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Valuing the Ecological and Socio-Economic Interests of the Oualidia Lagoon (Morocco): An Ecosystem Services Framework †

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Abstract: The Oualidia lagoon is providing different ecosystem services of socio-economic and ecological interests. These services and goods are important to the local population living there, particularly aquaculture, fishing, and agricultural activities. However, the human activities increase around such ecosystems have adversely influenced its environmental quality and caused its natural-resource depletion. In this context, the main ecosystem services and goods were analyzed; this lagoon is providing and define the main pressures on such an ecosystem. The analysis highlights the needs for building balances between the economic activities growth in this coastal system and the lagoon environment to sustain it natural resource development and avoid their depletion and losses.

Keywords: ecosystem services; natural resources; Oualidia lagoon; Morocco

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1. Introduction

Lagoon is an ecosystem open to the sea and ensure the communication ocean land. The lagoons ecosystems are offering many ecosystem services including habitats, nursery, fisheries, climate regulation, protection against storms and erosion and coastal tourism [1].

The Oualidia lagoon is a RAMSAR site as it provides many services and goods that needs to be protected and sustained for the future generations. Many activities are practiced in and along the lagoon including oyster farming that lunched in 50s, followed by coastal tourism, and agriculture.

This lagoon has been the subject of many research works because of its ecological interest and socio-economic importance [2–13]. In-depth literature search using the Dimensions database revealed that 62 publications were published between 1986 and 2023 focused on biological and earth sciences, ecology and environmental sciences (Figure 1). This implies that the Oualidia lagoon is suffering from human activities pressures which the scientific committee is aware of. Indeed, several management projects were carried out in the lagoon mainly to avoid its closure as it is affected by confinement phenomena [2]. In this sense, the present study analyzes the main ecosystem services of the Oualidia lagoon, mainly because almost all previous studies were focused on the monitoring and assessment of pollutants and the lagoon environmental degradation effects on the biodiversity.

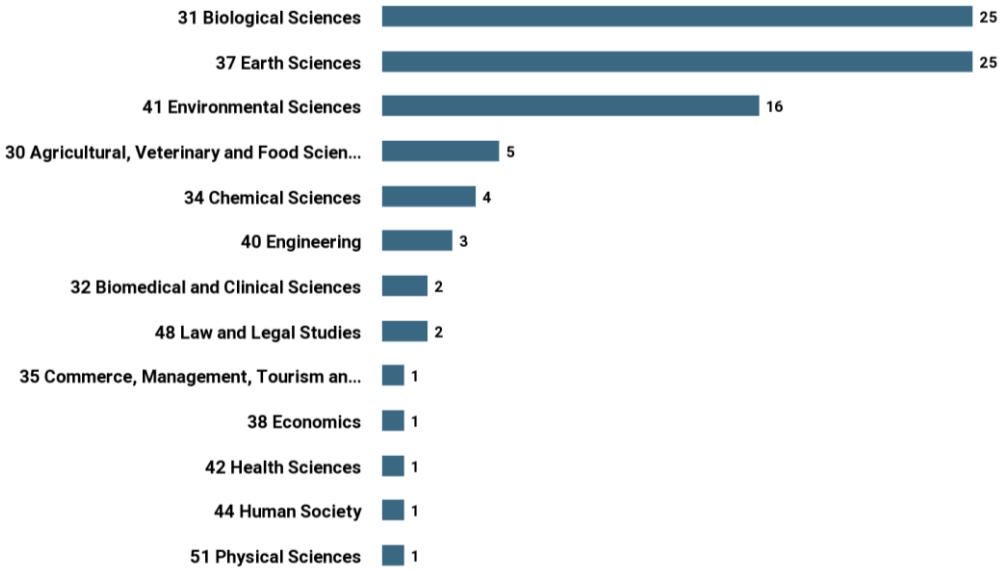

Figure 1. Screenshot of the number of publications of each research category related to our search query, "Oualida lagoon". Taken from the dimensions.ai database in 4 August 2023

2. Methods and Materials

2.1. Study Area Description

The Oualidia lagoon is part of the lagoonal complex of the Sidi Moussa-Oualidia lagoon located in the Moroccan Atlantic coastline. This lagoon is located in the region of Abda-Doukkala. By its geographical location, the lagoon receives many visitors mostly in the summer period. Besides, the lagoon is known for its biodiversity richness mainly because it is located in an area affected by upwelling activities which contribute to the lagoon fisheries resources richness including oyster farming. Other activities are practiced in the lagoon providing income to the local population including agricultural activities where the lagoon is surrounded by an agricultural area mainly for vegetables [8].

2.2. Data Collection

The data collection was carried out using Dimensions.ai database, from where we extracted scientific papers related to the "Oualidia lagoon". The purpose is to define and identify what are the main research categories and subjects related to the lagoon issue. The search was carried out in title and abstract allowing collecting 62 scientific research papers. The main authors were Maanan Mo. (10 papers), Zourarah B. (9 papers), Errhif A. (9 papers) followed by Mejjad N. (7 papers) (Figure 2). Those research papers are mainly related to the environmental assessment and monitoring using different matrices which allow helping in ecosystem services analysis and human pressure analysis.

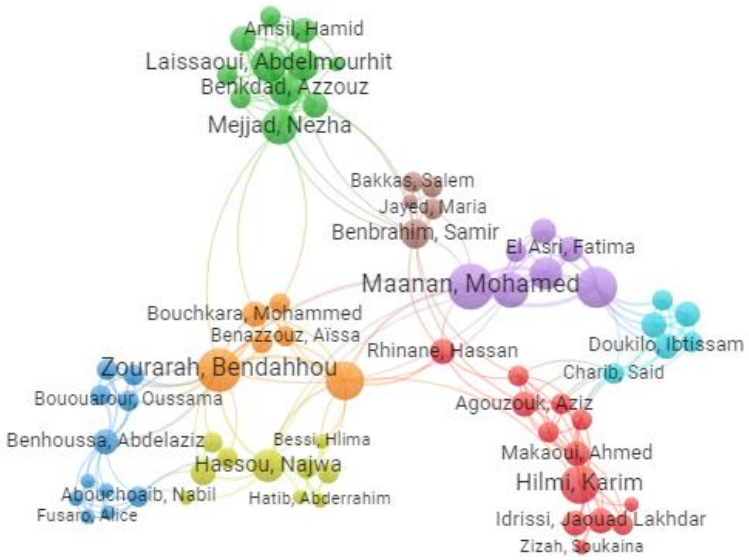

Figure 2. Screenshot of co-authorship analysis related to our search, "Oualida lagoon".

3. Results and Discussions

3.1. What Ecosystem Services the Oualidia Lagoon Offers?

According to Ma (2005) conceptual framework, four types of ecosystem services were identified including supporting services, provisioning services, regulation services and cultural services Figure 3 [14].

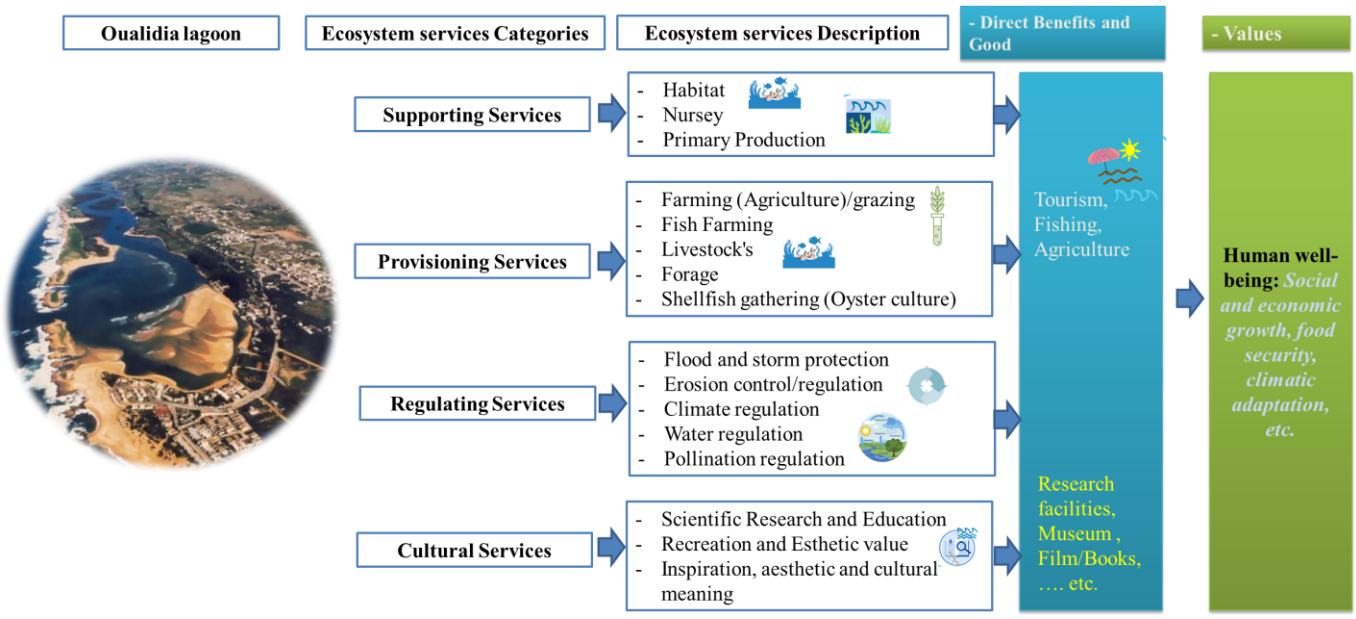

Figure 3. The main ecosystem services are provided by the Oualidia lagoon.

The Oualidia lagoon is presenting numerous supporting services which other services rely upon. The Oualidia lagoon plays an essential role as habitat for many species in addition to being a stopover wintering point for migratory birds. Also, the Oualidia lagoon is acting as a natural nursery for juvenile fishes [15,16]. The presence of seagrass plants in the lagoon known as the most productive habitats in the earth and acts as sink of carbon is other services the lagoon providing. These plants play an important role as the primary producer of the total productivity of their habitat. It is worthily noting that

seagrass play indeed an essential role in climate regulation through sequestering the CO_2 [17].

In addition to the lagoon offer what is termed provisioning services which include aquaculture and fisheries. Those activities are the promoters of other sectors such as coastal tourism and business food. Unless the supporting services are sustainably protected, the lagoon will not be able to provide the provisioning services. Accordingly the human well-being is not only linked to the direct services (provisioning services) but instead closely linked to indirect services (supporting services and regulating services).

Regarding the cultural services, the Oualidia lagoon is among the most attractive lagoonal system in Morocco and in the world as it attracts national and international visitors. Different spiritual and recreation values characterize this lagoon which fascinates its visitors. In addition, the Oualidia lagoon has cultural and historical characters distinguish it from the other lagoons. Accordingly, this lagoon was among the most studied and investigated systems which another cultural service provided by the lagoon (scientific research and education).

3.2. What Pressures on the Oualidia Lagoon Ecosystem Services?

The Oualidia lagoon has known since the 50s an exponential growth of human activities with the creation of the first oyster farming. Other activities were developed in the lagoon since 70s with the population growth mainly agriculture activities which represent the main income source for the local community. However, this increase in human activities was not well correlated to the environmental growth of the lagoon. Indeed, in 2011, it was detected biological contamination by Salmonella in farmed and wild bivalve shellfish samples [18]. Consequently, the fishing hulls and raising clam's activities were prohibited which reflects the influences of anthropogenic activities on biodiversity, the lagoon health, the local economic activities' including coastal tourism and social sector (Job loss). To be noted that the reported biological contamination is intermittent and not a continuous contamination [3]. An excess of "Escherichia coli" in the Oualidia lagoon leads to its classification as "Zone B" in 1996 [18]. Bouchriti et al. (1992) [3], reported that the harvested oyster from the lagoon contains fecal bacteria and can also contain human pathogens. A study carried out in drinking water and water used for agricultural purposes for water samples collected from the Oualidia region and the lagoon shows that in many wells, the water is not suitable for drinking and agricultural uses according to the Moroccan standard NM 03.7.001 [19]. The excessive use of fertilizer, coastal tourism, farming activities are the possible origin of the water quality degradation. Hassou et al. (2014) [20] have indeed, indicated that the source of pollution into the Oualidia lagoon has two origins: i) urban pollution which is concentrated in the watershed and the downstream part of the lagoon and related to tourism activities; ii) agricultural activities occupying the upstream part of the lagoon and watershed through the leaching and infiltration of agricultural related practices around the lagoon mainly during the rainy season [20].

The analysis showed a lack of microbiological studies carried out in the lagoon in the latest years; The population incomes depend mainly on the lagoon natural resources; That environmental quality growth of the lagoon does not follow its social and economic growth.

4. Conclusions

The Oualidia lagoon is known as a blue lagoon and called the Moroccan oyster capital which ranks it among the most attractive Moroccan and touristic destination for national and international visitors. Its ecological and socio-economic interests lead to extensively investigated its environmental quality which results in carrying out several management projects to protect it, conserve and safeguard its natural resources from anthropogenic activities.

The analysis of the Oualidia lagoon ecosystem services is still weakly investigated mainly the role of the lagoon as habitat and in the climate regulation and green gas house emission mitigation. Developing a research projects related to the Oualidia lagoon ecosystem services is an important step toward achieving sustainability in this lagoon

Seeing the lagoon importance for the local population and its ecological role as habitat, nursery, and in climate regulation implies developing management projects for regulating human activities in the lagoon instead focusing in the lagoon itself and only in the assessment and monitoring of the pollution level. Starting from the sources can be efficiently helped in building balance between environmental quality development and socio-economic sector growth.

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Conflicts of Interest: The authors declare no conflict of interest.

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