Heavy metal contamination in surface water of Mohammedia wetland, Morocco

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Abstract. Assessing heavy metal concentrations in wetlands and identifying sources of metal contamination are critical steps in protecting wetlands. Using seven sampling stations, we evaluated the spatial variation of some heavy metal concentrations in surface waters of the Mohammedia wetland and a selected segment of the El Maleh wadi that feeds the wetland. Field observations made it possible to identify and map the pollution discharged into El Maleh wadi, carrying heavy metals into the wetland. The analyses showed that the concentrations of lead, manganese, and cadmium far exceed the thresholds relating to fish life in 100% of sampling stations. All the evidence points to heavy metals contamination of surface water in Mohammedia wetland, generated by industrial activities, wastewater discharges, and leachate from the old landfill located upstream.

1 Introduction

Water quality is a potential factor in supporting biodiversity [1]. Water quality degradation can seriously affect wetland ecological functions [2-4]. Heavy metals from anthropogenic sources are considered one of the most common types of pollutants [5]. Heavy metals are widely present in rivers and serve as important indicators of environmental water quality [6]. Riverine input and runoff from land carry pollutants into estuaries, thus impacting biotic communities and sensitive habitat areas [7].

Mohammedia wetland, located in the eponymous city in the west of Morocco, is a Ramsar site corresponding to El Maleh Wadi’s estuary and its flood plain [8]. The wetland mainly consists of some marshes fed by rainfall and El Maleh Wadi floods, a permanent water body supplied by seawater during high tide, and another permanent body of water fed by groundwater [9]. In the latest decades, the urban development of Mohammedia city has led to the release of wastewater into El Maleh Wadi. Several industries (mainly an oil refinery and coal-fired power plant) surrounding the wetland also pose a severe threat. Some studies are available on the surface water quality of Mohammedia wetland [10-11] but have not assessed heavy metals in surface water.

In this paper, we highlight the spatial variation of some heavy metals in Mohammedia wetland surface water. The goal is to investigate heavy metal concentrations in different areas and identify heavy metals contamination sources of Mohammedia wetland as the first step for its protection and Restauration. Physico-chemical analyses were carried out on five heavy metals. The concentrations obtained for each parameter are compared to the thresholds tolerable for fish life [12]. The objective is to verify the ability of Mohammedia wetland to offer natural conditions for biodiversity.

2 Materials and Methods

The sampling network was designed to cover sites that reasonably represented El Maleh Wadi’s water quality, taking into account discharges identified during the field observations and impacting Mohammedia wetland water quality. Sampling station 11 is chosen as the reference station given its location far from anthropogenic disturbances. The surface water samples were made in June 2019. All samples were collected in double, in new polypropylene bottles rinsed with deionized water, then stored at 4°C in the dark and transported on the same day to the laboratory. The analyses were performed according to Rodier [13] in the Laboratory “Geosciences Applied to the Engineering of the Development” (GAIA) in Hassan II University of Casablanca – Ain Chock Faculty of Sciences. Lead (Pb), Manganese (Mn), cadmium (Cd), Chromium (Cr), Zinc (Zn), and copper (Cu) were measured at seven selected points (1-3, 5, 6, 9-11) (Fig. 1).
3 Results and Discussion

The mean concentrations of heavy metals are summarized in table 1. The analyses carried out show that, apart from Zn, all other heavy metals were detected in levels exceeding maximum values tolerable for fish life. The concentrations of lead in the study area are significant. Due to urban processes, Pb and other metals are regularly discharged into fields, water, and soils through sewage sludge, urban runoff, automobile exhaust, and gasoline containing Pb [14-15].

The highest concentration of lead recorded in the sampling station (S10) (Fig. 2a) may originate from the old landfill of Mohammedia city. During the field observations, we noted in this area leachate seepage into El Maleh wadi. Analyses carried out on the leachate from Mohammedia landfill have shown lead concentrations up to 690 μg/L [16]. Sample station ten also shows the highest concentration of manganese (Fig. 2b). Wastewater and industrial pollution are also responsible for surface water contamination by manganese [17]. Indeed, S9, S5, located near wastewater discharges in El Maleh wadi, show significant these parameters concentrations. Concerning cadmium, all levels detected far exceed the maximum allowable for fish life (Fig. 2c). Except in station 10, downstream concentrations are more important than those recorded upstream. Station S1, located in the estuary, shows the highest value (100.5 μg/L). The affinity of Cd can explain this with chlorine in a salty environment. This affinity results in the desorption of Cd from the particulates towards the dissolved phase [18-20]. The significant contamination of sites S1 and S3 by Cd could be related to phosphate fertilizers runoff [21] which could be used in the Mohammedia golf that covers 27 ha in this area. According to N’Gessman [21], some phosphate fertilizers have cadmium concentrations that can be about 300 times higher than the natural content of soils. Copper was detected in only three samples. The station (S10), located downstream from the landfill, records a value far exceeding the threshold of this parameter (Fig 2d), attesting to possible contamination of surface water by the leachate.
Table 1. Parameters measured in the study area during June 2019

| Sampling station | S1  | S3  | S5  | S6  | S9  | S10 | S11 | Thresholds Fish life [12] |
|------------------|-----|-----|-----|-----|-----|-----|-----|--------------------------|
| Pb μg/l          | 32.5| 161.5| 64.5| 0.1 | 64.5| 226 | 53.94| 20                       |
| Mn mg/l          | 0.89| 0.92| 1.02| 1.01| 0.96| 1.40| 0.10| 0.1                      |
| Cd μg/l          | 100.5| 78  | 60  | 48.5| 53  | 77.5| 47.5| 5                        |
| Zn mg/l          | 0.27| 0.23| 0.022| 0.07| 0.04| 0.32| 0.15| 1.3                      |
| Cu μg/l          | -   | 13.5| -   | -   | -   | 137 | 13  | 40                       |

4 Conclusion

In this study, industrial discharges, domestic sewage, and the old landfill of Mohammedia city were identified as potential pollution sources in the study area. Mn, Cd, and Pb are the major heavy metal contaminants in El Maleh Wadi and Mohammedia wetland surface water. The spatial variation of heavy metals concentrations shows that pollution discharged in El Maleh Wadi reaches Mohammedia wetland and may affect aquatic communities [22]. To prevent the ecosystem health risks, there is a critical need for implementing effective measures to reduce pollution in El Maleh Wadi, such as treatment of the old landfill leachate and treatment of domestic and industrial wastewater before discharging it into El Maleh wadi.

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