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Assessment of nutrient content of raw water close to water treatment plants located in Baghdad City

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ABSTRACT

Significant variations in the nutrient contents and other physical and chemical factors were noted at several stations at various times. The pH values varied from 7.73 to 8.11 indicating that water samples were almost neutral to sub-alkaline in nature. Nitrite values at Al-Rashid and Al-Wahda WTPs were found to be higher than those recorded in other WTPs; while nitrate values at Wathba, Al-Rashid, and Al-Wahda WTPs were found to be higher than those recorded at other stations. Ammonia contents showed higher rates at Al-Dawrah, Al-Rashid, and Al-Wahda WTPs. Phosphate proportions were found to be higher at Al-Dawrah WTP during 2010, 2011, and 2012; while the highest value of silicate (6.06 mg/L) was recorded at the East Tigris WTP during 2010. The paper established a relationship between diverse industrial wastes discharged in the Tigris River and the amount of nutrient in its waters.

Keywords: Nutrient; Phosphate; Silicate; Tigris River; WTPs

1. Introduction

In Iraq, water availability shows a great deal with spatial and temporal variability. Population increment and economic activities' expansions, undoubtedly lead to the increase in water demands used for human and industrial purposes [1].

Pollution occurs when a product added to our natural environment adversely affects nature's ability to dispose it off. Generally, most pollutants are introduced in the environment as sewage, waste, accidental discharge, and as compounds used to protect plants and animals [2]. However, in urban areas, the rivers play a major role in carrying municipal and industrial wastewater, manure discharges, and surplus from agricultural fields and streets, all participate into river pollution [3–5].

The Tigris River receives a lot of pollutants when it passes through Baghdad City, due to high municipal activities and factories discharging wastewater into the river without any real treatments. Therefore, the Tigris River had been used as a sink for wastes from industry, agriculturally added to human activities, due to its flow and ecological nature [6].

Nutrient such as nitrogen and phosphorus can degrade water resources and produce risks of health and environment raising nationwide and of regional concerns. Problems of nutrient arise not only from wastewater, stormwater, and agricultural discharges, but also from naturally occurring sources as well. They affect our rivers, lakes, groundwater, and eventually our drinking water [7]. Therefore, the objective of this research was to assess the nutrient content

of raw water of the Tigris River close to water treatment plants in Baghdad city.

2. Material and methods

2.1. Study area

The study area (Tigris River) is one of the largest rivers of the Middle East stretching for over 1,900 km, of which 1,415 km are within Iraq, with a catchment area of 235,000 km^2, sharing with the Euphrates River as the main sources for human use, especially for drinking water since they pass through the major cities in Iraq [8].

The Tigris River is the main source of drinking water for Baghdad, the capital of Iraq. The river extends from Al-Fahama in the north to Al-Zafaraniyah in the south before it confluences with the Diyala River. It divides the city into west (Karkh) and east (Risafa) districts with a flow direction from north to south. The area is characterized by arid to semi-arid climate with dry hot summers and cold winters; the mean annual rainfall is about 151.8 mm [9].

2.2. Sampling and analysis

The data used in this paper were provided by the Baghdad Mayoralty (Amanat Baghdad) covering the period from January 2010 to December 2013. Raw water samples were collected using clean polyethylene containers from sites in the river just close to the WTPs that represent the stations of this study. Samples were analyzed for chemical and physical properties immediately after collection. The data were merged (monthly average values for each parameter) to obtain a data set covering three years of data for nine raw water samples (Tigris river before treatment), Fig. 1. In this study, the assessments of nutrient content (nitrate, nitrite, ammonia, silicate, and phosphate) were applied on raw water of the Tigris River.

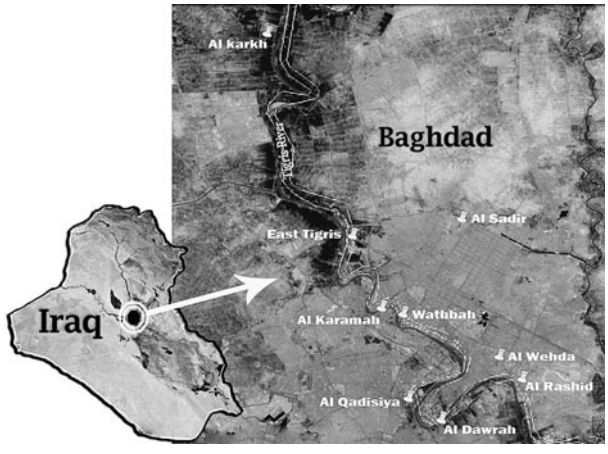

Fig. 1. Map of the Tigris River illustrating the study sites. Source: Google Earth@2009, version 5.0.11337.1968 (beta).

3. Results and discussion

3.1. Physical water analysis

Data on the physical water analysis of the Tigris River during three years are shown in Fig. 2.

(1) Water temperature: maximum water temperature (24.42˚C) was recorded in 2010 close to Al-Karkh WTP and minimum (20.75˚C) in 2011 close to Al-Sadir WTP. They were, thus, subjected to seasonal change of 3.67˚C. Slight differences were noticed among the different sites.
(2) Hydrogen ion concentration pH: The result of pH varied from 7.73 to 8.11 indicating that the water samples are almost neutral to sub-alkaline in nature. The higher values had been recorded close to Wathba and Al-Karama WTPs. pH is an important factor that determines the suitability of water for various purposes [10]. The recorded range of pH values in this study were general in accordance with the pH values of fresh waters [11,12] and were in permissible levels (6.5–8.5) recommended by Iraq and WHO for drinking water [13,14].
(3) Electrical conductivity (EC): the importance of (EC) as a mean to measure salinity which greatly affects the taste and thus has a significant impact on the user acceptance of the water as potable [15,16]. EC is about the conducting capacity of water which was determined by the presence of dissolved ions and solids. Higher the ionizable solids, greater will be the EC [17]. Slight changes were seen in the values of all the stations, higher values had been recorded at 2013. The highest value of EC (932 μS/cm) was recorded close to Al-Dawrah WTP; this may be due to the effluent of Al-Dawrah Refinery with its contain of high dissolved solids.

3.2. Chemical water analysis

Data on the chemical water analysis of the Tigris River during three years are shown in Fig. 3.

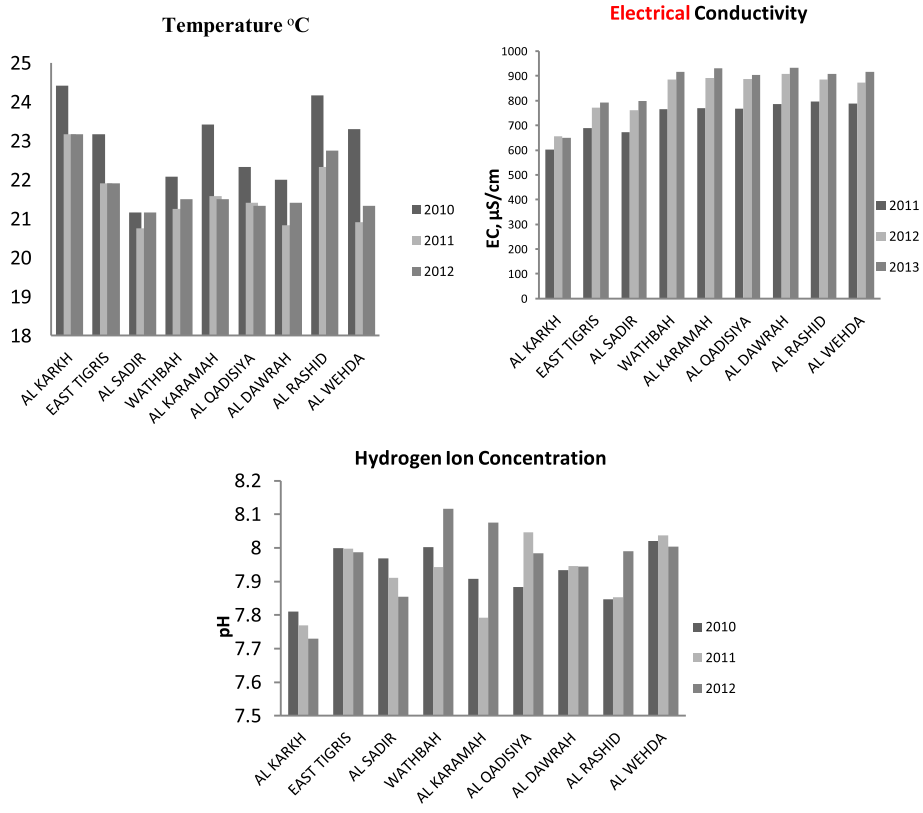

Fig. 2. Physical water analysis at different stations of the Tigris River.

3.2.1. Nitrite (NO_2)

It has been observed that the nitrite values are increasing from the first station to the last one with few exceptions. This was accompanied by an increase in the amount of ammonia in these stations. The ascending trend in nitrite values can be attributed to the nitrification process of ammonia by the nitrifying bacteria. Nitrite values at Al-Rashid and Al-Wahda WTPs were found to be greater than those recorded in other WTPs. This may be due to the sewage discharges, agriculture surplus, or infiltration of pollutants from various sources like the effluents of State Company for Vegetable Oils Industry and Baghdad South Gas Power Plant-2.

3.2.2. Nitrate (NO_3)

The high nitrogen content is an indicator of organic pollution. It results from the added nitrogenous fertilizers, decay of dead plants and animals, animal urines, feces, etc. They are all oxidized to nitrate by natural process, and hence, nitrogen is present in the form of nitrate. The increase in one or all the above factors is responsible for the increase in nitrate content [18]. Nitrate values at Wathba, Al-Rashid, and Al-Wahda WTPs were found to be higher than those recorded in other WTPs. Higher values were recorded for 2011 and 2012 (0.936 mg/L and 0.905 mg/L, respectively) at Al-Wahda WTP; while for 2013 (1.065 mg/L) at Al-Rashid WTP. This may be due to the infiltration of pollutants from various sources like the effluent of the State Company for Vegetable Oils Industry. Also, high nitrate content is observed at Wathba WTP (1.05 mg/L) for 2013, which attributed to the amount of organic wastes from the effluent of the medical city which on decomposition by micro-organism results in the production of nitrates.

3.2.3. Inorganic nitrogen

The ammonia contents of the Tigris River showed a wide variation (Fig. 3). They varied from 0.0125 mg/L in 2012 at Al-Karkh WTP to 0.38 mg/L in 2011 at Al-Rashid WTP. Values recorded at Al-Dawrah, Al-Rashid, and Al-Wahda WTPs were found to be higher than those recorded in other WTPs, which are attributed mainly to the introduction of sewage and

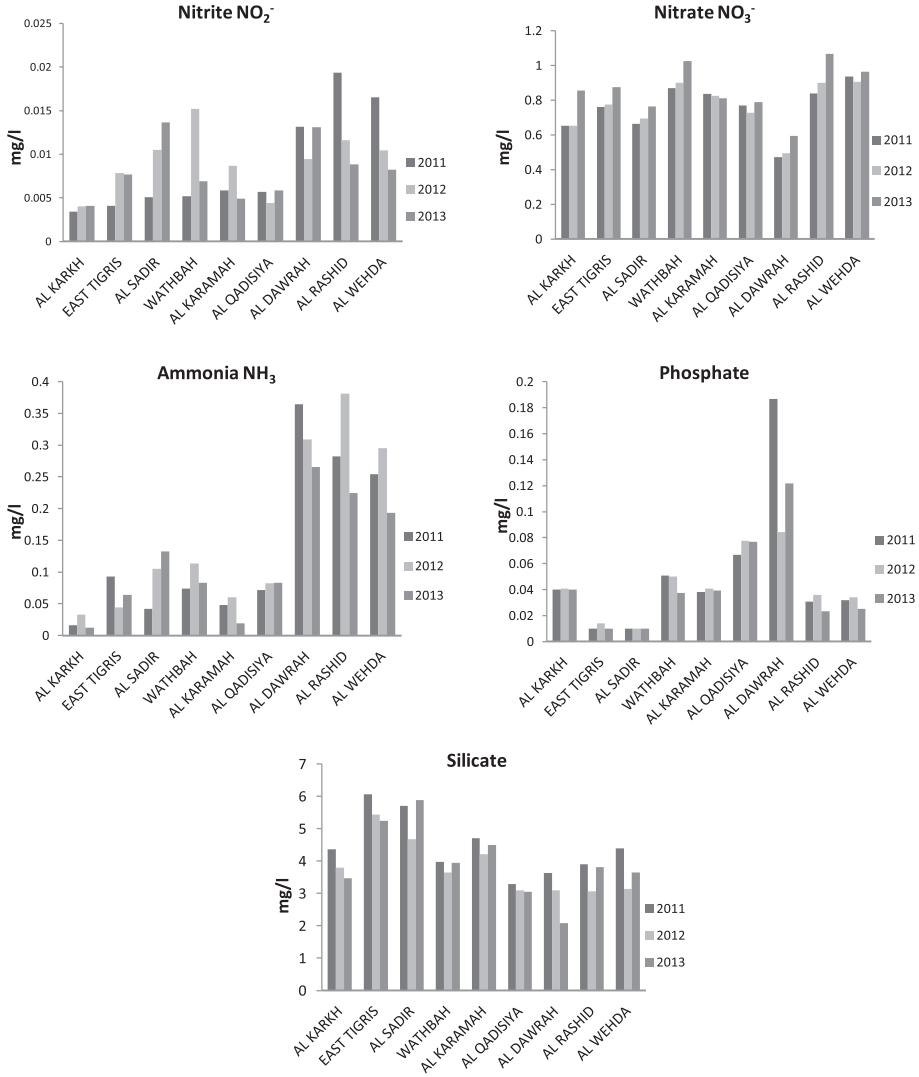

Fig. 3. Chemical water analysis at different stations of the Tigris River.

the decomposition of organic nitrogen to ammonia which diffused in the overlying water as well as the absorption of ammonia on clay and sediments [19].

3.2.4. Phosphate (PO_4)

The major cause for phosphate concentration may be the agricultural runoff from the irrigated lands containing phosphate fertilizers. Values varied from 0.01 mg /L at Al-Sadir WTP to 0.187 mg/L in 2011 at Al-Dawrah WTP. Values recorded at Al-Dawrah WTP during 2010, 2011, and 2012 were found to be higher than those recorded in other WTPs; this may be due to the effluent of Al Dawrah Refinery and agricultural overflow.

3.2.5. Silicate

The silicate values in the Tigris River showed a slight variation (Fig. 3). Higher values were recorded at East Tigris WTP (6.06 mg/L) and (5.44 mg/L), in 2010 and 2011, respectively. In 2012, it was recorded at Al-Sadir WTP (5.89 mg/L). The highest value of silicate (6.06 mg/L) was recorded at East Tigris WTP during 2010; this may be due to the waste of Neuroscience Hospital.

4. Conclusion

Water temperature showed a seasonal change of 3.67˚C ranging. A peak record of EC was recorded close to Al-Dawrah WTP. The values of nitrite, nitrate,

and ammonia were found to be higher close to Al-Rashid and Al-Wahda WTPs than those recorded in other WTPs; while the highest values of phosphate and silicate were found close to Al-Dawrah and East Tigris WTPs, respectively. These noticeable values were more likely to be due to the industrial wastes which discharged by the factories, for instance, the State Company for Vegetable Oils Industry, Baghdad South Gas Power Plant-2, Al-Dawrah Refinery, and Neuroscience Hospital near the water treatment plants.

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