

Impact of human activities on the Marchica lagoon ecosystem in northeast Morocco

Mohammed Hlal^{1}, Bilal El Monhim², Mohamed Bouymajjan², Abdelkader Sbai², Khadija Benrbia², Gary Cwick³, Abderrahmane El Harradji², Mohamed Benata² and Abdelouahid Saidi⁴*

¹ Center of Urban Systems, Mohammed VI Polytechnic University, Benguerir 43150, Morocco.

² Laboratory of Dynamics Arid Environments and Regional Development, Faculty of Letters and Human Sciences, Mohammed 1st University, Oujda, Morocco.

³ Department of Physics & Eng. Physics, Southeast Missouri State University, Cape Girardeau MO 63701, USA.

⁴ Department of Geography, Polydisciplinary Faculty of Taza, Taza 35000, Morocco.

Abstract. This study aims to analyze and assess the human-induced pressures on the Marchica lagoon ecosystem in north-eastern Morocco, a designated Site of Biological and Ecological Interest (SBEI) known for its rich biodiversity. Employing a multifaceted approach, the research will: examine existing scientific literature on the lagoon's biodiversity and documented human activities, utilize spatial data (e.g., land use maps, pollution levels) to assess the spatial distribution of human activities and potential impacts, and potentially conduct field observations to gather data on the current state of the lagoon. However, human activities have progressively exerted ever-increasing pressure on this fragile ecosystem more than 70% of the pressure comes from urban and agricultural activities. This comprehensive analysis aims to identify and quantify human-induced pressures on the lagoon's health and biodiversity, ultimately highlighting the importance of SBEI preservation and informing future management strategies for the lagoon's long-term sustainability.

Keywords: Lagoon ecosystem, biodiversity, anthropogenic, vulnerability.

1 Introduction

In the northwest of the Oriental Region lies the Marchica lagoon, which is teeming with endemic, threatened or rare species on a national and regional scale. It is also an ecological asset. It is classified as a protected biological and ecological site under RAMSAR [1]. The interest in the Marchica lagoon complex stems from its heritage values, which remained little known until its classification as a SIBE and Ramsar Site. Through the diversity of its habitats, it supports varied fauna and flora rich in remarkable elements [2]. However, human activities have gradually exerted increasing pressure on this fragile biosphere, with major consequences for its health and biodiversity.

Corresponding author: mohammed.hlal@um6p.ma

This paper aims to assess and analyze the impact of human activities on the Marchica lagoon and to highlight the importance of conservation measures to preserve this sensitive ecological heritage.

2 Methods

In this study, we are looking at areas vulnerable to the impacts of human activities, using various environmental and socio-economic parameters defined based on previous scientific work by Sbai, (2008), Lassgâa, (2014), Benatta, (2015), Saidi et al. (2014), and fieldwork carried out by us between 2018 and 2022, to identify the study area, the state of the lagoon ecosystem and the areas likely to be impacted by pollution. It is easier to focus on the sectors likely to be affected by socio-economic activities.

2.1 Study area

The Marchica Lagoon ($35.156944^\circ / -2.845278^\circ$), also known as the Sebkhia de Bouareg, is one of the largest coastal lagoons in the Mediterranean (115 km², 25 km long and 7.5 km wide) and the only one on Morocco's Mediterranean coast [3-4]. It is bounded north by the dune lido that separates the lagoon from the Mediterranean Sea, northwest by the Gourougou mountains, and east and south by the BouAreg plain (See Fig. 1 below).

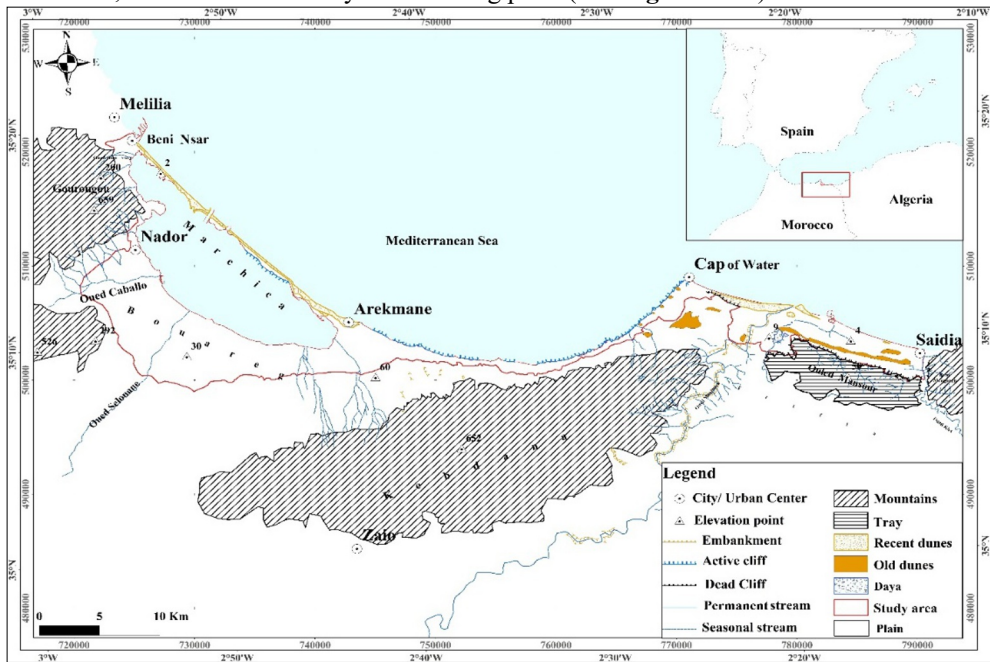


Fig. 1. Location map of Marchica.

3 Result

The massive development of economic activities in Nador and Beni Nsar is occupying large areas of natural land. The Marchica lagoon is also in contact with the urban areas of Nador, Béni Nisar and Arekmane, whose domestic, industrial and agricultural waste threatens the Marchicalagoon ecosystem by polluting it (See **Photo. 1** below).



Photo. 1. Pollution of the Marchica lagoon.

3.1 Rapid urbanization around the Lagoon

Accelerated urbanization and coastal development around Marchica have significantly altered the lagoon ecosystem [5]. The construction of residential complexes, shopping centers and tourist infrastructures has destroyed natural habitats such as fauna and flora [6-7]. This degradation and fragmentation of the ecosystem has disrupted natural cycles and reduced the availability of resources for local species (See **Error! Reference source not found.** below).

3.2 Water pollution

Agricultural and industrial activities in the region have led to significant pollution of the waters of the Marchica Lagoon [8-9]. Effluent discharges containing chemicals, fertilisers and pesticides have affected water quality, harming the aquatic species present (Oujidi et al., 2021). The excessive nutrient input from intense agriculture led to a proliferation of algae, creating imbalances in the ecosystem and damaging biodiversity (See **Error! Reference source not found.** below).

3.3 Over-exploitation of resources

Intensive, unregulated fishing in the Marchica lagoon has led to the over-exploitation of marine resources. The practice of destructive fishing techniques, such as using small gillnets and dredges, has led to a decline in fish populations, Jeopardizing the ecological balance of the lagoon ecosystem [10-11] (See **Error! Reference source not found.** below).

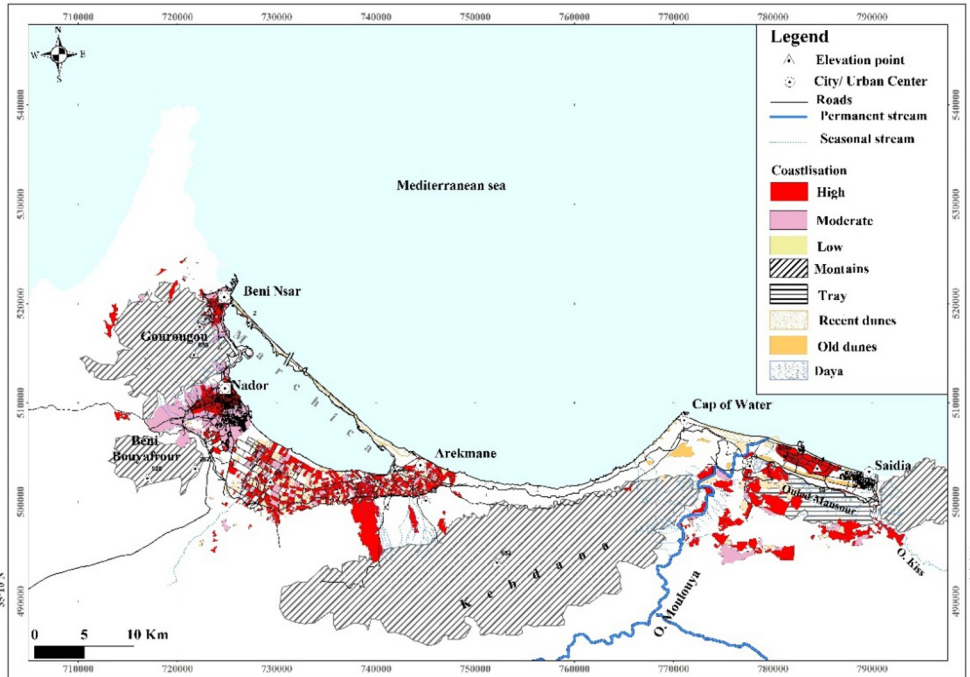


Fig. 2. Coastalisation intensity around the Marchicia.

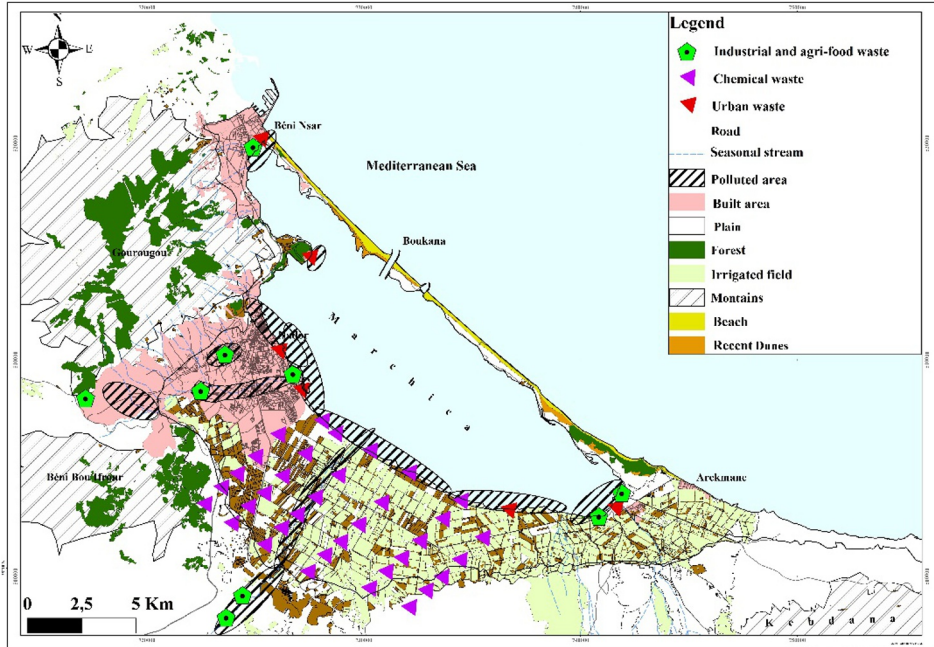


Fig. 3. Environmental impact of human activities.

4 Discussion

The analysis of results shows that human behaviour via the lagoon ecosystem is unbalancing the Marchica lagoon environment. Vulnerability is also a factor in the degradation of the lagoon's flora and fauna.

To preserve this heritage, it is necessary to integrate the logic of preserving lagoon resources, raising awareness among the population, elected representatives, private players and public players, and taking appropriate measures to ensure sustainable action without any harmful impact on the lagoon environment.

It is important to underline the negative consequences of these human activities on the fragile ecosystem of the Marchica lagoon, highlighting the need to take conservation and sustainable management measures to preserve this heritage classified as an SIBE under the Ramsar Convention.

5 Conclusion

The Marchica Lagoon in northeastern Morocco is facing several challenges due to human activities impacting its fragile ecosystem. To mitigate these issues, it is crucial to establish sustainable management strategies for urban development, agriculture, and industry and regulate fishing to protect this important ecological area. Moreover, effective measures should be implemented to address water pollution. These proactive steps are essential to ensure the continued preservation of the Marchica Lagoon ecosystem for the mutual benefit of humans and the environment.

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Author Contribution

Mohammed Hlal contributed to the conceptualization, methodology, data collection, analysis, and original draft preparation. Bilal El Monhim was responsible for data analysis, review and editing of the manuscript, and visualization. Mohamed Bouymajjan handled fieldwork coordination and data management. Abdelkader Sbai provided supervision and validation of the research. Khadija Benrbia conducted the literature review and resource curation. Gary Cwick contributed through technical review and language editing. Abderrahmane El Harradji supported the fieldwork and spatial data analysis. Mohamed Benata oversaw project administration and stakeholder engagement. Abdelouahid Saidi contributed to data analysis and draft review.

Ethics Approval and Consent to Participate

Not applicable.

Consent for Publication

All authors have agreed to publish this article.

Competing Interests

The authors declare that they have no competing interests.

Data Availability Statement

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request. Certain spatial and ecological data are subject to restrictions due to data confidentiality agreements.

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