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# Olive mill wastewater causing pollution in the Oum Er Rbia River and potential environmental effects and impact on the Eurasian Otter

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## ABSTRACT

The Oued Oum Er Rbia (River) is one of the major rivers in Morocco. It represents a source of water used for human consumption, culture irrigation, industrial purposes and hydroelectric production in a large part of Morocco. In recent years, the number of incidents of pollution generated by the olive mill wastewater has increased in the Oued Oum Er Rbia. In this paper, we document the pollution of the Oued Oum Er Rbia by olive mill wastewater in November 2020, and we present the potential effects on environment and on the Eurasian otter population. Nine surveys were conducted in November-December 2020 in the Middle Oued Oum Er Rbia. Results of surveys showed that the Oued Oum Er Rbia River was polluted by olive mill wastewater. The disposal of olive mill wastewater into river caused coloration of water and odors. Observations showed that olive mill wastewater affect the wild fauna living in the river. The olive mill wastewater has high organic content and many complex organic materials and has negative environmental effects such as odors, discoloring of natural waters, toxicity, and threat to aquatic life. The pollution of the Oued Oum Er Rbia River by olive mill wastewater may have serious consequences on Lutra lutra and their survival. Several solutions and recommendations were proposed to sustainable management of olive mill wastewater and to conserve the Eurasian otter.

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## **1. Introduction:**

The Oued Oum Er Rbia (River) is one of the major rivers in Morocco and is 550 km long. It originates in the region of Khenifra (32°56'22"N 5°40'3"W), located in the Middle Atlas Mountains, and it flows into the Atlantic Ocean at Azemmour city (33°17'16"N 8°20'32"W). The most important tributaries of the Oued Oum Er Rbia River are Oued El Abid, Oued Derna, Oued Tessaoute, Oued Lakhdar, Assif Melloul and Oued Ahansal Rivers. The basin of the Oum Er Rbia is the basin which concentrates the largest water demand of Morocco (4.25 billion cubic meters, or 35% of total water demand of Morocco) [1,2]. The Oum Er Rbia River and its tributaries have 15 Dams. The most important of which are Al Massira, Bin El Ouidane, Hassan 1er, Moulay Youssef and Ahmed El Hansali Dams. According to the Hydraulic Basin Agency of Oum Er Rbia, the total irrigated area by Oum Er Rbia River and its tributaries is approximately 323 000 hectares, and the hydropower production in the Hydraulic Basin of Oum Er Rbia is about 1 887 Million kilowatt hours per year which represents, 70% of hydropower production in Morocco. The Oued Oum Er Rbia aquatic and humid ecosystems have a rich and varied biological diversity. They contain a very large species of mammals, births, reptiles, amphibians, fish, and invertebrates [3,4].

The cultivation of olive trees and the consumption of olive oil are rapidly increasing in the region of Beni Mellal-

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Khenifra, due to its high dietetic and nutritional value. Consequently, there is an increasing of environmental problems related to wastes produced during olive oil production. Today, the management of olive mill waste is a priority for the regional authorities, especially the Hydraulic Basin Agency of Oum Er Rbia, and for the Government. The olive mill wastewater generated from olive oil extraction causes a major environmental issue when they are directly discharged into rivers [5]. Although the Moroccan Government has established a number of national plans in the management of olive mill wastes, the number of incidents of pollution generated by the olive mill wastewaters has increased in the Oued Oum Er Rbia River in recent years. In this paper, we document the pollution of the Oued Oum Er Rbia by olive mill wastewater in November-December 2020, and we present the potential effects on environment and on the Eurasian otter population.

## 2. Material and methods:

The study was conducted in the Middle Oued Oum Er Rbia, province of Fkih Ben Salah, especially between the village of Sidi Aissa Ben Ali in the east and the village of Masghouna in the west (Figure 1). This region belongs to the plain of Tadla which covers an area of approximately 3 600 km<sup>2</sup> and is crossed by the river of Oued Oum Er Rbia. The region of Sidi Aissa Ben Ali belongs to the zone of Beni Moussa which is located on the left of this river. Beni Moussa is a vast irrigated agricultural area covering an area of 96 500 ha. The study region is characterized by a very cold winter and a hot summer [6]. The main land uses are shifting agriculture and pastoralism. In the zone of Beni Moussa, the most cultivated tree is olive and the cultivation of olive trees plays an important socio-economic role.

Nine surveys were conducted in November 2020 in the study site (Figure 1). This site, called 'la chutte' is dangerous and there were many cases of attacks against visitors each year. For this reason, surveys were conducted with 1-2 local assistants. During the study period, we collected information about the pollution of the Oued Oum Er Rbia by olive mill wastewater. We made preliminary observations on water quality (color, odor, appearance, presence of black debris, presence of oil over water, etc.) and on river Ecosystems, especially the fauna living in the river. We collected also data on the Eurasian otter *Lutra lutra* (spraints, footprints, food remains, cadavers, and soil displacement).



**Figure 1.** Map of the study area showing the River of Middle Oum Er Rbia, the study site and the main roads and localities. The rectangle on the inset indicates the location of the study region in the Morocco map.

#### 3. Results and discussion:

#### 3.1. River pollution and potential effects on environment:

During November-December 2020, the Oued Oum Er Rbia was polluted by olive mill wastewater (Figure 2). The water is brown-black with the presence of an oil film on the surface the river (Figure 3). It emits from the river a special smell of olive mill wastewater. The production of olive oil generate three products: olive oil (20%), solid waste (30%), olive mill wastewater (50%) [7]. The composition of olive mill wastewater varies significantly between regions [8]. Tsagaraki et al. [7] reported that in terms of pollution effect, 1 m<sup>3</sup> of olive mill wastewater is equivalent to 100-200 m<sup>3</sup> of domestic sewage. Olive mill wastewater is rich in organic pollution and in polyphenols which are toxic to most microorganisms. The disposal of olive mill wastewater into watercourses could lead to deterioration of natural water bodies, pollution and environmental degradation [9,10], with the dangerous effects, such as coloring of natural waters, threat to the aquatic life, causing surface and ground water pollution, changing soil quality and plant growth and causing odors; and caused dysfunctional of the wastewater treatment plant [8]. Recent studies found that the addition of unprocessed olive mill wastewater causes significant shifts in the structure and function of microbial communities which in turn influences the soil fertility [11].



Figure 2. Pictures showing the pollution of the Oum Er Rbia River by the olive mill wastewater in Sidi Aissa Ben Ali region during November 2020.



Figure 3. Pictures showing the presence of an oil film in the surface of the Oum Er Rbia River water in Sidi Aissa Ben Ali region during November 2020.

During this study, results of surveys showed that olive mill wastewater affect species living in the river. The comparison of the fauna existing in the banks of the rivers between November 2019 and November 2020 showed important differences. In November 2019, the water is so clear with presence of algal flora and many invertebrate species (Fig. 4, a). In November 2020, the water in the river is darker with presence of a surface layer of oil and absence or scarcity of algal fauna and invertebrates (Fig. 4, b and c). During surveys, we have not encountered any fisherman in the river; on the contrary, we met several fishermen every day in the same period of 2019. This may be due to the scarcity of fish in the river and the pollution of the water (black color and unpleasant odors) during November 2020.

The olive mill wastewater has high organic content and many complex organic materials and has negative environmental effects such as odors, discoloring of natural waters and toxicity, threat to aquatic life by building impenetrable film on the surface causing oxygen transfer problem [12]. The olive mill wastewater possesses an antibacterial and phytotoxicity effects, which causes serious environmental problems [13]. It can be a serious pollution risk for superficial and underground waters [14]. In addition, the presence of phenolic compounds in the olive mill wastewater makes them highly toxic and ecologically noxious [15]. Polyphenols in olive mill wastewater are phytotoxic and known to have a plant growth inhibition properties and antibacterial effect thus prohibiting its disposal neither to the environment nor to the sewage systems [16,17].



Figure 4. Pictures showing the difference between water in the banks of the rivers between November 2019 and November 2020.

## 3.2. Observation on the Eurasian otter and potential impact of olive mill wastewater on its population:

Results of the surveys confirmed the presence of *Lutra lutra* in the west of the village of Sidi Aissa Ben Ali. In this site, we found footprints of otters in November 2020 (Figure 5). Observation of footprints indicated that there are adult otters (large footprints) and juvenile otters (small footprints) (Figure 4). In the study region, *Lutra lutra* occurs in two sites: in Sidi Aissa Ben Ali and in the south west of the village of Lamrabta [18]. In the Oued Oum Er Rbia, the Eurasian otter is an apex predator, and its population status reflects the overall health of riverine ecosystems. The Oum Er Rbia water

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quality is strongly affected by agricultural and industrial activities including oil mills, phosphate extraction, livestock farming, and sugar beet processing [19]. The species is very vulnerable to pollution and so it is often used as a bioindicator species [20]. In Europe, some contaminants severely diminished the population of *Lutra lutra* [21]. The main anthropogenic factors responsible for the decline of the Eurasian otter populations are pollution and habitats alterations [22]. Pollutants affect the species by reducing the food supply. One study reported that in the Moroccan Middle Atlas, Fish represent more than 75 % of the prey of Lutra lutra with a very large predominance of 3 species of barbells (Luciobarbus labiosa, Labeobarbus fritschii, and Labeobarbus paytoni), the anuran amphibians constitute 15 % of the prey, and the rest is represented by insects, ophidians, a chelonian, birds, crustaceans and finally small mammals [23]. The pollution of the Oued Oum Er Rbia River by olive mill wastewater may have serious consequences on Lutra lutra and their survival. The olive mill wastewater is rich in toxins and harmful compounds that can act on their prey and the water quality. Mucci et al. [22] reported that bioaccumulation of organochlorines and heavy metals has also indirectly damaged L. lutra by harming its prey. The toxic compounds in preys should cause reproductive failure to otters [24]. The olive mill wastewater contains many heavy metal including cadmium, cobalt, nickel, manganese, lead, zinc, copper, iron, etc. [8]. The Moroccan samples of olive oil mill wastewater have generally a pH of 4.5-5.32, a conductivity of 13-50 S/m, a turbidity of 2654-2662 NTU, and a density of 1.001 and 1.05g/cm<sup>3</sup> [8]. Consequently, it can affect the water quality of the river water, especially pH of water. The Eurasian otter is sensitive to pH changes in the water, with acidification affecting the carrying capacity, and requiring large numbers of lakes and fiords for breedinguses [25]. Some pollutants can affect directly these otters such as organochlorines dieldrin and DDT/DDE, PCBs, and mercury [26]. The Eurasian otter is listed as Near Threatened by the International Union for Conservation of Nature and Natural Resources since 2004 [27] and under Appendix I by the Convention on International Trade in Endangered Species of Wild Fauna and Flora [28]. Morocco ratified the Basel and Rotterdam Conventions regarding hazardous waste [29].



**Figure 5.** Footprints of Lutra lutra found in the south west of the village of Sidi Aissa Ben Ali (November 2020) (SF: small footprint, BF: big Footprint).

### 4. Conclusion:

The study of Barakat et al. [19] showed that the water of the Oum Er Rbia River was potentially hazardous to health of the consumers and highlighted the need to treat industrial and municipal wastewater and to encourage sustainable agricultural practices to prevent adverse health effects. In Morocco, direct discharge of olive oil wastewater into the receiving natural water bodies is strictly forbidden, because of its ecological consequences. The olive oil wastewater contains a variety of organic and inorganic compounds of very different nature and concentration: phenolic compounds, tannins, carbohydrates, residual fat, orthophosphates, nitrates, chlorides, sulfates, and metallic trace elements [8]. Several compounds and characteristics of the olive oil wastewater valorization and management become one of the important research fields aiming to protect the environment. The future olive oil waste management strategy should be toward a combination of detoxifying and utilizing it, at the same time, for producing valuable by-products [7]. We recommend using appropriate methods and technologies for the sustainable management of the olive oil wastewater. Several technologies and methods have been proposed to minimize the environmental impact of olive mill wastewater: dilution, evaporation, sedimentation and land spreading, filtration and centrifugation, coagulation-flocculation, thermo-chemical treatment, electro-coagulation, biological degradation of the organic matter in anaerobic digesters, recovery of natural products from this effluents, and composting, fertilization, and animal feeding [30,31]. We recommend also installing municipal solid waste landfills, and proper treatment of municipal and industrial wastewater before being released to the environment, and also the improvements in agricultural practices. An environmentally friendly strategy for the olive oil wastewater valorization, including different procedures, was detailed by Haddad et al. [32]. Dutournié et al. [31] proposed a sustainable strategy for recovery of water from olive mill wastewater. This strategy includes (i) the impregnation of olive mill wastewater on lignocellulosic biomass, (ii) the controlled drying of the impregnation samples in a convective

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dryer, (iii) the water recovery from the drying operation through condensation process, and (iv) the material recovery of the dried impregnated biomasses for thermochemical conversion process [1].

In the study site, the Eurasian otter is facing extreme threats by human-induced habitat destruction, in particular gravel and sand extraction from the river bed, disturbances by local people, pollution, low water quality and vegetation burning **[18]**. Conservation efforts on behalf of the wildlife fauna should consider the local people's opinion regarding human-wildlife conflict and the effects of human activities on natural habitats **[33]**. El Alami and Chait **[4]** recommend several measures to encourage the conservation of threatened species including *Lutra lutra* such as the increase of the surveillance of wild habitats and wildlife, education to raise the awareness of the local people, and encouragement of development projects. We recommend also to study of the ecology of species, including age structure and reproduction, sex ratio and reproductive status; population viability, including the temporal and spatial distribution of causes of death and to establish a national strategy of *Lutra lutra lutra* conservation.

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