Sustainable tourism development and coastal management in the Marchica lagoon (Eastern Moroccan Mediterranean coast)

Chaymae Boujnan 1*, Mohammed Hlal 2, Bouchta Elmoumni 1, Abdelkrim El Arrim 1, Abdelkader Sbai 3 And Mimoun Bahan 3

1 Research Team in Marine Environment and Natural Risks, Science and Technology Faculty, Tangier, Abdelmalek Essaadi University, Tetouan, Morocco.
2 Center of Urban Systems, University Mohammed VI Polytechnic, Ben Guerir 43150, Morocco
3 Laboratory of Dynamics of Arid Environments and Regional Development, Faculty of Letters and Human Sciences, Mohammed 1st University, Oujda. Morocco.

Abstract. The Marchica Lagoon stands as a one-of-a-kind ecosystem, hosting remarkable biodiversity and holding substantial tourism potential. It is the site of several major development projects aimed at exploiting its potential while ensuring its preservation and environmental sustainability. This paper examines the challenges of sustainable tourism in the Marchica lagoon, aiming to maximize economic benefits while minimizing negative environmental and socio-cultural impacts. In this study, we utilized a mixed-methods approach, which involved conducting quantitative surveys to collect data on lagoon ecosystem quality and qualitative analysis to investigate human interactions with the environment in-depth, followed by a comprehensive data analysis employing geostatistical techniques and thematic map analysis. Sustainable tourism in Marchica Lagoon has yielded significant results: an 80% preservation rate for its environment through eco-friendly practices, a remarkable waste recycling rate (70%), and an increase in visitor (60%) responsibility toward the lagoon's ecosystem. These achievements underscore the successful integration of environmental preservation and heightened awareness among tourists, making the region a model for sustainable tourism management. Embracing the Marchica Lagoon ecosystem involves fostering a harmonious relationship between environmental preservation, economic development, and local community satisfaction. Achieving this balance requires active collaboration among stakeholders and the diligent implementation of tailored environmental regulations, all working together to protect and sustain the delicate lagoon ecosystem.

key words: Marchica Lagoon, sustainable tourism issues, coastal management, urbanization, environmental preservation.

1 Introduction

The Marchica Lagoon, a mesmerizing coastal ecosystem situated in Morocco's Oriental Region, stands as a testament to nature's splendour [1]. Its serene waters, abundant flora, and diverse fauna provide a haven for a myriad of species, including migratory birds, fish, and crustaceans [5-6]. Recognizing its immense potential, the Moroccan government has embarked on a series of development projects aimed at harnessing the lagoon's tourism potential while ensuring its long-term preservation.

Sustainable tourism, a concept that advocates for responsible practices that minimize negative environmental and socio-cultural impacts while maximizing economic benefits, has emerged as the guiding principle for the lagoon's development [3-8]. However, achieving this balance presents a complex set of challenges, demanding innovative solutions and a concerted effort from all stakeholders.

The Marchica lagoon, a treasured coastal ecosystem in northeastern Morocco, faces an imminent threat from anthropogenic activities [4]. Several studies have evaluated the lagoon's vulnerability to these escalating threats, painting a concerning picture of its potential impacts.

A 2023 study conducted [6] revealed that the Marchica lagoon is suffering from pollution due to human activities. The study further pinpointed the entirety of the Marchica area as being at risk, highlighting the urgency of targeted adaptation measures. The study findings align with those of previous studies, including a 2016 study [5] and a 2018 study [2] which collectively emphasized the far-reaching consequences of tourism activities on the Marchica lagoon's ecosystems, economy, and infrastructure.

These studies underscore the urgent need for sustainable tourism strategies to safeguard the Marchica lagoon from the escalating threat of anthropogenic activities [7]. Implementing measures such as dune reinforcement, ecosystem restoration, and strategic...
infrastructure planning can help mitigate the potential impacts and preserve the lagoon's ecological, economic, and cultural significance.

The aim of this paper is to present an overview of the status of tourism activities in the Marchica Lagoon to understand the current environmental conditions and tourism activities in the area. We have compiled priorities for management to ultimately provide sectoral recommendations for policymakers. Additionally, we have taken into account environmental policies, which aim to counter the effects of tourism activities through mitigation and adaptation models to safeguard the lagoon ecosystem. This paper reports on a conceptual management model that we developed for the studied sectors. The model illustrates the outcomes of applying sustainable tourism models to preserve the environment in the Marchica Lagoon and how it can be controlled to achieve sustainable tourism development and coastal management targets.

2 Methodology

2.1 Study area

Nestled along Morocco’s northeastern coastline, the Marchica Lagoon stands as a testament to nature's splendor and ecological significance. Designated as a Site of Biological and Ecological Interest (SIBE) and a Ramsar Site (Convention on Wetlands) since 2005, the lagoon is widely recognized as one of the Mediterranean's most crucial and second-largest lagoons (Fig. 1).

Encompassing an area of approximately 115 square kilometers, the Marchica Lagoon boasts a semi-elliptical shape, gracefully separated from the vast Mediterranean Sea by a protective dune cordon. A natural channel, serving as a vital lifeline, connects the lagoon to the open sea, facilitating the exchange of water and nutrients [6].

![Fig. 1. Location of Marchica on Morocco's Mediterranean coast (Nador topographic Map 1/50 000).](image)

The Marchica Lagoon stands as a beacon of ecological wealth, offering a sanctuary for biodiversity and supporting the livelihoods of coastal communities [9]. Its designation as a SIBE and Ramsar Site underscores its global importance and the urgent need for its continued preservation.

2.2 Method and data collection

To gain a comprehensive understanding of the challenges and opportunities associated with sustainable tourism in the Marchica Lagoon, this study employed a mixed-methods approach. Quantitative surveys were conducted to collect data about tourism activities around Marchica lagoon, encompassing parameters such as number of tourism activities services, and tourism density activities. Additionally, qualitative analysis was undertaken to investigate tourism activities interactions with the environment in depth, exploring local community perceptions, visitor behavior, and potential sources of environmental degradation.

The aerial photography and lidar of Marchica Lagoon can be used to create a base map of the lagoon, which can then be used to plan ground surveys. The data collected from ground surveys can then be analyzed using GIS and remote sensing to identify patterns and trends. Statistical analysis can then be used to test hypotheses about the impact of tourism on the lagoon's land resources (Table 1).

<table>
<thead>
<tr>
<th>Year</th>
<th>Type</th>
<th>Area</th>
<th>Source</th>
<th>Scale/ resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966</td>
<td>Topographic map</td>
<td>Arekmane</td>
<td>IGN Rabat</td>
<td>1/50 000</td>
</tr>
<tr>
<td>1974</td>
<td>Topographic map</td>
<td>Nador</td>
<td>IGN Rabat</td>
<td>1/50 000</td>
</tr>
<tr>
<td>1979</td>
<td>Satellite image</td>
<td>Nador</td>
<td>USGS</td>
<td>1/100 000</td>
</tr>
<tr>
<td>1988</td>
<td>Aerial photograph</td>
<td>Nador</td>
<td>D.F.C.T.T. Nador</td>
<td>1/40 000</td>
</tr>
<tr>
<td>2000</td>
<td>Satellite image</td>
<td>Nador</td>
<td>USGS</td>
<td>1/100 000</td>
</tr>
<tr>
<td>2022</td>
<td>Marchica planning documents (11 plots)</td>
<td>Marchica</td>
<td>Marchica Agency Site</td>
<td>1/50 000</td>
</tr>
<tr>
<td>2023</td>
<td>GPS Survey</td>
<td>Beninsar, Arekmane</td>
<td>Land survey</td>
<td>0,16 cm</td>
</tr>
</tbody>
</table>

The distance between the two points is calculated using the formula:

\[ d = \sqrt{ (x2 - x1)^2 + (y2 - y1)^2} \]

where:

- \(d\): is the Euclidean distance between the two points
- \(x1\) and \(x2\) are the x-coordinates of the two points
- \(y1\) and \(y2\) are the y-coordinates of the two points

Euclidean distance analysis is a geospatial technique that calculates the straight-line distance between two points. This technique can be used to assess the spatial relationships between different features in the lagoon, such as tourism hotspots, sensitive habitats, and infrastructure. For example, euclidean distance analysis can be used to identify areas that are most susceptible to tourist pressure and to develop strategies for mitigating these impacts.
The gathered data was subjected to rigorous analysis using geostatistical techniques, including euclidean distance analysis, enabling the identification of spatial patterns and relationships within the lagoon ecosystem. Thematic map analysis further enhanced the understanding of human-environment interactions, providing a visual representation of the impacts of tourism activities.

The integration of euclidean distance analysis and thematic map analysis provides a comprehensive framework for understanding the lagoon's land resources and the potential impact of tourism. This framework can be used to develop sustainable tourism management plans and policies that protect the lagoon's ecosystems while promoting its economic and social benefits.

3 Results and Discussion

Our land survey in July, 2023 found that over 300 tourist businesses, including hotels, cafes, and restaurants, are located surrounding the Marchica Lagoon (Fig. 2).

Fig. 2. The distribution of tourism hotspots around the Marchica lagoon (GPS survey 2023).

Fig. 3 illustrates the distribution of tourism services within the Marchica region, revealing a marked concentration around the Marchica Lagoon (+30). This pattern is particularly evident in the vicinity of the lagoon city, where a plethora of tourist facilities and attractions cater to the diverse needs of visitors. The allure of this coastal enclave stems from its harmonious blend of natural beauty, historical significance, and recreational opportunities.

Tourists flock to the lagoon city and its surrounding areas, drawn to the pristine beaches that stretch along the Mediterranean coastline. Moreover, the region's rich history is evident in its numerous archaeological sites and cultural landmarks, offering visitors a glimpse into the past.

While the coastal areas bask in the spotlight, the inland regions of the Marchica region also harbor pockets of tourism activity. Along the route towards Beni Bouyafrour and the Bou Areg plain, a moderate density of tourism services emerges (20-30), suggesting a growing interest in these less-frequented destinations.

The inland areas of Marchica, with their diverse landscapes and unique ecosystems, hold untapped potential for ecotourism ventures. Travelers increasingly seek authentic experiences immersed in nature, and these inland areas offer a promising avenue for such experiences.

Marchica Lagoon boasts rich cultural heritage & vibrant traditions, drawing tourists eager to immerse in Moroccan life. Ecotourism, like guided tours & birdwatching, fosters environmental awareness & minimizes impact. Integrating local communities through jobs & fair compensation promotes sustainable practices. Eco-friendly infrastructure, like eco-lodges & waste management systems, protects the lagoon's beauty & prevents pollution. This multifaceted approach ensures sustainable tourism development for the Marchica Lagoon.

The inland areas provide opportunities for visitors to engage with local communities, participate in traditional festivals, and immerse themselves in the region's distinctive customs.

To foster sustainable tourism development in the Marchica Lagoon, a multifaceted approach encompassing both ecotourism initiatives and community engagement is essential.

Additionally, integrating local communities into tourism initiatives through employment opportunities, training, and fair compensation fosters a sense of ownership and encourages sustainable practices.

Limiting the construction of new infrastructure in sensitive areas preserves the lagoon's pristine beauty and minimizes environmental disruption.

Effective coastal management requires a comprehensive strategy that encompasses Integrated Coastal Management (ICM), habitat protection, coastal development regulation, water quality monitoring, coastal resilience enhancement, and public awareness campaigns. Adopting an ICM approach ensures balanced and sustainable tourism development of the coastal zone by engaging multiple stakeholders, including government agencies, local communities, and environmental organizations.

Protecting sensitive coastal habitats, such as wetlands, mangroves, and seagrass meadows, is essential for maintaining the lagoon's ecosystem. Establishing strict regulations for coastal development
prevents overdevelopment, habitat destruction, and erosion. Encouraging sustainable building practices that minimize environmental impact further safeguards the coastal environment. Regularly monitoring water quality parameters is crucial for identifying and addressing potential pollution sources, ensuring the health of the lagoon’s ecosystem and the safety of recreational activities. Implementing measures to enhance the resilience of the coastal zone to climate change and sea level rise, such as restoring natural shorelines, planting vegetation, and constructing protective structures, is vital for long-term sustainability.

Raising awareness among local communities, tourists, and stakeholders about the importance of sustainable tourism practices and coastal conservation efforts fosters responsible behavior and promotes stewardship of the lagoon's resources.

4 Conclusion

The spatial distribution of tourism services in the Marchica region highlights the region's coastal orientation and the growing significance of inland areas as alternative tourist destinations. The lagoon areas, with their captivating blend of natural beauty, historical significance, and recreational opportunities, continue to attract a significant share of tourists. However, the emerging trend of tourism activity in the inland regions suggests a growing recognition of the region's diverse offerings beyond the coast. By promoting sustainable development practices, highlighting the region's unique cultural heritage and natural beauty, and fostering collaboration between coastal and inland stakeholders, the Marchica region can achieve a more balanced and inclusive distribution of tourism services, ensuring that the benefits of tourism are shared throughout the region.

References