# Effect of Urban Sewage Water on Pollution of the Euphrates River, Iraq

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# Effect of Urban Sewage Water on Pollution of the Euphrates River, Iraq

**Mohamed M. Sharqi, Omar M. Hasan[1] and Thaer A. Salih[2]**

*College of Women Education, University of Anbar, Iraq*
*[1] College of Sciences, University of Anbar, Iraq*
*[2] College of Education for Pure Sciences, University of Anbar, Iraq*
*E-mail: sc.omerhasan@uoanbar.edu.iq*

***Abstract:*** Discharge of wastewater in aquatic ecosystems such as rivers may cause changes in water quality of these water bodies, which adversely affect human health. This study aimed to assess the effect of urban wastewater on the water quality of the Euphrates River in Iraq. The identified sites were: the discharge point, the meeting point of effluent with the river, 100 m from the meeting point and control. The significant decrease in the pH and $DO_2$ values of the river water was recorded at the meeting point compared to the control. The significant increase was observed in EC, $CO_2$, $BOD_5$, and the viable count of bacteria in effluent and river water at the meeting point compared to the control values. The study shows that the river has the ability to restore the balance of pH, EC, $DO_2$ and $CO_2$ after 100 m from the meeting point. Nevertheless, the adverse effect of microbial pollution and increased $BOD_5$ was persistent.

***Keywords*:** Wastewater, Euphrates, Pollution

The study of the aquatic environment and its protection from the pollution risks are of practical importance in human life, especially in recent times (Haseena et al 2017). Environmental pollution has become one of serious issue across different part of world and water pollution is part of this problem, which results from contamination of water with various wastes leading to the change of the water's physical, chemical and biological properties to become unsuitable for human use (Inyinbor et al 2018). Pollution from point sources such as sewage treatment plants (STP) has a common impact on river ecosystems especially in conurbations. As STPs do not remove all contaminants from sewage waters (Aristi et al 2015), their effluents include a complex mixture of nutrients and pollutants. Nutrients can support autotrophic and heterotrophic organisms, while toxic pollutants can act as stress factors, depending on their concentration and interactions with the environment. Hence, it is difficult to predict the overall effect of STP effluents on river ecosystem functioning (Zhenhua *et al* 2019). When more assimilable substances enter freshwaters via STP effluent can decrease water quality, alter the structure of biological communities, cause harmful algal blooms and affect ecosystem functioning (Jin et al 2017). These substances enhance the biomass and activity of both primary producers and microbial communities, capable of utilizing dissolved nutrients and organic matter (Fox et al 2017). Moreover, their impacts can transmit upwards to other trophic levels and thus affect the entire ecosystem (Ali et al 2017). The toxic pollutants entering freshwaters via STP effluents can have direct harmful effects on aquatic life. Toxic pollutants reduce the abundance and affect the ecosystem processes rates (Divahar et al 2019).

Iraq is characterized by the abundance of fresh surface water resources represented by the Tigris and Euphrates rivers and their tributaries. Water is an important natural resource, and this importance increases in countries with desert climates and semi-desert like Iraq because it controls the distribution of the population and their economic activities (Ali et al 2017). Iraqi waters, in general, is hard water tends to be light alkaline, its pH ranges (6.5-8), dissolved oxygen (4-6 mg/l), electrical conductivity (3-5 mS/cm) and BOD about 1-3 mg/l (Hassan et al 2018). The industrial and wastewater discharged into the river always leads to a significant increase in most of the environmental risk factors such as phosphates and nitrates, with a decrease in some of them such as dissolved oxygen is mainly due to the low water level in Iraqi rivers, which leads to an increase in the concentration of environmental determinants (Salih and Hassan 2020). The present study was conducted to observe the effect of urban sewage water on pollution of the Euphrates river.

## MATERIAL AND METHODS

**Study area:** The study was conducted on the Euphrates river in Ramadi city - Iraq at the point of discharge of the sewage treatment plant. Four sites were selected for water samples, including P1- the discharge point of wastewater, P2- the meeting point for sewage and river water, P3-100 m after the meeting point, and P4-100 m before the meeting point (as a control). Water samples were collected from the study sites twice a day at 8 am and 2 pm, with 5 replications for each sample. Sample collection continued for a month.

Measurements: Water temperature, pH, electrical conductivity, and dissolved oxygen were measured in situ using portable digital meters equipped by Hanna Instruments - Italy. The concentration of dissolved $CO_2$, $BOD_5$, and the Viable count of bacteria were measured according to the standard methods (APHA 2017). Statistical analysis of the data was conducted using software Genstat v12. The mean and standard deviation was assumed and all data was subjected to analysis of variance (ANOVA). All differences between the means were compared using LSD multiple range test after a significant F-test at $p \leq 0.05$.

## RESULTS AND DISCUSSION

The values of the physical and chemical water quality parameters of the Euphrates River are shown in Table 1. The climate of Iraq is subtropical continental and the northwest winds prevail during the seasons. The average air temperature was 15°C with a range from 12.2°C to 17.8°C during the monitoring period, consistent with local climate characteristics. When the STP effluent was pumped into P1, the water temperature at P1 was higher than at other sites. These differences may be related to the high microbial activities and the type of treatment in STP (Cerqueira et al 2019). The pH values of the study sites were variable, the pH was alkaline (pH = 8.02) at P4 site and it corresponds to the nature of the Iraqi freshwater, while the pH was acidic in the wastewater sample (pH = 5.99) and slightly acidic at the meeting point site (pH = 6.86). The pH of the Euphrates water is influenced by the wastewater which loaded with acids, organic matter and products of microbial activity. It is also observed that the river rebalanced the pH at site P3 as a result of the dilution effect of the river.

A significantly higher EC value (3.3 $mS.cm^{-1}$) was at the P1 site, compared to lower EC values at the P2, P3, and P4 sites (2.1, 1.36, and 1.32 $mS.cm^{-1}$ sequentially) with no statistically significant differences among them. The high EC value at P1 is due to the presence of high concentrations of dissolved substances, especially phosphate, nitrate and chloride salts (Rodríguez-Rodríguez et al 2018) and suggest that the polluted water at P1 may be purified by self-purification of the river, and thus, its values decreased in the other sites. The concentrations of $DO_2$ varied considerably, ranging from 1.4 to 9.6 mg/l. The concentration of $DO_2$ at P3 and P4 was relatively high throughout the entire monitoring process (9.3 and 9.6 sequentially), while the minimum of $DO_2$ concentration was only 1.4 mg/l at P1. The presence of microorganisms and algae, in addition to the high proportion of the organic matter and dissolved chemicals in wastewater, results in the consumption of dissolved oxygen (Kate et al 2018).

Carbon dioxide concentrations varied significantly. The highest average was at P1 (7.8 mg/l) and the lowest concentration was at P4, reaching 0.8 mg/l. The solubility of carbon dioxide in water is good compared to a gas such as oxygen or nitrogen. Carbon dioxide interacts with water slightly (only about 0.2%, depending on the temperature) and is in chemical equilibrium with it, according to the equation: $CO_2 + H_2O\ H_2CO_3$. (Kolev 2011). The increase in carbon dioxide at P1 may be due to the high respiratory activities of the organisms.

$BOD_5$ parameter was measured as indicators of organic pollution. The spatial changes in the concentrations of $BOD_5$ after the influx of STP effluent were severe (Table 2). The concentration of $BOD_5$ was high at P1, the mean 28 mg/l, and more than all other sampling points. The average of $BOD_5$ value for the P2, P3 and P4 were 16, 2.3 and 0.6 mg/l, respectively. This difference in $BOD_5$ could be explained by variation in the amount of organic matters in the study sites (Muller et al 2014). The significant variation in the $BOD_5$ between the sites P3 and P4 shows the severity of the

**Table 2.** Some biochemical and biological parameters of Euphrates

| Sites | $BOD_5$ (mg/l) | Viable count of bacteria (CFU/ml) |
|---|---|---|
| P1 | 28.0±3.18 | $1.26*10^8$±$5.7*10^4$ |
| P2 | 16.0±2.74 | $7.7*10^6$±4286 |
| P3 | 2.3±1.66 | $8*10^3$±723 |
| P4 | 0.6±0.22 | $6*10^2$±46.6 |
| L.S.D. (P≤0.05) | 28.0 | $5.24*10^3$ |

**Table 1.** Physical and chemical water quality parameters of Euphrates

| Sites | Temperature* (°C) | pH | EC (mS/cm) | $DO_2$ (mg/l) | $CO_2$ (mg/l) |
|---|---|---|---|---|---|
| P1 | 18.1±1.24 | 5.99±0.80 | 3.30±0.55 | 1.4±0.53 | 7.8±1.42 |
| P2 | 14.3±1.05 | 6.86±0.64 | 2.1±0.42 | 3.2±0.47 | 4.1±1.29 |
| P3 | 13.5±0.88 | 7.94±0.56 | 1.36±0.20 | 9.3±0.31 | 1.2±0.55 |
| P4 | 13.4±0.76 | 8.02±0.28 | 1.32±0.15 | 9.6±0.26 | 0.8±0.49 |
| L.S.D. P≤0.05 | 1.96 | 0.89 | 1.14 | 4.52 | 2.63 |

* Air temperature is 15°C

organic pollution, which somewhat resisted the self-purification factor of the river, which confirms the risk of pollution with wastewater. Mean total bacteria viable counts (CFU/ml) was detected in water samples collected from the 4 sites (Table 2). The microbial counts were high and varied with location. The values ranged from $6*10^2$ CFU/ml (P4), to $1.26*10^8$ CFU/ml (P1). Mean total bacteria counts for P1 were significantly ($p < 0.05$) higher than counts from the other sites. This was due to availability of organic matter and salts in wastewater, which is a nutrient necessary for the growth of colonial cells. The total bacteria counts' recorded from all sites exceeded the WHO standard of $1.0*10^2$ CFU/ml. The WHO standard is the standard acceptable limit of total bacterial counts for drinking water (Leong et al 2018).

## CONCLUSIONS

The presence of pollutants in urban sewage effluents can significantly destabilize aquatic ecosystems and significantly participate in the quantitative and qualitative degradation of water resources. However, there is a limited effect of urban sewage on the Euphrates water quality. The effect was more at the meeting site (sewage with Euphrates water) and with the spatial gradient, the negative impact of pollution with wastewater begins to diminish by the self-purification, especially for the physicochemical parameters. However, there is a potential biological risk, which caused by wastewater pollution that requires more attention.

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