Water quality dynamics of alluvial marches Al-Khaweze of southeastern Iraq

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Abstract. This study determines four hydrochemical parameters being turbidity, water pH, dissolved oxygen, total dissolved solids in water in three sections of alluvial marches Al-Khaweze in southeastern Iraq. The results of laboratory tests have shown that all indicators exceed the permissible norm. This is due to an increase in precipitation in 2018 and 2019 and, accordingly, an increase in the level of water and flow of rivers feeding alluvial marches Al-Khaweze.

1. Introduction

Alluvial marches (waterlogged lands; wetlands) of the Mesopotamian Lowlands (Mesopotamian or Iraqi alluvial marches) are wetlands of the region located in southeastern Iraq and partly in southwest Iran (Fig. 1). Alluvial marches Al-Khaweze are to the east of the Tigris River and some of them are located on the territory of Iran. The Iranian part of alluvial marches known as alluvial marches Al-Azim is fed by the Karha River while the Tigris and its tributaries Musharah and Al-Kahlaa supply water to the Iraqi side of alluvial marches but in much less quantity than Karha. During the spring flood Tigris waters can also flow into alluvial marches Al-Khaweze, which are drained by Al-Kassar, a river of great importance in maintaining alluvial marches Al-Khaweze as a flow system and thereby preventing their salination.

Alluvial marches Iraq are included in the UNESCO World Heritage List. Wetlands played an important role in the development of the earliest cities and in the emergence of various nationalities in southern Mesopotamia called the cradle of civilization due to the fact that they possessed cultural and natural features [2].

Alluvial marches Al-Khaweze differ from Central alluvial marches and Al-Hammar as a source of surface water. Water flows into them from Iraq through the Al-Kahlaa and Musharah rivers and the territory of the Islamic Republic of Iran through the Karha River. Al-Khaweze is characterized by the presence of two main sources of surface water: the Tigris River, Al-Kassar in the province of Maysan (Al-Azir District) and Al-Svayb in the province of Basra (Al-Qurna District), which creates a continuous hydraulic cycle, which is an important environmental factor of diversity and biodiversity in the region (Fig. 2).
Figure 1. Distribution of water bodies and alluvial marches in Iraq [1]: 1 are rivers, 2 are lakes, 3 are impounded bodies, 4 are alluvial marches, 5 is territorial border.

Figure 2. Main sources of surface water from the Iraqi and Iranian sides to alluvial marches Al-Khaweze (A, B, C are sampling points) [6]
2. Materials and research methods
This study is devoted to the spatiotemporal dynamics of the hydrochemical state of the Mesopotamian alluvial marches of Iraq. It covers various geoecological indicators which determine its hydrological and hydrochemical state (turbidity, hydrogen index, dissolved oxygen, total amount of dissolved solids in water (2018–2019), the water level for the period 2010–2019 and 2018–2019) [6].

3. Water quality in the alluvial marches of Al-Khaweze
To characterize the water quality of alluvial marches Al-Khaweze, a study was carried out on the following representative hydrochemical indicators: water turbidity, water hydrogen indicator, dissolved oxygen, total amount of dissolved solids.

Water turbidity is an indicator characterizing a decrease in water transparency due to the presence of inorganic and organic finely dispersed suspensions as well as the development of planktonic organisms. [5] Water turbidity in rivers and coastal areas of water bodies increases with rain, floods, and melting glaciers. Typically, in winter, the turbidity level in water bodies is the lowest, in spring and during summer rains it is the highest. The turbidity of drinking water is normalized mainly due to the fact that turbid water protects microorganisms from ultraviolet disinfection and facilitates the growth of bacteria as well as aesthetic reasons. For example, according to WHO, turbidity is not standardized from the point of view of health effects, however from the point of view of appearance the recommended turbidity is not higher than 5 FTU, and from the point of view of disinfection it should be not higher than 1 FTU. However, the turbidity value of alluvial marches AL-Khaweze (A: Lake Um Al Nua'ach, B: Um Al Toos, C: Al Kassara) is more than 30 FTU, and in 2018 the turbidity value at all points was higher than in 2019, the reason for this is that the waters of the Al-Svayb and Al-Kassar carry out the weighed particles with greater intensity (Fig. 3).

![Figure 3. Water turbidity at sampling points (A, B, C are sampling points, Fig. 2), standard (5 FTU)](image)

The pH of water from surface sources is usually from 6.5 to 8.5, while the groundwater pH is from 6 to 8.5 (Fig. 4).

![Figure 4. PH at the sampling points (A, B, C are sampling points, Fig. 2)](image)

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1Formazine Turbidity Unit (EMF) or FTU (Formazine Turbidity Unit) in Western terminology. 1FTU = 1EMP = 1EM / dm³. The relationship between the basic units of turbidity is as follows: 1 FTU (EMF) = 1 FNU = 1 NTU.
An appropriate amount of dissolved oxygen (DO, ppm) is necessary for good water quality. Oxygen is an essential element for all life forms. When the proportion of dissolved oxygen in the water volume is below 5.0 mg/L, the life of the organisms living in the water is placed under a threat. An oxygen level not exceeding the value of 1–2 mg/l can lead to the death of large fish within a few hours [3].

Figure 5 shows that the dissolved oxygen content exceeds acceptable limits and reaches more than 10 ppm in all studied areas (A, B, C) shown in Figure 2, which are the inputs and outputs of alluvial marches Al-Khaweze. Location Um Al-Tus (B) is considered a branch of the Al-Kalah River and extends to alluvial marches Al-Khaweze, location (C) is within the exit of Al-Kassar as well as location (A) being Lake Um Al Nua'ach located north of alluvial marches Al-Khaweze. Running water in rivers, waterways, and swamps has a higher percentage of oxygen than stagnant water, in which oxygen is consumed by aquatic biota. In addition, an abundance of aquatic plants and living algae as well as exchange with the atmosphere increase the amount of oxygen dissolved in water and directly affects the increase in the DO fraction; therefore, despite the high temperatures that lead to a decrease in solubility, the oxygen content in water remains high.

The natural environment, flow morphology and its regime also play a large role in the reaeration and oxygen capacity of the flow. For example, a stream moving directly down from a wetland may reflect the naturally low concentrations of DO found in wetlands. A shallow turbulent flow with a high gradient has better reaeration potential than a slow deep flow with a low gradient. Under conditions of a weak flow, aeration and the content of dissolved oxygen gradually decrease reaching the level of stagnant water. Therefore, any analysis of DO deterioration should also take into account these indicators (river flow rate, water level, channel width). The oxygen content in 2019 increased at points B and C since there is a strong flow of water and at point A, which is located above lake Um Al Nua'ach, the water flow slowed down and the oxygen content decreased in 2019 due to the great depth. (fig. 5).

![Figure 5](image-url)

**Figure 5.** Dissolved oxygen at the sampling points (A, B, Care sampling points, Fig. 2), standard (5-8 ppm)

The threshold for acceptable aesthetic criteria for total dissolved solids (TDS) for human drinking water is 500 mg/L. Most aquatic ecosystems including mixed ichthyofauna can tolerate TDS levels of 1000 mg/L. Water can be classified by TDS as follows: fresh is 500 ppm; saltish is 500–30,000 ppm; salted is 30,000–40,000 ppm; mineralized is more than 40,000 ppm [4]:

The total amount of dissolved solids in the studied alluvial marches sections exceeds 1000 ppm, which is explained by an increase in the amount of precipitation and, accordingly, an increase in the level and an increase in flow of the rivers feeding Al-Khaweze in 2018 and 2019 (Fig. 6). On the territory of southeastern Iraq, the prevailing soils are divided into two types according to their physicochemical composition: Shoura characterized by sodium chloride, sodium sulfate and potassium being the most soluble salts in these soils and a white layer of bark on the surface, and...
Sabcha rich in chlorides and nitrates of calcium and magnesium. These salts, as a rule, absorb moisture from the air, so the soil seems moist [7, 8].

The orography of southeastern Iraq has a flat surface with a gentle slope to the south, about 9 m above the sea level. Its most distinguishing features are the low level of groundwater, the absence of natural and artificial drainage as well as the high total evaporation leading to the accumulation of surface salts.

The level of mineralization of the Tigris River water and its tributary, namely the Al-Kahla River, which flows into the alluvial marches Al-Khaweze in the Maysan province, ranges from 0.750 to 4 ds.m\(^{-1}\) (750 to 4000 ppm) [9]. This value is considered medium and high in accordance with the classification of water quality for irrigation of agricultural land (US Salinity laboratory staff, 1954) (table 1). Due to the flow of these Al-Khaweze rivers, mineralization in 2019 was increased compared to 2018 [6].

![Figure 6. Total amount of dissolved solids in alluvial marches Al-Khaweze (A, B, C are sampling points, Fig. 2), standard (1000 ppm)](image)

| Electrical conductivity EC (ds.m\(^{-1}\)) | Water types |
|-----------------------------------------|-------------|
| Less than 0.250                         | low salt solution |
| 0.250–0.750                             | moderate     |
| 0.750–2.250                             | average      |
| 2.250–4                                | high         |
| 4–6                                     | very high    |

4. Conclusion

It has been shown that the turbidity in Al-Khaweze is more than 30 FTU. The pH of water from surface sources is usually from 6.5 to 8.5 while the pH of groundwater is in the range from 6 to 8.5. The dissolved oxygen content exceeds acceptable limits and reaches more than 10 ppm in all studied areas. The total amount of dissolved solids in the studied alluvial marches areas exceeded 1000 ppm in 2018 and 2019, which can be explained by the increase in water level as a result of increased runoff of rivers feeding alluvial marches Al-Khaweze and an increase in rainfall.

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