

## Carrying capacity assessment in tourism: the case of the Dodecanese archipelago

B. S. Tselentis<sup>1</sup>, D. G. Prokopiou<sup>1</sup>, M. Toanoglou<sup>2</sup>  
& D. Bousbouras<sup>3</sup>

<sup>1</sup>*Department of Maritime Studies, University of Piraeus, Greece*

<sup>2</sup>*University of Surrey, England*

<sup>3</sup>*Hellenic Ornithological Society, Greece*

### Abstract

Greece depends heavily on the tourist trade, as tourism is the main economic activity. Carrying capacity assessment has become an indispensable tool for formulating policy and strategies in the tourist industry worldwide. The Dodecanese archipelago has 19 islands; mainly concentrated over than 250.000 beds. The tourist product is a blend of ecological, social and economic sub-systems, operable in the area of interest. For the Greek Islands, environment, both natural and man made, plays a leading role in the sustainable development of the industry. It is the purpose of this paper to apply the principles of carrying capacity assessment to the Dodecanese islands, differing in their tourist development, in an effort to highlight the importance of such a tool in developing long-term sustainable policies for such communities.

### 1 Introduction

The World Tourism Organisation (WTO) proposes the following definition of carrying capacity: "The maximum number of people that may visit a tourist destination at the same time, without causing destruction to the physical, economic, socio-cultural environment and an unacceptable decrease in the quality of visitors' satisfaction." [1].

Today, controlling tourist growth has become a central policy issue for the tourist trade [2], and it is noteworthy that carrying capacity assessment has



become an important tool for facilitating planning and developing policy in the industry [3]. The Dodecanese islands have a concentration of over 2 million tourist arrivals per year.

Relevant carrying capacity indicators have been developed and categorised into three groups: 1. physical-ecological, 2. infrastructural and 3. Sociological-psychological [4]. It is highly topical to develop and integrate such indicators [5] into the planning process of the Greek tourist business.

## 2 Basic population characteristics figures for Dodecanese

Table 1: Population in the Dodecanese: Islands with a population greater than 50 inhabitants.

POPULATION CHARACTERISTICS (2001)				
Island	Population	Area (km <sup>2</sup> )	Density inhabitants / km <sup>2</sup>	Municipality status
AGATHONISI	158	13,5	11,70	MUNICIPALITY OF AGATHONISSI
ARKI	54	6,7	8,0	MUNICIPALITY OF PATMOS
ASTYPALAIA	1.238	96,85	12,7	MUNICIPALITY OF ASTYPALAIA
FARMAKONISI	54	3,9	13,8	MUNICIPALITY OF LEROS
HALKI	313	28,12	11,13	MUNICIPALITY OF HALKI
LEROS	8.133	52,95	153,60	MUNICIPALITY OF LEROS
LIPSI	600	15,97	37,57	MUNICIPALITY OF LIPSI
KALYMNOS	13.257	110,8	148,38	MUNICIPALITY OF KALYMNOS
KARPATOS	5.908	301,17	19,62	MUNICIPALITY OF KARPATOS, MUNICIPALITY OF OLYMPUS
KASOS	990	65,67	15,10	MUNICIPALITY OF KASOS
KOS	30.947	290,2	106,64	MUNICIPALITIES OF KOS, DIKAIOS, AND HERACLEIDES
MEGISTI	430	9,12	47,15	MUNICIPALITY OF KASTELORIZO
NISYROS	948	41,4	22,90	MUNICIPALITY OF NISIROS
PATMOS	2990	34,05	87,81	MUNICIPALITY OF PATMOS
PSERIMOS	130	20	6,50	MUNICIPALITY OF KALYMNOS
RHODES	117.007	1.398,07	83,65	10 MUNICIPALITIES: ARHAGELOS, ATTAVIROS, AFANDOU, IALYSOS, KALLITHEA, KAMIROS, LINDOS, SOUTH RHODES, PETALOUEDES, RHODES TOWN
SIMI	2.606	58,1	44,85	MUNICIPALITY OF SIMI
TELENDOS	54			MUNICIPALITY OF KALYMNOS
TILOS	533	62,82	8,48	MUNICIPALITY OF TILOS

### 3 Tourist indicators

#### 3.1 Tourist development

Tourist development in Kos started in the early '70s and that in Rhodes started in the 60's. On the other hand, tourist development in Kalymnos, Patmos and Karpathos started in 1989. All development data are presented in table 5.

Table 2: Bed capacity in the Dodecanese related to area and local population.

BED CAPACITY IN DODECANESE (2006)						
<i><sup>6</sup>Islands with population over than 50 inhabitants</i>						
	Hotels	Hotel's beds	Other hospitality enterprises	Beds in hospitality enterprises	Total beds	Density beds/ km <sup>2</sup>
AGATHONISI	-	-	3	34	34	2,52
ARKI	-	-	?	60	60	
ASTYPALAIA	8	270	91	1.073	1343	13,87
HALKI	5	89	38	192	281	9,99
LEROS	26	1.149	60	846	1.995	37,68
LIPSI	2	75	22	234	309	19,35
KALYMNOS	44	1918	102	1.216	3.134	28,29
KARPATOS	99	4.547	93	1.323	5.870	19,49
KASOS	2	27	5	60	87	1,33
KOS	371	38.947	472	10.436	49.283	169,82
MEGISTI	3	73	18	200	273	29,93
NISYROS	5	233	10	150	383	9,25
PATMOS	43	1826	107	1.091	2917	84,55
PSERIMOS	-	-	?	24	24	1,20
RHODES	511	73.420	906	15.378	88.798	63,51
SYMI	13	481	84	569	1.050	18,07
TELENDOS	1	39	?	56	95	
TILOS	5	234	29	419	653	10,39

Table 3: Closed hotels in the Dodecanese.

CLOSED HOTELS IN DODECANESE [7]	
ASTYPALAIA	1
LEROS	5
KALYMNOS	9
KOS	20
PATMOS	3
RHODES	76
SYMI	1



Table 4: Airports and ports in the Dodecanese.

AIRPORTS AND PORTS IN DODECANESE					
	International airports	National airports	Ports	Organized marinas	Shelters for fishing boats and little ports
AGATHONISI	-	-	1	-	-
ARKI	-	-	1	-	-
ASTYPALAIA	-	1	2	-	1
FARMAKONISI	-	-	-	-	1
HALKI	-	-	1	-	-
LEROS	1	-	-	-	-
LIPSI	-	-	1	-	1
KALYMNOS	-	1	3	-	7

Table 5: Bed capacity history in the Dodecanese: Islands with a population greater than 50 inhabitants.

BED CAPACITY HISTORY 1989-2006									
	Hotel's beds			Beds in other hospitality enterprises			Total beds		
	1989 [8]	1999	2006	1989	1999	2006	1989	1999	2006
AGATHONISI	0	0	0	0	0	34	0	0	34
ARKI	0	0		0	0		0	0	
ASTYPALAIA	128	126	270	326	621	1.073	454	747	1343
HALKI	-	88	89	85	141	192	85	229	281
LEROS	541	1.187	1.149	330	766	846	871	1.953	1.995
LIPSI	28	82	75	0	107	234	28	189	309
KALYMNOS	1.172	1.928	1918	594	1.928	1.216	1.766	3.856	3.134
KARPATOS	603	3.823	4.547	427	977	1.323	1.030	4.800	5.870
KASOS	32	32	27	8	34	60	40	66	87
KOS	16.227	31.272	38.947	7.760	9.480	10.436	23.987	40.752	49.283
MEGISTI	32	32	73	0	176	200	32	208	273
NISYROS	85	254	233	0	138	150	85	392	383
PATMOS	1.280	1.799	1826	185	776	1.091	1.465	2.575	2917
PSEIMOS	0	0	0	-	1993: 37	24	0	?	24
RHODES	45.059	65.500	73.420	13.127	13.489	15.378	58.206	76.989	88.798
SYMI	220	473	481	113	493	569	333	996	1.050
TELENDOS	0	96	39	0	0	56	0	96	95
TILOS	75	0	234	17	141	419	75	141	653

For tables 5, 6, 7 and 8 we have not any data for: Agathonisi, Arki, Astpalaia, Lipsi, Pserimos and Telendos. Economic crises have taken place in tourist enterprises; a lot of hotels have stopped working (Table 3). As indicated by Table 7, the island of Kos has the most arrivals and overnight stays per 100



inhabitants compared to the other islands. As indicated by Table 8, total airport arrivals do not compare to hotel arrivals, indicating that other lodgings are operable in the islands, such as non-licensed hotels and rooms to let, as well as camping facilities that are not taken into account in the official statistics.

### 3.2 Tourist arrivals, related to local population, during high and low season

Table 6: Overnight stays.

OVERNIGHT STAYS IN HOTELS AND OTHER ROOMS IN 2003		
	Low season, overnight stays in October	High season, overnight stays in August
LEROS	201	2.345
KALYMNOS	944	14.599
KARPATOS	4.736	46.358
KASOS	12	59
KOS	359.636	1.077.136
MEGISTI	53	288
NISYROS	529	1.883
PATMOS	991	13.613
RHODES	949.104	1.906.729
SYMI	2.294	1.518
TILOS	15	1.889

Table 7: Tourists related to residents.

TOURIST ARRIVALS IN HOTELS PER 100 INHABITANTS IN 2003				
	Low season, October airport arrivals per 100 inhabitants	High season, August airport arrivals per 100 inhabitants	Low season, overnight stays per day/ 100 inhabitants	High season, overnight stays per day/ 100 inhabitants
ASTYPALAIA	24,31	78.19	-	-
LEROS	10,11	15	2,47	28,83
KALYMNOS	1,95	118,4	0,1	1,95
KARPATOS	57,74	265,25	80,16	815,88
KASOS	24,04	41,31	1,21	5,96
KOS	403,37	484,54	1.162.10	3480,58
MEGISTI	71,86	187,21	12,33	66,98
NISYROS	-	-	55,80	198,63
PATMOS	-	-	33,14	455,28
RHODES	122,67	255,34	811,15	1.629,58
SYMI	-	-	88,03	58,25
TILOS	-	-	2,81	354,41



Table 8: Comparison of airport arrivals to hotel arrivals.

AIRPORT AND HOTEL AND OTHER ACCOMMODATION ENTERPRISES ARRIVALS IN 2003 <sup>9</sup>				
	Arrivals in the airports, October	Arrivals in the airports, August	Arrivals in hotels and other rooms, October	Arrivals in hotels and other rooms, August
ASTYPALAIA	301	968		
LEROS	822	1.221	95	422
KALYMNOS	-	-	503	2.426
KARPATOS	3.234	15.130	584	5.503
KASOS	238	409	9	32
KOS	124.832	149.952	53.000	137.000
MEGISTI/KASTELORIZO	309	805	17	48
NISYROS	-	-	112	302
PATMOS	-	-	402	2.966
RHODES	143.528	298.752	117.000	256.000
SYMI	-	-	329	1.518

Table 9: Beach impact factor for Rhodes.

BEACH IMPACT FACTOR IN DODECANESE							
Municipalities	Beach length (m)	Inhabitants	Hotel beds	Rooms to let (beds)	Total beds	Seasonal populatio n	Beach impact factor (people/km of beach)
AGATHONISI	0,25	158	-	34	34	192	768
ARKI	-	54		45	45	110	
ASTYPALAIA	3	1.238	270	1.073	1343	2.581	860,33
FARMAKONIS I	-	54	-	0	-		-
HALKI	0,6	313	89	192	281	594	990
LEROS	10	8.133	1.149	846	1.995	10.128	1012,8
LIPSI	0,8	600	75	234	309	909	1136,25
KALYMNOS	8	16.441	1918	1.216	3.134	19.575	2,68
KARPATOS	22	5.908	4.547	1.323	5.870	11.778	535,3
KASOS	0,6	990	27	60	87	1.077	1795
KOS <sup>10</sup>	38,9	30.947	38.947	10.436	49.283	80.230	2,18
MEGISTI	0,3	430	73	200	273	703	234,33
NISYROS	5	948	233	150	383	1.331	266,2
PATMOS	7	2990	1826	1.091	2917	5.907	843,86
PSERIMOS	4	130	-	24	24	154	38,5
RHODES [11]	151	117.007	73.420	15.378	88.798	205.805	2,8
SYMI	4	2.606	481	569	1.050	3.656	914
TELENDOS	2	54	39	56	95	149	74,5
TILOS	5	533	234	419	34	567	113,4

## 4 Environmental indicators

The Psalidi wetlands at Kos and south of Rhodes are considered as the most environmentally sensitive region of the Dodecanese.

### 4.1 Beach impact factor

With this indicator we analyse the pressures facing the coastal environment, as they describe the concentration of people visiting and using the facilities of the coastal area, and especially beaches.



Rhodes (2.68 persons per metre of beach) and Kos (6.5) do not face the same pressure on their coastal regions as Lipsi (1136.25) and Leros (1012.8). Rhodes and Kos seem to be the islands with the highest number of beaches with Blue Flag certification (10 in Kos and 31 in Rhodes), indicating that serious attempts have been made to protect the environment and possibly increase competitiveness in the tourist services offered. All the other islands do not have any beaches with Blue Flag certification, a result that agrees well with other indicators that they have slow tourist development.

## 4.2 Natural environment

In the Dodecanese there are only two established national parks; one is in Tilos and the other is in Kos. To conclude, we also have fourteen environmentally protected areas, which belong to the “Natura” network. These environmentally protected areas, based on the “Natura” program, do not, as yet, have a management scheme and are not governed by a specific establishment or organization. Two of these areas are in Rhodes and one is in Kos [12]. The Natura area in Kos island houses an important bird area of Greece, the Psalidi wetland area. This wetland area is under threat as it is situated in the suburbs of the town of Kos, which is a main tourist area. The park of Tilos has different species of eagles. Many different migratory birds visit Psalidi in Kos and Tilos island within the year.

The regulations that comprise the management options adopted have been developed and implemented by the Ministry of Environment. In Rhodes, one of the protected areas is the well-known area called the “Butterfly valley” which is managed by the local municipality. Rhodian deer and little ponies from the Archagelos are species of special interest to the island of Rhodes and many efforts are underway to ensure that both survive excessive human intervention. The indicators presented above indicate the number of threatened species in proportion to the total number of native species (Table 10) [13].

## 4.3 Garbage and waste management

Urban waste management (solid and liquid) on all the islands is characterized by the lack of efficiency. Only the large urban centers fulfill the basic requirements of modern waste management installations. It is interesting to note that other smaller settlements do not even have a complete urban waste collection network.

## 5 Conclusions

In this paper we present selected carrying capacity assessment indicators for Dodecanese Archipelago islands that differ in their tourist development, as well as draw some conclusions as to how these indicators can assist in developing sustainable tourist development policies, in island settings.



Table 10: Protected areas (Natura network) in the Dodecanese related with protected local fauna.

SITE NAME	AREA (ha)	Management body of Protected Area	<i>Monachus monachus</i>	<i>Puffinus yelkouan</i>	<i>Larus audouinii</i>	<i>Hieraetus fasciatus</i>	<i>Buteo rufinus</i>	<i>Falco peregrinus</i>	<i>Falco eleonorae</i>	<i>Emberiza caesia</i>
KASOS AND ISLATS	13452,39		v							
CENTRAL KARPATOS AND ISLETS	9321,90	National Level	v		v	v			v	
NORTH KARPATOS	11297,96	National Level	v		v	v			v	
KASTELLORIZO, RO, STRONGYLI	1769,68									
RODOS: AKRAMYTIS, ARMENISTIS, ATTAVYROS	27514,59		v							
RODOS: PROFITIS ILIAS - EPTA PIGES - PETALOUDES	11184,40									
NOTIA NISYROS KAI STRONGYLI	4055,74		v						v	v
KOS: AKROTIRIO LOUROS - LIMNI PSALIDI - OROS DIKAIOS - ALYKI-PARAKTIA THALASSIA ZONI	10138,24									
EAST ASTYPALAIA END ISLETS	7027,21		v							
ARKOI, LIPSOI, AGATHONISI AND ISLETS	12407,03		v							
SOYTH AEGEAN ISLETS	4568,46									
PATMOS ISLETS	62,00								v	
AGATHONISI, AND ISLETS	1419,00			v	v		v		v	
LIPSI ANS ISLETS	876,00			v	v		v		v	
ARKI AND ISLETS	502,00			v	v		v		v	
LEROS ISLETS	62,00				v			v	v	
KALYMNOS ISLETS AND TELENDOS	528,00						v	v	v	
KINAROS KAI LEVITHA KAI NISIDES LIADA, PLAKA, GLAROS, MAVRIA	1457,00									
EAST ASTYPALAIA AND ISLETS	1459,00								v	



Table 11: Urban waste and garbage management in the Dodecanese islands.

URBAN WASTE AND GARBAGE MANAGEMENT				
	Inhabitants	Urban waste treatment plant	Percentage of waste treated	Garbage management
AGATHONISI	158	NO	0	Place of sanitary burial
ARKI	54	NO	0	?
ASTYPALAIA	1.238	NO	0	Scrap heap
FARMAKONISI	54	NO	0	?
HALKI	313	NO	0	Dump place
LEROS	8.133	1	0	Dump place
LIPSI	600	1	100%	Place of sanitary burial
KALYMNOS	16.441	NO	0	Dump place
KARPATOS	5.908	NO	0	Dump place
KASOS	990	NO	0	Scrap heap
KOS	30.947	1	72%	Place of sanitary burial
MEGISTI	430	NO	0	Dump place
NISYROS	948	NO	0	Dump place
PATMOS	2990	1	0	Dump place
PSERIMOS	130	NO	0	Dump place
RHODES	117.007	5	70%	Place of sanitary burial
SYMI	2.606	2	25%	Dump place
TELENDOS	54	NO	0	Dump place
TILOS	533	NO	0	Place of sanitary burial

- The data, presented in the form of tourist infrastructure indicators, highlights the fact that the islands of Kos 169,82 (beds/ km<sup>2</sup>), Patmos (84.55 beds/ km<sup>2</sup>) and Rhodes (63,51 beds / km<sup>2</sup>) have higher tourist concentrations in terms of accommodation. Comparing these three islands to other municipalities, such as most of the Dodecanese archipelago islands, we conclude that the former ones could already be saturated, and have no real capacity for further development in accommodating a greater number of visitors except some municipalities at south Rhodes and west Kos; taking into account other indicators the conclusion is reached that these saturated islands can progress towards developing quality and alternative tourist services. Areas that have not been developed, should not necessarily develop along the same lines as the major tourist attraction areas, but should, at this stage of their development, plan ahead in order that planning and policy development and implementation lead to a truly competitive and environmentally sound business [14].
- Hotel occupancy indicators for Kos and Rhodes, showing 50% during low season and 100% in the peak periods, combined with the fact that the tourist season on the other islands is mainly during the months of August and July, as hotel occupancy in October in Karpathos is 10% of the occupancy in August, lead us to conclude that the tourist industry should aim at extending the tourist



season to include more months, and probably visitors with varied interests and expectations of the beautiful islands [15].

- Kos, through local tourism organizations, has achieved a better balance between high and low season tourist figures compared with tourism in Rhodes and all the other Dodecanese and seen the need for policies and measures aimed at alternative tourist attractions, thus achieving a better quality and extended tourist season [16]. In Karpathos October arrivals (3.234 passengers) are only 20% of the August arrivals (15.130).
- Environmental indicators indicate that the transformation from a low quality, high numbers tourist trade, to an alternative high quality one will not be easy, since waste management systems are insufficient in dealing with urban and solid waste. It is well known that such inadequacies have serious environmental consequences, and hinder any attempts towards developing a tourist industry based on quality. Urban waste treatment plants operate only at Rhodes, Kos, Lipsi and Symi.
- Calculated coastline impact indicators indicate that the island of Kalymnos (with a total of 8 km of beach), Kos 38.9 Km of beach and Rhodes 151 Km of beach, does not face the same pressure on its coastal regions (data in people/km of beach) as Lipsi 1.136,25, Leros 1.012, Astypalaia 860,33, Simi 914, Halki 990 and Patmos 843.86
- The Dodecanese has 14 environmentally protected areas. The increasing public interest in nature and landscape preservation is, today, considered a major positive factor in the tourist development process. It is true that the growing influx of visitors can exert strong pressures on fragile ecosystems [17]. Environmentally sensitive areas should have an effective management scheme [18] and be run under a modern and highly sophisticated regime.

## Acknowledgements

We would like to thank for their help and collaboration: Dimitra Tselou, economist, University of Piraeus, Spyros Gavanozis Hellenic Civil Aviation Authority, Loucas Mastis, Chief Editor "Rodiaki" newspaper, Mr Petsis, Department of Tourism, Periphery of South Aegean, Rhodes and Paraschos, Vasiliki, Maria and Matia Zouglas, Rhodes and Nikos Kadarzis, Kos.

## References

- [1] UNEP/MAP/PAP, 1997
- [2] Coccosis H and Mexa A, 'The challenge of Tourism Carrying Capacity Assesment', Ashgate 2004
- [3] Fernando J Garrigós Simón, Y. Narangajavana, and D. Palacios-Marqués. 'Carrying capacity in the tourism industry: a case study of Hengistbury Head'



- [4] Jurincic I 'Carrying capacity assessment of Slovene Istria for tourism', 2<sup>nd</sup> International Conference on sustainable planning and development Bologna 2005, Wessex Institute of Technology
- [5] Zannou V, 'Guide of Socio-Economic Studies for the Integrated Management of the Water Environment' 1999
- [6] Direction of Tourism, Periphery of South Aegean, Rhodes
- [7] Mr Petsis, 'Department of Tourism, Periphery of South Aegean, Rhodes'
- [8] Logothetis M. Dodecanese economy 1988-89, Athens 1990
- [9] Hellenic Civil Aviation Authority, Air traffic statistics for 2003
- [10] Prokopiou DG 'A study of environmental impact assessment in Kos and Rhodes coasts' Third Conference in Coastal Management, National Technical University of Athens, Athens 2005(in Greek)
- [11] Prokopiou DG – Tselentis BS 'Environmental Impacts of Development in Rhodes' International Conference of sustainable planning and development Skiathos 2003, Wessex Institute of Technology
- [12] Hellenic Ornithological Society, [www.ornithologiki.gr](http://www.ornithologiki.gr)
- [13] Indicators for the sustainable development in the Mediterranean region, Blue Plan – PNUE 2000
- [14] 'Rodiaki' newspaper 2006-02-12
- [15] Prokopiou DG and Tselentis BS 'Regional development and the islands of Kos and Rhodes - a study of sustainable financial opportunities' 2nd Conference on sustainable planning and development Bologna 2005, Wessex Institute of Technology
- [16] Prokopiou DG, MBA Dissertation: 'Regional Investment Study for Kos and Rhodes islands', University of Piraeus, 2005(in Greek)
- [17] Papayanis T, 'Tourism carrying capacity in areas of ecological importance'
- [18] Prokopiou DG and Tselentis BS 'Proposals for sustainable development and Environmental protection for the island of Rhodes', Rhodes 2003 (in Greek)

