projects. Reduced drainage below normal levels leads to increased water salinity, negatively affecting the quality of water used for drinking and irrigation.

## V. WATER RESOURCES AND REDUCED WATER FLOW TO THE EUPHRATES RIVER

### ➤ Overview of Water Resources

Studies indicate that water has become the central issue around which future disputes and problems will revolve. Over the past two decades, water has transformed from a free resource into a vital economic asset. Iraq's water resources depend primarily on surface water, rainwater, and groundwater. The Tigris and Euphrates rivers and their tributaries constitute approximately 98% of the total water supply in Iraq, and these rivers depend mainly on rainfall and snow levels, in addition to the management of dams and reservoirs in Turkey, Iran, and Syria.

### ➤ The Euphrates River Basin

The Euphrates River originates in the mountains of Eastern Anatolia in Turkey, collected by two main tributaries: the Euphrates Su and the Murat Su, which meet at the Keban region to form the main course of the river. The Euphrates then crosses the Turkish-Syrian border and continues into Syrian territory before entering Iraq at the city of Al-Qaim (Nusaybah). Table 3 presents the distribution of the Euphrates River basin area among the riparian countries.

### • Rainfall and Evaporation

Southern Iraq is classified as having a semi-arid climate with very low average annual rainfall (around 100 mm or less). Al-Muthanna Governorate is one of the driest areas in this region. Pan evaporation (PET) values are high due to high temperatures and aridity, with studies indicating rates as high as 3,000–3,200 mm/year. A study in the Al-Amaid area recorded an average annual evaporation of approximately 3,182 mm/year. High evaporation rates lead to significant water losses in irrigation canals and reservoirs, increasing pressure on surface water sources.

## VI. CONCLUSION

The Euphrates River is the lifeblood of Al-Muthanna Governorate, yet efforts to preserve it are very limited. Due to population growth, the Euphrates has become increasingly polluted by sewage and medical waste disposed of by dumping into the river. Compounded by climatic factors, this problem is worsening day by day. The study found that the Euphrates River is heavily polluted, with high turbidity, elevated levels of dissolved heavy metals, and rising bacterial indicators. Due to fluctuating climatic conditions, the Euphrates River has suffered from drought and water shortage, making it difficult for the river to break down large quantities of pollutants. The Euphrates River requires

effective treatment, and this study presents a set of solutions and recommendations to reduce the level of pollution in the river.

### SOLUTIONS AND RECOMMENDATIONS

#### ➤ *Engineering and Environmental Treatments*

- Establishing wastewater treatment plants before discharging into the Euphrates River to reduce levels of chemical and organic pollution.
- Lining irrigation canals to reduce losses resulting from leakage and evaporation.
- Building small dams and water tanks to control and regulate water flow during the dry season.
- Adopting modern irrigation systems (drip and sprinkler irrigation) to save water and reduce waste.
- Maintaining and improving agricultural drainage networks to prevent the accumulation of salts in soil and water.

#### ➤ *Administrative, Legal, and Legislative Procedures*

- Updating water resources management laws and regulations to encourage rational use and protection of water resources.
- Strengthening environmental monitoring for industrial facilities and enforcing compliance with environmental standards.

#### ➤ *Scientific and Technological Measures*

- Using remote sensing technologies and Geographic Information Systems (GIS) to understand and address periodic changes in water levels and flow.
- Establishing a comprehensive local and national database for information about drainage levels, pumping rates, rainfall, and evaporation.
- Deploying sophisticated early warning monitoring systems to detect pollution or sudden drops in water levels.

#### ➤ *General Recommendations*

- Adopting a national water management strategy focused on sustainability and resource allocation.
- Conducting awareness campaigns on the importance of clean rivers and water sources.
- Supporting cooperation between universities and government agencies to develop innovative solutions.

Integrating environmental awareness and natural resource management into school curricula.

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