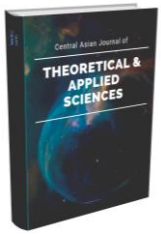

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Article

A review of Water Quality and Pollution Assessment of the Euphrates River

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Abstract: Water contamination is widely acknowledged as a serious environmental problem, largely due to the rapid rise of human civilization and inadequate management of water resources. Due to its detrimental effects on ecosystems and public health, river and lake contamination—caused by trash from industry, agriculture, and residential sources—has gained significant attention in environmental and conflict studies. The purpose of this review is to assess the environmental changes in water quality along the Euphrates River from its source at the border between Turkey and Syria to southern Iraq. Identifying seasonal fluctuations in chemical concentrations, evaluating variations in the physical and chemical qualities of water, and improving the water quality database for academics are some of the main goals. Iraq's rivers, such as the Tigris and Euphrates, have seen a decline in water quality because of untreated waste discharge and climate change. The effects of critical water quality parameters on aquatic life and agricultural appropriateness are assessed. These factors include temperature, pH, total dissolved solids, and the concentration of components including sodium, calcium, magnesium, chloride, and sulfate. The review also looks at the hydrological and geological aspects of the Euphrates River, emphasizing the role of climate, groundwater, and rock formations. The construction of dams in Syria and Turkey has drastically decreased the river's discharge, making Iraq's problems with water quality worse. The study emphasizes the necessity of collaborative water management and environmentally friendly methods to lessen the negative impacts on the Euphrates River and guarantee the wellbeing of the region's population and ecosystems.

Keywords: Environmental Impact, Euphrates River, Pollution, Water Quality.

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1. Introduction

Water pollution has become a major environmental problem because of the advancement of human civilization, the decline in the management of water resources in recent decades, and rising water demand. Since pollution of rivers and lakes has a major impact on water quality, it is especially dangerous and a major area of attention for environmental and conflict studies. Water supplies are under threat worldwide due to human activity, both industrial and agricultural, which alters the environment chemically and physically and causes ecological imbalances. Numerous types of pollution, including as residential, commercial, and agricultural waste, worsen this decline in water quality, which has an immediate negative effect on the environment and public health. With a focus on the Euphrates River, this study attempts to evaluate environmental changes in water quality starting at the source[18].

It focuses on investigating changes in the chemical and physical characteristics of water, looking at seasonal fluctuations in the quantities of chemical elements, and improving the database of pollution and water quality by giving environmental researchers access to crucial data.

2. Materials and Methods

Water Quality in Iraq

The quality of water in Iraq is significantly impacted by the discharge of untreated industrial and residential waste, leading to a decline in the physical and chemical properties of water. Seasonal climatic changes also play a critical role, affecting the water flow and quality in rivers like the Tigris and Euphrates [1].

Temperature

Water temperature is one of the most crucial characteristics affecting aquatic life. It influences the solubility of oxygen in water, with higher temperatures reducing oxygen levels, thereby limiting its availability to aquatic organisms [2].

pH

The pH level of water indicates the concentration of hydrogen ions and affects the solubility of various metals. Water used for irrigation typically has a slightly alkaline pH due to the presence of carbonates and bicarbonates. The pH level can influence the solubility and toxicity of certain elements, making it an important factor in water quality assessment [3].

Total Dissolved Solids and Electrical Conductivity

Electrical conductivity measures a solution's ability to conduct electricity, which depends on the concentration of dissolved ions. It is a common method for estimating the total dissolved solids (TDS) in water. High levels of TDS indicate significant amounts of dissolved salts, which can affect water quality and suitability for various uses [30].

Sodium

Sodium concentration in water increases with salinity, and high levels can be toxic to plants. It is a critical factor in determining water quality for agricultural purposes [4].

Calcium

Calcium is essential for plant growth and improves soil structure by reducing the negative effects of sodium. High calcium levels in water can enhance soil permeability and aeration, promoting better plant growth [3].

Magnesium

Magnesium is widespread in nature and is crucial for plant photosynthesis. However, high concentrations can cause water hardness and negatively affect plant nutrient uptake.

Chloride

Chloride is a naturally occurring ion that, in high concentrations, can be toxic to plants. It is a significant factor in determining water quality for agricultural purposes [5].

Sulfate

Sulfate is commonly found in natural waters and contributes to water hardness. It can form salts with calcium and magnesium, affecting water quality and plant growth [5].

Pollution: Concept of Pollution

Pollution refers to any change in the physical, chemical, or biological properties of water due to human activities that makes it unsuitable for its intended use. Sources of water pollution include industrial, residential, and agricultural activities that discharge untreated waste into water bodies [6].

Sources of Pollution

Pollution sources can be classified into point sources, such as industrial waste discharge, and non-point sources, such as agricultural runoff. Both types of pollution contribute to the degradation of water quality, affecting the ecosystem and human health【25†source】.

3. Results and Discussion

Introduction and Literature Review

Factors Affecting the Quality of Euphrates River Water

1- Rocks

The geological nature of rock formations (such as crystallized limestone and sandstone) through which the Euphrates River passes have a significant impact on determining the nature of the river's course and the quality of its water [7], [8]. In Iraq, the Euphrates River flows along the dividing line between the western desert plateau, located southwest of the Al-Jazira region in the north, and the sedimentary plain located to its east. This line geologically separates the different regions [9].

2- Groundwater

Groundwater is water stored beneath the Earth's surface and appears naturally on the surface in the form of springs and wells. It is considered one of the essential water resources in Iraq. Groundwater dissolves minerals and salts, leaching them into surface water and increasing their concentration. The concentration of dissolved salts in groundwater is not constant but varies depending on the amount of water supply available [10].

3- Hydrological of the Euphrates River

Studying the Euphrates River system reflects the climatic elements and phenomena prevailing in that region. This fact highlights the strong relationship between climatology and applied hydrology. The hydrological system formed by the river basin reflects the climate's impact and its elements over the ages in the study area [4].

4- Boundaries of the Euphrates River Basin

The Euphrates River originates in Turkey, in the middle of the Armenian plateau, east of Anatolia. Most of its tributaries in their early stages flow from the southern slopes of the Taurus Mountains [11]. The river is formed by the union of two tributaries (Frat Su) and (Murat Su). The length of Frat Su is 510 km, while Murat Su is 700 km long, and their union flows from east to west [12]. The total length of the river in Turkey is 1167 km, of which 455 km have a unified course, and the basin area is 124,300 km^2, constituting 27.15% of the total basin area. The annual water inflow to the river basin in Turkey varies from 1000 mm and decreases as we approach the Syrian border, reaching 250-300 mm until it reaches 100 mm near the Syrian-Iraqi border. Many small tributaries flow into it between Keban and the Syrian border[5].

The river then enters Syrian territory at Jarablus, northwest of Syria, and then flows into Iraqi territory from Al-Qaim to Al-Qurnah[6].

Sudkhan, [10] indicated that determining water inflows and their variations throughout the months or seasons of the year impacts the physical and chemical properties and the concentration of their elements. It also plays a significant role in determining the amount of transported sediment, which, in turn, affects the variation of these elements. When water inflow increases in a river section, discharges rise, which leads to a decrease in the concentration of elements in it, and vice versa. In the case of decreased water inflow, discharges decrease, and thus the concentration of elements in the river water increases. The floods witnessed by the Euphrates River during the last century have significantly impacted the river's course over time through the development of several features, including bends, twists, islands, and the advancement and retreat of banks [7].

Bomola, [13] showed that Euphrates River, flowing through Turkey, Syria, and Iraq, faces significant challenges due to natural factors and human activities. Its flow is highly seasonal, with peak flow in April and May, but has been significantly reduced by dams and reservoirs in Turkey and Syria, lowering Iraq's annual flow from 31-33 BCM to 16-20 BCM. Water quality deteriorates downstream, with salinity levels exceeding 4000 ppm near its mouth into the Shatt al-Arab, exacerbated by pollution from untreated sewage, industrial discharges, and agricultural runoff. Climate change further impacts the river with increased temperatures, changing precipitation patterns, and high evaporation rates. The lack of cooperative water management among riparian countries complicates downstream water availability and quality, making sustainable utilization and preservation challenging for Iraq[8].

Al-Taei, (2012) mentioned that the water inflow to the Euphrates River is continuously decreasing compared to its inflow[9] during the fifth and sixth decades of the last century. This is due to the increased demand for its water by Turkey, Syria, and Iraq. Turkey fills water reservoirs after constructing several dams within the Southeastern Anatolia Project, in addition to Syria consuming more water than its allocated share. This has led to increased salinity of the river water and deterioration of its quality in Iraq [14].

The study by ***Al-Obaidi***, [15] aimed to determine the causes of salinization in the Euphrates River within the Qadisiyah and Muthanna governorates, focusing on total dissolved solids (TDS)[10]. The study involved fourteen stations for measuring water pollution, along with identifying agricultural drainage sites, sewers, groundwater seepage, and soil for both governorates. Chemical and physical properties were examined, including pH, electrical conductivity, total dissolved solids, and ion concentrations (sodium, calcium, magnesium, chloride, sulfate, bicarbonate, boron). Additionally, the study measured concentrations of heavy metals like lead and cadmium, turbidity, and calculated the sodium adsorption ratio and total hardness[11].

Al-nsari et al. [16] explained The Euphrates River plays a crucial role in the region's hydrology. Research indicates that the construction of dams in Turkey and Syria has led to a significant reduction in the river's discharge, with some areas experiencing a more than 40% decrease in flow. Turkey's Southeastern Anatolia Project (GAP) has been a focal point in the literature[12], aiming to enhance hydroelectric energy generation and expand irrigable farmland. However, concerns have been raised regarding the project's impact on downstream countries like Syria and Iraq. Issues such as increased salinity levels, attributed to irrigation practices and changes in the river's flow regime, have been highlighted as key challenges for the Euphrates River. These environmental implications pose risks to the ecosystems and water quality downstream, prompting further research and management strategies to address these pressing concerns[13].

Abdul-Razzaq and Al-Naseri, [17] investigated the hydro-chemical analysis of water resources in the region between Kifl and Samawa in southwest Iraq. The research explores the relationship between groundwater and surface water, particularly in the Euphrates River, using techniques such as hydrochemistry and environmental isotopes to assess water composition. Key findings include the analysis of cations and anions, observations on changes in water quality in the Euphrates River as it traverses the study area, and the socio-economic significance of water resources for the local population's well-being and stability. The study provides valuable insights into the interactions between surface and groundwater, highlighting their implications for the environment and society in the region.

4. Conclusion

The Euphrates River water contamination study brings to light the detrimental effects of human activity and resource mismanagement on water quality. The review show that trash from homes, businesses, and farms greatly contributes to the chemical and physical deterioration of the river, creating an ecological imbalance and endangering public health. Seasonal changes are particularly important because varying pollution levels are seen all year round.

The review emphasizes how crucial it is for nations that share the Euphrates River to work together internationally and implement efficient water management strategies to reduce pollution and maintain the quality of the water. To create strategies for sustainable water resource management, environmental researchers must improve the database pertaining to pollution and water quality. To preserve and improve the Euphrates River's health, the report recommends several comprehensive actions, such as tighter rules on garbage disposal, better wastewater treatment facilities, and environmentally friendly agriculture methods.

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