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Surface water quality assessment of Wadi El Bey, Tunisia

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Abstract. In the present study, a surface water quality assessment of Wadi El Bey, located in the northeast of Tunisia and considered a highly polluted river, was performed to evaluate the water quality status and identify the hotspots requiring immediate intervention. A monitoring program using sampling series along Wadi El Bey was carried out during two years. The samples were analyzed in situ and at the laboratory using chromatographic analysis, multi-parameter sounds and high-resolution monitoring sensors (HRMS). The main focus was to monitor the polluted sources discharging to the Wadi.
Several physicochemical parameters were assessed in this study, including pH, electrical conductivity (EC), turbidity, salinity, chemical oxygen demand (COD), biochemical oxygen demand (BOD), dry residue, suspended solids, dissolved oxygen (DO), chloride, nitrite, nitrate, phosphate, sulfate, calcium, magnesium, potassium and sodium. The obtained results confirmed the alarming water quality deterioration status at the different hotspots, characterized mainly by high concentrations of nitrates and COD. This pollution is due to the discharge of untreated and insufficient treated municipal and industrial wastewaters directly in the Wadi, increasing anthropogenic. The study reveal a significant pollution degree and water quality degradation, affecting the ecosystem integrity.

Keywords: Discharging, Quality, Pollution, Surface water, Wastewaters, Wadi.

1 Introduction

Urban, industrial, and agricultural activities are considered the leading causes of surface water contamination and groundwater deterioration (McIntosh et Pontius, 2017; Singh et al., 2004; Wang et al., 2013).
Wadi El Bey watershed is declared one of the most polluted areas of the Cap Bon peninsula, influenced by the increasing anthropogenic pressures such as industrial discharge in the aquatic ecosystem, agricultural activities and urban wastewater release.

At the national level, surface water quantity and groundwater level are relatively well assessed. However, the monitoring of water quality is poorly carried out in terms of its spatial distribution, the number of assessed parameters and sampling frequency. This study proposes a water quality assessment of Wadi El Bey in Tunisia, combining conventional sampling methods with high-frequency sampling techniques. To this end, high-resolution monitoring sensors (HRMS) will be introduced as an innovative monitoring technique to measure nitrate concentration in the Wadi El Bey and its main tributaries.

2 Materials and Methods

Case study

This study was conducted in the Wadi El Bey watershed, located in the northeast of Tunisia. Series of surface water sampling campaigns along the wadi were carried out for the period November 2019 to March 2021. Obtained results were compared to different previous monitoring studies of the wadi such as Attya et Jomaa, 2013, Ben Salem et al., 2019; Gasmi et al., 2017; Khadhar et al., 2013. Nine sampling points were selected (from S1 to S9), covering the whole river stream from upstream to downstream

The location choice of these points was made based on previous studies and area prospecting while considering hotspots sites, subject of a suspected high degree of pollution related to several polluting activities

Parameters analyses

Concerning lab measurements, all samples were placed in autoclavable glass bottles and transferred to the laboratory to undergo various qualitative analyses of chemical parameters such as chemical oxygen demand (COD) using dichromate titrimetric method (Rodier et al., 2009) and Cl^-, NO_2^-, NO_3^-, PO_4^{3-}, SO_4^{2-}, Ca^{2+}, Mg^{2+}, K^+, Na^+ concentrations using an ion chromatography IC Metrohm 761. Temperature, pH, electrical conductivity (EC), salinity, turbidity and total dissolved solids (TDS) were measured in-situ using a multi-parameter type Hanna HI9829. All values are undertaken twice or triplicate to ensure reproducibility.

The high-resolution monitoring sensor (HRMS), type AquaTroll 600, provided by In-situ company, is used to measure and monitor nitrate concentration at real time in the wadi as perspective.

3 Results

Results showed that pH values of water samples range from 7.33 to 8.95 (Fig. 1,2), which means that the water is slightly alkaline.

Concerning EC, a significant spatial variation was noted, especially at the point of wine industry discharge (S3) (Fig.3), tannery discharge (S5) and wadi Ellouza (S7), which is located near an agricultural drainage system.

The COD of all water samples of Wadi El Bey are within the range of 56 and 2200 mg O_2/L in the first sampling campaign (Fig. 1,2). The values decreased at almost all sampling points in 2021. The lowest COD of about 56 mg/L and 84 mg/L were found in

the stream water of Wadi El Malah (S8) and Wadi Ellouza (S7), respectively. However, the COD value increased significantly at the industrial discharge of the wine industry (S3).

For nitrate, the analyses were carried out on the samples in the first sampling campaign showed high concentrations, which exceed the tolerance threshold (50 mg/L) prescribed by Tunisian standards (NT 106.02), especially at point S3 related to Wine industry discharge location with a value of 129 mg/L and at S9 (Wadi El Bey), reaching 103 mg/L. These values keep increasing, and high values have been recorded in 2021, reaching 159 mg/L, 98 mg/L and 79,9 mg/L in S9, S7 and S1, respectively (Fig. 4).

A high-resolution monitoring sensor was used at some sampling points, the obtained results were compared with those performed with IC. In point S1 (Discharge of industrial zone), the value given by HRMS is almost five times higher than the value given by the ion chromatography method reaching 416 mg/L, which considerably exceeds the Tunisian standards (NT 106.02)

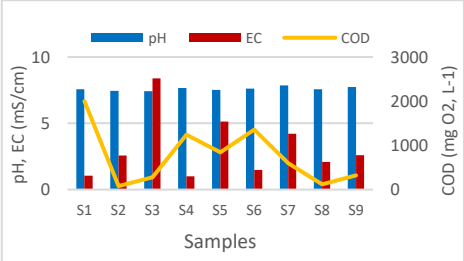

Fig. 1. pH, EC and COD variation (Samling campaign 1)

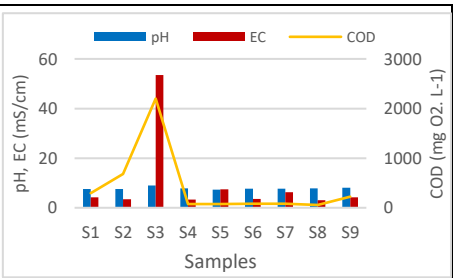

Fig. 2. pH, EC and COD variation (Samling campaign 2)

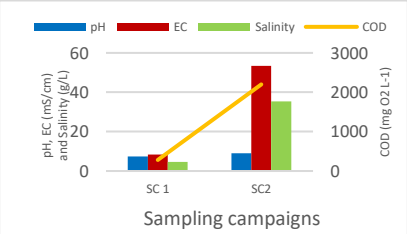

Fig. 3. pH, EC, salinity and COD variation of S3

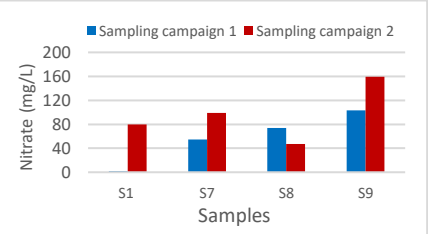

Fig. 4. Nitrate concentration in some samples points

4 Discussion

pH values which indicate that the wadi water is slightly alkaline, may be due to the relatively higher concentration of bicarbonate ions in the wastewater effluents and tributaries of Wadi El Bey (Gasmi et al., 2017).

Concerning the EC results, the behaviour confirmed those found by previous studies (Attya et Jomaa, 2013; Ben-Salem et al., 2019; Gasmi et al, 2017; Khadhar et al., 2013), which refer to a high salinity due to industrial discharges and especially the wastewater release of the leather washing waste of the tannery (Attya et Jomaa, 2013) from one side and excessive use of agricultural fertilizer causing an increase of concentration.
High COD is a result of organic pollution caused by discharges of untreated wastewater from treatment plants and industrial effluents, while the lowest COD value may be due to the assimilative phenomenon in the downstream area of the Wadi.
The presence of high nitrate concentration in the wadi is suspected to be the result of the cumulation from industrial discharges, wastewater from sewage treatment plants and runoff from agricultural land cultivated with organic and inorganic fertilizers. The previous studies of Attya et Jomaa (2013), Ben-Salem et al. (2019) and Gasmi et al. (2017) have indicated that nitrate concentrations do not exceed the tolerable threshold (50 mg/L). However, actually our results show a high nitrate concentration, especially at the exit of industrial and Wasterwater Treatment Plant, indicating the increasing deterioration in the quality of discharged wastewater.
The difference in the results of nitrate concentrations at the same point S1 between IC method and HRMS approach can be explained by the filtration and dilution effect, which precedes the IC analysis and which can increase the error. In comparison, the measurements taken by HRMS (Aquatroll 600) were performed in-situ by evaluating the raw water without filtration and with all its residues. This study is still ongoing to better understand the water quality states of the wadi and their controlling factors andlink the approach of the high-resolution optical nitrate sensor and the nature of the natural environment under study.

5 Conclusions

In this study, we made a diagnosis of the surface water quality of the Wadi EL Bey and its tributaries through the assessment of different physicochemical parameters. The results showed an extremely high degree of pollution, especially the nitrate concentration level. This pollution is mainly due to the release of untreated point sources in the study area, generated by increasing anthropogenic pressures such as urban, agricultural, or industrial activities.

6 References

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