

CARRYING CAPACITY ASSESSMENT IN TOURISM: THE CASE OF MYKONOS ISLAND, GREECE

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ABSTRACT

Nowadays, controlling tourism growth has become a significant policy issue for the tourism sector. As population density and tourism demand increase in the coastal regions during the peak tourist period, more pressure is placed on coastal areas. The need to evaluate the impact of the tourist industry on the environment leads to developing a group of sustainable development indicators. Several studies propose indicators and models. The island of Mykonos is one of the most famous tourist destinations in Greece. In our research, we examined the negative and positive impacts of massive tourist development in high quantity and a cosmopolitan Greek destination. We analyse the current condition of the natural resources, such as coastal zones, ports and environmental infrastructure.

Keywords: carrying capacity in tourism, coastal zones and tourism, tourism development.

1 INTRODUCTION

In recent years, especially after the COVID-19 pandemic, there has been a trend of increasing travel. New possibilities for remote work made it possible to stay in one area, even outside the holiday season. Especially during peak tourist periods, the increase in population in tourist destinations is so significant that it adds pressure to tourist areas. To deal with the risk of hypertourism and its consequences, various theories have been developed [1]. However, as in all risk management problems, before planning a solution, the risk must be measured.

Carrying capacity can be defined as the maximum number of people who may simultaneously visit a tourist destination (a) without destroying the physical, economic and socio-cultural environment, and (b) with an acceptable level of services for the visitors. The carrying capacity methodology has become essential for planning and developing policy issues. Especially in the tourist sector, carrying capacity is a helpful tool for environment protection and sustainable tourism development.

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This paper aims to apply the principles of carrying capacity assessment to Mykonos Island to address tourism development and business opportunities. In this study we have used carrying capacity indexes in order to formulate a sustainable tourism development plan for the island.

2 TOURISM IN THE ISLAND OF MYKONOS

One of the most popular tourist destinations in the Cyclades region archipelago is the island of Mykonos. Tourist development was initiated as early as the 1960s and peaked in the early 1990s. In the years that followed the island followed a terrifying development of tourism and became one of the most important tourist destinations worldwide. According to the 2021 census, the population of Mykonos was 10,704 [2], but the population increases dramatically during the tourist period.



Table 1: Arrivals to Mykonos International Airport (passengers).

Month	International flights			Domestic flights			Total		
	2022	2023	Δ %	2022	2023	Δ %	2022	2023	Δ %
January	34	48	41.2	5,058	7,745	53.1	5,092	7,793	53.0
February	14	17	21.4	6,786	7,753	14.2	6,800	7,770	14.3
March	801	864	7.9	8,941	11,680	30.6	9,742	12,544	28.8
April	30,760	21,806	-29.1	27,179	28,740	5.7	57,939	50,546	-12.8
May	81,323	67,121	-17.5	55,580	58,465	5.2	136,903	125,586	-8.3
June	194,941	182,963	-6.1	79,889	83,375	4.4	274,830	266,338	-3.1
July	310,482	300,753	-3.1	87,168	93,768	7.6	397,650	394,521	-0.8
August	321,333	302,766	-5.8	84,407	91,188	8.0	405,740	393,954	-2.9
September	196,633	188,461	-4.2	77,236	87,198	12.9	273,869	275,659	0.7
October	60,353	61,940	2.6	39,950	45,043	12.7	100,303	106,983	6.7
November	1,044	838	-19.7	10,339	12,999	25.7	11,383	13,837	21.6
December	15	3	-80.0	81,101	8,073	-90.0	81,116	8,076	-90.0
Total	1,197,733	1,127,580	-5.9	490,304	531,507	8.4	1,688,037	1,659,087	-1.7



Table 2: Arrivals to the Port of Mykonos.

Month	From Pireaus			From Rafina			Total arrivals		
	2022	2023	Δ %	2022	2023	Δ %	2022	2023	Δ %
January	2,716	2,966	9.2	2,022	2,023	0.0	4,738	4,989	5.3
February	2,546	2,366	-7.1	5,698	9,238	62.1	8,244	11,604	40.8
March	4,749	4,988	5.0	2,228	6,138	175.5	6,977	11,126	59.5
April	13,792	14,216	3.1	9,420	11,105	17.9	23,212	25,321	9.1
May	22,039	22,597	2.5	19,547	18,434	-5.7	41,586	41,031	-1.3
June	28,545	23,350	-18.2	17,382	17,830	2.6	45,927	41,180	-10.3
July	15,887	24,896	56.7	22,773	25,840	13.5	38,660	50,736	31.2
August	18,965	15,371	-19.0	28,405	25,186	-11.3	47,370	40,557	-14.4
September	17,752	21,509	21.2	18,173	22,839	25.7	35,925	44,348	23.4
October	13,954	14,622	4.8	14,463	18,690	29.2	28,417	33,312	17.2
November	3,146	2,281	-27.5	11,441	12,794	11.8	14,587	15,075	3.3
December	1,864	1,733	-7.0	6,460	5,675	-12.2	8,324	7,408	-11.0
Total	147,977	152,918	3.3	160,034	177,815	11.1	308,011	330,733	7.4



2.1 Demand from tourist services

According to the official data from Mykonos International Airport and the island port, more than 2,000,000 people arrived on the island annually in the last 2 years (Tables 1 and 2).

The number of arrivals creates pressure on all the island's infrastructure and environment. For example, in August 2023, more than 430,000 people arrived at Mykonos, 302,000 via international flights, 91,000 via domestic flights and 38,000 from vessels, with a mean stay of six nights. The island's average daily number of tourists was 85,000 (Table 3), 15 times more than the permanent population.

Table 3: Arrivals per month and stays per day, 2022–2023.

Month	Arrivals per month			Stays per day	
	2022	2023	Δ %	2022	2023
January	9,830	12,782	30.0	1,966	2,556
February	15,044	19,374	28.8	3,009	3,875
March	16,719	23,670	41.6	3,344	4,734
April	81,151	75,867	−6.5	16,230	15,173
May	178,489	166,617	−6.7	35,698	33,323
June	320,757	307,518	−4.1	64,151	61,504
July	436,310	445,257	2.1	87,262	89,051
August	453,110	434,511	−4.1	90,622	86,902
September	309,794	320,007	3.3	61,959	64,001
October	128,720	140,295	9.0	25,744	28,059
November	25,970	28,912	11.3	5,194	5,782
December	89,440	15,484	−82.7	17,888	3,097
Total	2,067,356	1,992,317	−3.6	34,422	33,172

To the above number, the visitors who arrive on the island by cruise ships and private boats must be added. According to the data of Fig. 1, the number exceeded 1,200,000 visitors in 2023, with over 5,000 arrivals on average per day.

Is the increase in tourism sustainable? Can the island welcome such a number of tourists without burdening the environment and the lives of the inhabitants? This is the research question of the present study.

3 METHODOLOGY

Due to the growing pressure from the current explosion of tourist demand reaching such a dramatic level, tourism flow management is becoming a priority theme [3] in the policy of all the local governments that have decided to intervene effectively to address the consequences of overtourism [4].

Butler [5] has described the life cycle of tourist product development. Carrying capacity referred in this model, as the element that limits growth, appears in the economic stagnation stage of the tourist destination. The link between the life cycle representing tourism development and the carrying capacity is a dynamic process. Although unlimited growth to any destination is impossible, the shape of growth can have a cyclical form. As suggested in the final stage of economic stagnation or even earlier, the life cycle of a tourist destination can begin again to show growth if new products or marketing systems are imported.



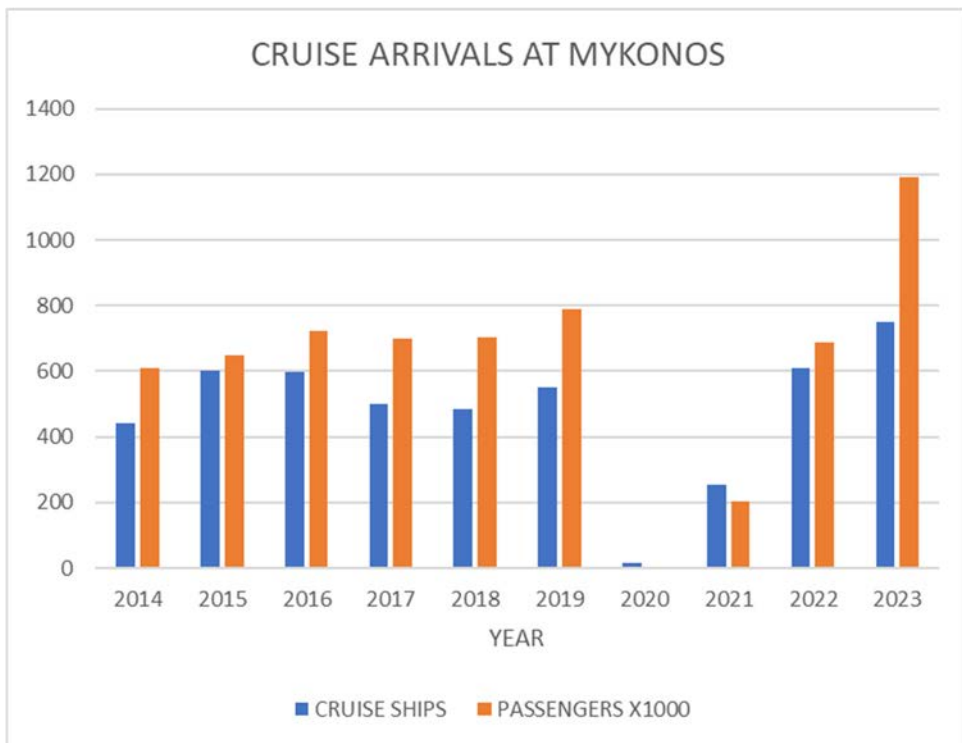


Figure 1: Cruise arrivals, 2014–2023.

According to the above, measuring carrying capacity through indicators is essential in policymaking. But, although the pressure on resources is increasing, the increased impact of tourism on the GDP does not make the choices of changing the tourism model easy.

Several studies propose indicators and models [4], [6], [7]. Losano-Oyola et al. [6] introduced a model with three dimensions: social, economic and environmental. Botta and Comoglio [7] proposed a set of leading environmental indicators, and Bertocchi et al. [4] proposed a model to study over-tourism in Venice. In our research, the proposed carrying capacity assessment model is based on sixteen variables (Table 4). The variables can be separated into two groups: (a) environmental and infrastructure indicators, and (b) tourism indicators [8]. A structured questionnaire was sent to the technical services of the municipalities, and we were given information on the existing infrastructure, as well as the percentage of coverage of the needs. Finally, each indicator was requested to be rated with values from 0 (very bad) to 100 (excellent).

The first group of variables rate the area's environmental characteristics. Environmental indicators describe urban waste treatment, garbage management, atmospheric pollution, water condition, land use, condition of the built environment, use of natural resources, and noise nuisance. Petrosillo et al. researched the weighted evaluation for environmental assessment indicators [9]. In the present study, we examine twelve environmental variables; air pollution was the only index not used because we did not examine urban centres.

The second group concerns tourism – ecological indicators. Losano-Oyola et al. [6], surveyed on sustainable tourism indicators using a series of them [7]. In this study, we use

three of these indicators: (a) beds per kilometre of beach, (b) beds per square kilometre, and (c) permanent beds per inhabitant.

Beaches are the major form of income for tourist destinations. The monitoring of the beaches' water quality affects their suitability or not. The 'blue flag' indicator is the only internationally adapted environmental program for the beaches' quality.

The total score was obtained using questionnaires and qualitative indicators of each area. The final score is calculated from:

$$Y_{\text{Score}} = (\sum_{i=1}^{16} (b_i \cdot x_i)) / 55,$$

where b_i is the corresponding weight (Table 5).

The weighting process was similar to that recommend by [10], [11] and was based on expert consultation, where a panel of experts using questionnaires assessed the criteria.

4 RESULTS

The environmental consequences of the development of tourism on the island are significant. Initially there was a significant building activity, the increase in the number of accommodations from 1997, which was about 12,000 beds in 2023 reaching 66,000 beds is typical, although the increased demand and the number of tourist arrivals shows that the actual number of beds is much higher (Table 4).

Table 4: Accommodation supply, beds per year, 1997–2004 and 2024.

Accommodation type	1997	2004	2024
B&B			33,098
Hotel beds	6,283	10,324	15,763
Rooms to let	5,793	9,067	9,842
Houses			6,996
Total	12,076	19,391	65,699

The need to dock cruise ships, passenger ships and private boats led to the construction of new ports and facilities. The municipality of Mykonos consists of three islands: Mykonos, Rineia and Delos. Delos is an archaeological site and permanent inhabitants are only in Mykonos. Port facilities exist on all three islands. There are a total of 13 port facilities in Mykonos municipality, nine are located on Mykonos Island, three on Rineia Island and one on Delos Island near the ancient harbour. The main uses of the port facilities in Mykonos are coastal shipping (ferries connections from and to Piraeus and other islands on a daily base), cruises, daily cruises, yachting and fishing. The new port at Tourlos bay has terminals for coastal shipping, cruising and a marina not fully equipped for yachts <25 m long. The capacity of the island in cruise passengers seems to be at its limits. The Old Port of Mykonos is used by the daily cruise ships, connecting Mykonos with Delos and Rineia, and by mega yachts >25 m (see Fig. 2).

Between the two ports, a *fishing shelter* provides berths to fishing boats and not only. At the south part of the island, from west to east, are located the port facilities of Ornos, Platis Gyalos and Kalafatis Port. The eastern Kalafatis port is used by the bulk carriers to avoid annoying traffic and noise at the city of Mykonos. Recently the port found proposed regulations for the port uses of Ornos and Platis Gyalos trying to find solutions for the anchorage of yachts especially.





Figure 2: Mykonos ports.

Table 5: Scores per indicator Mykonos and Greek Islands.

Variable name	Description	Scale	Weight	Greek islands	Mykonos
x_1	Urban waste management	0–100	5	38.94	25
x_2	Legality of buildings	0–100	3	46.61	50
x_3	Protection of noise nuisance	0–100	3	22.23	80
x_4	Garbage management	0–100	5	34.93	80
x_5	Protection of pesticides using	0–100	1	45.38	100
x_6	Overpumping in sea waters	0–100	2	37.95	100
x_7	Sufficient quantity of water resources	0–100	3	44.15	0
x_8	Sufficient quality of drinking	0–100	4	50.45	0
x_9	Protection of fire incidents	0–100	2	40.77	100
x_{10}	Forest clearance	0–100	2	36.9	0
x_{11}	Conservation of the landscape	0–100	3	33.41	0
x_{12}	Adequacy of green areas	0–100	2	45.76	0
x_{13}	Beds per kilometre of beach	0–100	5	1,347	10,388
x_{14}	Beds per square kilometre	0–100	5	121.11	1,255
x_{15}	Beds per inhabitants	0–100	5	83.83	9,980
x_{16}	Blue flags per kilometre of beach	0–100	5	0.7328	0.01

Table 5 shows the score for each indicator of the proposed model for Mykonos and the average value for the rest of the Greek islands [8]. According to the results the score for managing the urban waste variable is only 28%, indicating lack of efficiency as the other sewage is transferred by trucks. Low scores are presented also regarding sufficient quantity of water resources (0), sufficient quality of drinking (0), forest and coastline clearance (0), conservation of the landscape (0) as the adequacy of green areas. The low scores indicate a severe threat to the environment [8].

High scores are presented for the variables about the existence and inadequacy of water infrastructure: (a) overpumping in sea waters (100) and protection of pesticides (100). The score is low regarding the legality of buildings (50) and the noise nuisance (50).

Comparing the variables' scores of the island of Mykonos with the whole of the Greek islands, the island of Mykonos has a low score above the mean score, except the variables of protection of fire incidents. The growing pressure that the current explosion of tourist demand is exerting on tourist destinations is reaching such a dramatic level that tourism flow management is becoming a priority theme on the policy of all the local governments that have decided to intervene effectively on the consequences induced by overtourism. Mykonos has a high traffic index during the summer months.

5 DISCUSSION, CONCLUSIONS AND PROPOSALS

The above analysis concludes that tourism development on the island of Mykonos does not follow a logic of sustainability. But the challenges are ahead and very close. The policy of extending the tourist season with the implementation of tourist activities such as medical, walking, religious and conference tourism, as well as the development of long-term stay services for retirees and professionals, can offer economic development without directly affecting the environment.

Priority should be given to enriching the classic product 'sun and sea', with concepts and services such as wellness, luxury, local gastronomy and culture. It is important to upgrade and expand the classic summer vacation. The idea of linking visitors with culture, nature, and the environment in a harmonious way is not new, and it has recently been viewed on a global scale. The critical points for this change are:

- The island's architecture is a comparative advantage for the local cultural product, and there are many modern conference venues across the coastal zone.
- Completing urban waste treatment plants and networks, appropriate garbage handling (urban and olive press garbage management), restriction of illegal buildings at cities and coasts, and control of the hotel's urban waste management systems is crucial. The main problem of the island is the water resources, as the two water dams are empty.
- Tourism development should aim to prevent environmental damage involving the public and stakeholders in decision-making processes [12].

Taking into account the categories of the carrying capacity indices in Mykonos described above, several conclusions and proposals are reached on issues such as energy and natural resource management, primary and tertiary production, environmental infrastructure, protection of the natural environment and land use, and coastal zone planning. Other issues highlighted from the above carrying capacity analysis were also studied. Specific proposals on topics pertinent to sea and land transport, health services, culture and heritage, and public security were reached. The findings are summarised below, covering the relevant areas of interest regarding tourist policy and development [13]. For these proposals, we also made field research on the island as we met municipality and tourism stakeholders [14].



The biggest problems facing Mykonos are wastewater and water management. For the place to develop, the island needs to be covered by sewage treatment plants. Water reserves must become self-sufficient, and the water supply networks must be modernised and extended.

Greek tourism is based on ancient Greek history. Traditionally, tourism in Greece began with visits to archaeological sites on the mainland. Delos must be protected as has the appropriate facilities for tourists and antiquities guards.

The connection between tourism products and services and the environment is a strong relationship. Mykonos actually is an urban island and needs recreation areas.

Tourist awareness seminars: Tourist consciousness is the knowledge that we prove that we have through the professional and friendly service of the tourist who spends holidays in a place, predisposed to have a positive recreation, the tourist consciousness must become an experience for all of us. The tourist consciousness in practice is based on the knowledge of the employees for behaviour and provision of services through professional and friendly service, on knowledge of the tourist infrastructure of the destination.

The main problem of the island is that there not licenced marinas and smaller tourist ports. As a consequence there not facilities to provide services to the yachters, a significant income to be lost and the environmental protection of the sea to be in danger. Nowadays a tourist shelter for mega yachts in Platis Gyalos is under licensing. The port infrastructure of the old port must be renovated. Many other plans for private investments including port facilities are proposed but in some cases are stopped by juridical decisions.

The ring roads (old and 'new') of Mykonos have special characteristics of traffic congestion. Accidents are often observed, especially where the summer the traffic is difficult. Signalling or the constant presence of a traffic warden as a temporary measure is suggested. There is an urgent need to bypass the intersection, since the construction of a car.

Music is a cultural heritage and connects indigenous peoples. Mykonos has a rich island tradition. The cultural part of municipality supports artists of local and foreign artists. This work is notable and must be connected more with the tourists.

The parameters of tourist destination management are the levels of action strategy, the level of destination by service sector, the purpose set by stakeholders involved in tourism.

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