CEST 2023

18th International Conference on Environmental Science and Technology

Athens, Greece, 30 August to 2 September 2023

Environmental monitoring and sustainable planning for tourism in Balos lagoon in Western Crete

SKINITI G.[1,*], LILLI M.[2], SKARAKIS N.[1], TOURNAKI S.[1], NIKOLAIDIS N.[2], TSOUTSOS T.[1]

[1]Renewable and Sustainable Energy Systems Laboratory, School of Chemical and Environmental Engineering, Technical University of Crete, Chania, Greece

[2]Laboratory of Hydrogeochemical Engineering and Remediation of Soil, School of Chemical and Environmental Engineering, Technical University of Crete, Chania, Greece

*corresponding author
e-mail:gskiniti@tuc.gr

Abstract: Balos lagoon was used as the case study to test a new methodology developed under the CROSS-COASTAL-NET initiative, Development of a Cross-Border Network for the Promotion of Sustainable Coastal Tourism, which is underneath the Interreg Greece–Cyprus program. The project examines the regions of Balos and Akamas in an attempt to settle any concerns raised in such sensitive coastal ecosystems, due to the issue of over tourism. Thus, environmental impact assessments and planning processes are considered essential to define an area's carrying capacity (CC), so that the foundations for its sustainable touristic growth, can be built.
In the current study, aiming to perform a holistic approach -investigation of all the aspects of sustainability, i.e., environment, society, and economy-, the methodology proposed for the carrying capacity identification is three-levelled: 1) calculation of the physical, real, and efficient carrying capacity, 2) quantification of the ecosystem's biological quality, 3) definition of the stakeholders' view, through ranking of proposed solutions derived from thorough research. Eventually, an integral strategy is being applied to capture a spherical view of the existing condition in Balos, as also to provide tailored made solutions.

Keywords: Sustainable Tourism; Ecosystems monitoring and management; NATURA 2000; Carrying Capacity; environmental quality

1. Introduction

Mediterranean regions' emboss has special morphological characteristics due to which those areas are endowed with a surface structure, responsible for the plethora of unique natural beauty sites, which most of the time form sensitive ecosystems of individual biodiversity. Hence, the uniqueness of those landscapes makes them highly rated attractions from a touristic perspective, leading to the development of such anthropogenic activities, causing problems as a result of the concept of over tourism (Vagena, 2021).

Balos Lagoon is a popular beach that draws a lot of tourists, and it is designated as a protected area under the Natura 2000 program. However, the beach has been experiencing environmental degradation lately, which is largely attributed to the high volume of tourist activities in the area. (Skiniti et al., 2022). CROSS-COASTAL-NET initiative, Development of a Cross-Border Network for the Promotion of Sustainable Coastal Tourism, which is underneath the Interreg Greece–Cyprus program, investigates Balos in order to address this issue. Thus, aiming to identify the human pressure on the area, and propose the most efficient sustainable plan for the area's management, a holistic approach was conceived-investigation of all the aspects of sustainability (Lange, 2015), i.e., environment, society, and economy.

2. Methodology

The methodology proposed for the carrying capacity (Hartvigsen, 2022) identification includes 1) the calculation of the physical, real, and efficient carrying capacity (Nilsen, 2010) to precisely compute the technical element of spatial analysis and compare the actual with the optimum tourists' flows, 2) the quantification of the ecosystem's biological quality (Naeem, et al., 1999). A status analysis, based on a sampling protocol, to a) determine the indicators that identify the environmental status of the lagoon, and b) propose management methods that will contribute to its sustainable tourism development, and 3) the definition of the stakeholders' view (Turker et al., 2016), through the ranking of proposed solutions derived from thorough research (PROMETHEE I & II). The stakeholders' groups approached included local authorities, the tourism sector, NGOs & environmental groups, local initiatives, the academic-research sector, the government, and financial investors.

3. Results

The first results of the methodology are presented in Table 2.

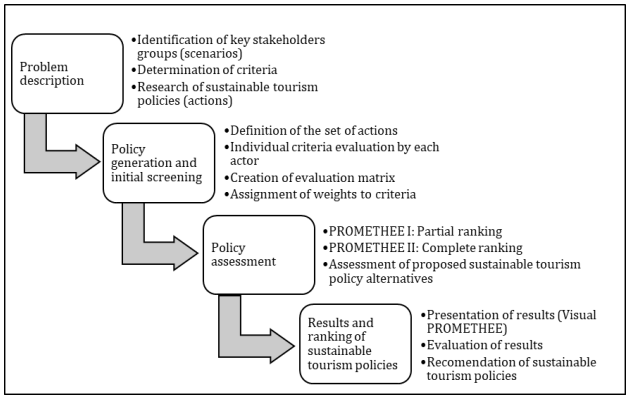

Figure 1 Description of the multi-criteria method for the evaluation of sustainable tourism development policies (Farmaki et al., 2018).

The Efficient Carrying Capacity was calculated at 2,330 persons per day, which is 1 thousand people less than the actual number that arrives in Balos a day, during the peak of the summer (Lilli et al., 2022).

A total of 60 samples were analyzed for TPH – Hydrocarbons, physicochemical parameters, heavy metals, microbiological parameters, microplastics, etc. The results of the physicochemical characterization (Table 1) of the samples showed that the values are typical for the coastlines, as also were all of the environmental quality results. The only indicator that was important to take into consideration, after the environmental monitoring of the quality of the Balos lagoon was the existence of large amounts of tar balls or residues onto the sand, sediment, and seawater.

Table 1. Average value of physicochemical parameters. Results are reported for both cross-sections (A and B). Parentheses show standard deviations. (Lilli et al., 2022).

Indicators	Sea water	Sand	Sediment
pH	6.6-8.19	-	-
DO	9.5 (0.95) mg/L	-	-
N-NO3	3.4 (1.98) mg/L	12.3 (9.7) mg/kg	10.9 (6.7) mg/kg
P-PO4	<0.01 mg/L	0.08 (0.07) mg/kg	0.09 (0.07) mg/kg
TPH	<DL	<DL	<DL
TOC	61.85 (78.14) mg/L	7.6 (16.63) g/kg	4.0 (0.96) g/kg
SO4	3668 (1192) mg/L	1,266 (756) mg/kg	1,285 (355) mg/kg

Table 2. Issues arrived from the multilevel analysis.

Issues	Ecosystem	CC	TripAdvisor
Marine tar residue	✓		✓
Presence of microplastics at the beach	✓		
Number of cars exceeds parking space			✓
Overcrowded ferries		✓	✓
Overcrowded beach		✓	✓
Road conditions unsuitable for most cars			✓
Litters	✓		✓
Uncontrolled grazing	✓		

After all the issues were addressed via the 3 – levelled methodology (Table 2), they constituted the baseline for the measures proposed and ranked via the multicriteria analysis for the sustainable development of the area, as listed below.

1. Regular beach cleanup
2. Parking lot reshaping
3. Implementation of the maximum number of ferries per day
4. Eco-friendly main road treatment
5. Implementation of the maximum number of visitors per day
6. Oil booms
7. Beach access by electric bus
8. Observatory for qualitative monitoring
9. Information boards about the protected area
10. Online booking tickets

4. Conclusions

In conclusion, it is undeniable that all of the above must be taken into account in a framework of extensive discussions and delinerations, so that the resulting management plan will be based on a cooperation and co-creation scheme, between all stakeholders, and in particular, with the agreement of the local authorities and society.

Further studies are required to identify the origin of the tar residues in the Balos lagoon and find solutions to address it. Without doubt, it is necessary to estimate the visitors' demand, to fully comprehend the social parameter of the subject, and most importantly to calculate the visitors' willingness-to-pay and therefore the economic value of Balos.

Aknowledgements

This publication was supported by the European Commission under the INTERREG V-A Greece-Cyprus 2014-2020 programme, within the framework of the project CROSS-COASTAL-NET initiative, Development of a Cross-Border Network for the Promotion of Sustainable Coastal Tourism ", Project MIS code: 5050612. The sole responsibility for the content of this paper lies with the authors. The European Commission is

not responsible for any use that may be made of the information contained therein.

References

Farmaki, E., Aryblia, M., Tsoutsos, T., and Tournaki, S. (2022). Assessing sustainable urban mobility policies in the Mediterranean tourism destinations through multi-criteria decision-making models. *In: Tsoutsos, T. (eds) Sustainable Mobility for Island Destinations. Springer, Cham.*

Hartvigsen, G. (2022). Carrying Capacity, Concept of. *Reference Module in Life Sciences*.

Lange, G. M. (2015). Tourism in Zanzibar: Incentives for sustainable management of the coastal environment. *Ecosystem Services, 11*(5).

Lilli, M., Skiniti, G., Nikolaidis, N., & Tsoutsos, T. (2022). Environmental monitoring of the Balos lagoon in Western Crete for sustainable tourism development. *1st International Conference on Sustainable Chemical and Environmental Engineering*, (p. 5). Rethymno.

Naeem, S., Chapin III, F. S., Costanza, R. P., Golley, E. F., Hooper, D., Lawton, J., Tilman, D. (1999). Biodiversity and Ecosystem Functioning: Maintaining Natural Life Support Processes. *Issues in Ecology, 4*, 2-12.

Nilsen, H. R. (2010). The joint discourse 'reflexive sustainable development' — From weak towards strong sustainable development. *Ecological Economics, 69*(3).

Skiniti, G., Skarakis, N., Tsoutsos, T., Nikolaidis, N., Tournaki, S., Kosmas, P., & Antoniou, L. (2022). Sustainable planning for tourism in sensitive coastal regions. A case study of Balos beach in Western Crete. *3rd Symposium on Circular Economy and Sustainability*, (p. 2). Chania.

Turker, N., Alaeddinoglu, F., & Can, A. S. (2016). The role of stakeholders in sustainable tourism development in Safranbolu, Turkey. *International Conference on Hospitality, Leisure, Sports, and Tourism - Summer Session (HLST-Summer 2016).*

Vagena, A. (2021). OVERTOURISM: Definition and Impact. *Academia Letters*.Aguado J., Arsuaga J.M., Arencibia A., Lindo M. and Gascón V. (2009), Aqueous heavy metals removal by adsorption on amine-functionalized mesoporous silica, *Journal of Hazardous Materials*, 163, 213-221.