

# Tourism carrying capacity assessment and environment: the case of Crete

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## Abstract

Crete is the largest island in Greece. It covers an area of 8,303 sq. km and has 170 km of beaches. Tourism supply in Crete includes more than 200,000 beds which serve more than 3.5 million international tourist arrivals per year.

Cretan environment, both natural and manmade, can sustain a polymorphic tourism product for the island. The physical and cultural environment consist of an extended coastline with many sandy beaches, picturesque cities and traditional villages, unique mountains, wetlands and lakes.

The environment plays a vital role for the sustainable development of the tourism industry and offers a unique tourist product for the island.

The objective of this paper is to evaluate the impact of tourism and other economic activities on the environment of Crete and to estimate the quality of tourism products and services offered by the island's infrastructure.

In our study we have used environmental and tourism indices to estimate the impact of tourism and other businesses in the environment of Crete, in an attempt to address the challenges and options, pertinent to formulate a novel sustainable tourist development proposal.

*Keywords: tourism carrying capacity assessment, carrying capacity in tourism, study for tourism in Crete, Crete tourism and environment, tourism and environment.*

## 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]. For the Greek Islands, environment, both natural and manmade, plays a vital role for the sustainable development of the industry

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 issues for the industry [3]. The purpose of this paper is to try and attain values for these indicators and integrate them into the planning process of the Greek tourist business [4].

Crete is the largest island of Greece and the fifth largest in the Mediterranean after Sicily, Sardinia, Cyprus and Corsica. It has an area of 8.162 square miles. Crete is the largest of the Greek islands, a long 260 km stretch with a width varying from 12 km to 60 km in its central part. It lies on the south of the Aegean Sea and its southern coast is on the Libyan Sea. Crete, with a population of 650,000 in year 2005, is one of the 13 regions into which Greece is divided. It forms the largest island in Greece and the second largest (after Cyprus) in the eastern Mediterranean. The island has an elongated shape: it spans 260 km (160 mi) from east to west, is 60 km (37 mi) at its widest point, and narrows to as little as 12 km (7.5 mi) (close to Ierapetra). Crete covers an area of 8,336 km<sup>2</sup> (3,219 sq mi), with a coastline of 1,046 km (650 mi); to the north, it broaches the Sea of Crete to the south, the Libyan Sea; in the west, the Myrtoan Sea, and toward the east, the Karpathon Sea. It lies approximately 160 km (99 mi) south of the Greek mainland [5].



Figure 1: Map 1: Crete [6].

Crete has a unique tourist product that combines human and the natural environment, as tourism is an activity which cuts across conventional sectors in the economy. It requires inputs of an economic, social, cultural and environmental nature.

## 2 Population

The population of Crete is mainly concentrated in the six large towns of the island, to the capitals of the four prefectures, Chania, Iraklion, Agios Nickolaos and Rethymno and also to Ierapetra and Sitia. As far as the education is concerned, there are two universities and one polytechnic school which gather students from all over Greece. We must also point out the fact that in Crete region, there is also a factory blooming industries. The population of Crete is employed in trade, handicrafts, tourism and agricultural economy, like farming and live stock rising. Cretans who either live in the cities or the villages, all maintain the time honoured customs and manners of their tradition. Cretan traditional music and Cretan cuisine are defining their uniqueness.

Crete has the highest population growth in Greece, increasing by approximately 20%.

Table 1: Population history in Crete.

	Heraclion	Lasithi	Rethimno	Chania	Crete
1981	243,622	70,053	62,634	125,856	502,165
2001	292,489	76,319	81,936	50,387	601,131
Growth %	20.1	8.9	30.8	19.5	19.7

## 3 Ports and airports

Crete gathers more than 4 million tourists per year. There are many ways to reach Crete. One can get there by plane or by boat.

Ports: In Crete, there are six ports that connect Crete with the other islands and the mainland of Greece, in Heraklion, Chania, Agios Nickolaos, Kasteli Kissamou, Rethymnon and Sitia. These ports are connected with continental Greece as to some Greek islands.

Airports: Three airports are operating in Crete. Two of them are international (Heraklion and Chania) and one is national (Sitia). Thousands of charters flights

Table 2: Arrivals in Cretan Airports.

ARRIVALS IN CRETAN AIRPORTS						
	Chania International Airport		Heraclion International Airport		Sitia Airport	Total for Crete
	Arrivals - Domestic	Arrivals Abroad	Arrivals - Domestic	Arrivals Abroad	Arrivals - Greece	Arrivals Abroad
1978	153330		281469	231180		665979
1980	152482	5387	266170	386952		810991
1985	253494	31589	465721	734288	1884	1486976
1990	155157	173770	298012	926820	1992	1555751
1995	110777	334118	223649	1559204	1459	2229207
2000	254231	450258	494317	20078233	799	21277838
2005	193179	555647	448461	2003643	9032	3210003
2006	212376	660904	493760	2159452	11109	3537601
2007	248906	683669	537718	2162769	17666	3650728
2008	254659	671477	547484	2154010	20000	3647635
2009	280717	608693	553679	1952074	18916	3414079



reach Crete every year, especially during the summer season. Specifically, in Heraklion airport more than 2,000,000 tourists arrive with international flights and in Chania airport more than 1,200,000 tourists arrive every year.

Tourist seasonality in Crete concentrates most of the tourist demand from May to October. Tourism industry of the island is trying to extend the season with the support of winter time charter flights.

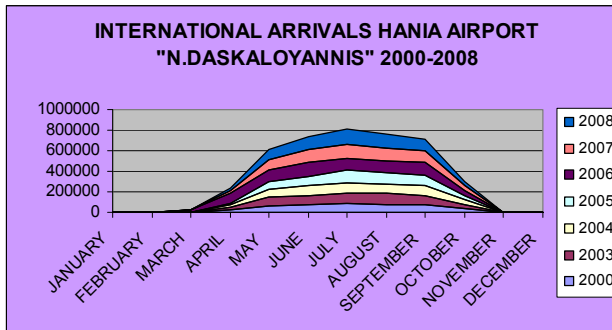


Figure 2: Arrivals in Chania Airport.

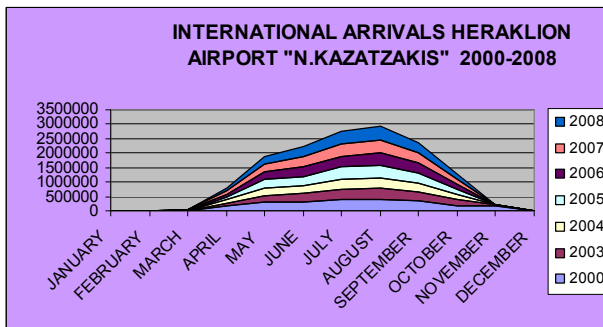


Figure 3: Arrivals in Heraklion Airport.

#### 4 Tourist supply

Since the 1970s, mass tourism has provided Crete with increasing proportions of its GDP. Most of the physical development associated with package tourism has been concentrated on the northern coast east of Heraklion, Chania, Rethimno and Agios-Nikolaos [7]. Tourism in Crete has been as a development strategy, due to its potential for employment and income generation, infrastructural development and overall community [8]. Crete gathers more than 4 million tourists per year. Cretan tourist accommodation includes more than 200,000 beds in hotels, rooms to let, furnished apartments and traditional small hotels.

Table 3: Tourism capacity in Crete.

TOTAL TOURISM CAPACITY IN CRETE					
	2006	2010		2006	2010
<b>PREFECTURE OF HERAKLION</b>			<b>PREFECTURE OF CHANIA</b>		
HERAKLION (town)	2852	2646	CHANIA (town)	3353	3063
AGIA VARVARA	0	0	ACROTIRIOU	1062	997
ARCALOHORI	236	138	AN.SELINOU	19	52
ARCHANES	65	103	ARMENVN	336	403
ASTTEROUSION	151	13	VAMOU	511	606
VIANNOU	125	22	VOUKOLION	63	158
GAZI	10871	10916	GEORGIOPOLIS	5403	5619
GOGROLAINI	0	36	EL VENIZELOU	0	0
GORTYNAS	101	79	THERISOU	63	56
GOUVES	9929	9319	INAHORIOU	0	0
EPISKOPI	0	0	KANTANOU	68	68
ZAROS	186	170	KERAMION	0	0
THRAPSANO	0	0	KISSAMOU	892	1151
KASTELEI		38	KYLYMVARIOU	1590	2128
KOFINA	0	40	KRYONERIDAS	15	46
KROUSONAS	180	0	MOUSOURON	101	101
MALIA	11478	11408	MYTHIMNIS	147	108
MIRES	97	59	NEAS KYDONIAS	10824	13295
NEA ALIKARNASOS	631	248	PELEKANOU	605	580
NIKOU KAZATZAKI	9	9	PLATANIA	8428	9610
ROUVA		0	SOYDA	99	110
TEMENOUS		0	SFAKION	339	353
TETRACHORIOU	21	21	FRE	0	0
TYLISSOU		62	ASI GVNIA	0	0
CHERSONISOS		28235	<b>PREFECTURE OF RETHYMNO</b>		
<b>PREFECTURE OF LASITHI</b>			RETHIMNO (town)	13287	13420
AGIOS NIKOLAOS	11954	12356	ANOZIA	50	50
IERAPETRA	4037	4238	ARKADIOU	4933	7272
ITANOU	239	275	GEROPOTAMOU	4933	5699
LAYKI		0	KOYLOYKONA	77	132
MAKRY GIALOS	582	1195	KOYRITON	0	3
NEAPOLI	30	30	LAMBIS	1472	1286
OROPEDIO LASITIOU	97	102	LAPPAION	12	12
			NIKOFOROU FOKA	304	335
			SYVRITOU		
GAVDOS		20	FOINIKA	1835	1950
			ZONIANA		

Crete is one of the most popular holiday destinations in Greece. Fifteen percent of all arrivals in Greece come through the city of Heraklion (port and airport), while charter journeys to Heraklion last year made up 20% of all charter flights in Greece. Overall, more than two million tourists visited Crete last year, and this increase in tourism is reflected on the number of hotel beds, rising by 53% in the period between 1986 and 1991, when the rest of Greece saw increases of only 25%. Today, the island's tourism infrastructure caters to all tastes, including a very wide range of accommodation; the island's facilities take in large luxury hotels with their complete facilities, swimming pools, sports and recreation, smaller family-owned apartments, camping facilities and others.



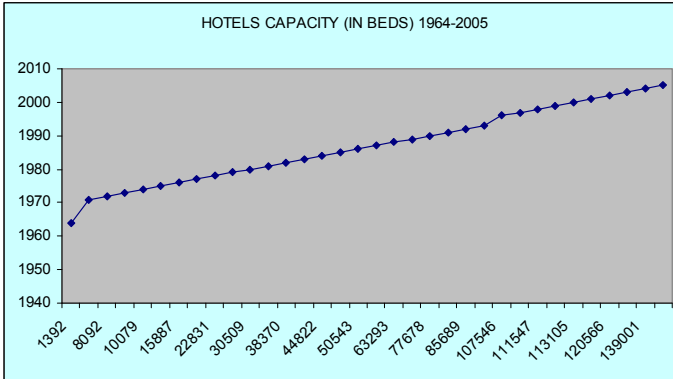


Figure 4: Hotel capacity history.

Today Crete has the infrastructure to offer its services even for athletic tourism. The combination of its numerous beaches and land will strong relief create an ideal environment [9] for the organizing of alternative tourism action, moreover, there are 69 diving centers.

Table 4: Alternative tourism enterprises, Crete [10].

ALTERNATIVE TOURISM ENTERPRISES			
HERACLION	LASITHI	CHANIA	RETHIMNO
11	3	4	8

## 5 Environmental indicators

The coastline is where the land meets the sea or ocean [11]. Tourist development is adding to already existing pressures in coastal areas. Population densities are increasing in the tourist coastal regions during seasonal peaks [12, 13].

There are specific touristic areas that are in more favor of tourist attention, that are settled close to Hania, Rethimnon, Iraklion, Agios Nikolaos and Sitia, the most popular cities of Crete. These cities are situated across the north coast of the island of Crete.

Furthermore, across the southern coast line, with the view of Libian Sea, there are plenty of hotels, most of them situated nearby Ierapetra – Makri Yalos, Timbaki – Messara’s bay, southern Rethimno, Sfakia, and the whole west coast line of Crete (Pelekanos and Inaschorio and Gramvousa area).

The coast and its adjacent areas on and off shore is an important part of a local ecosystem as the mixture of fresh water and salt water in estuaries provides many nutrients for marine life. Salt marshes and beaches also support a diversity of plants, animals, and insects crucial to the food chain.



Figure 5: Map 2 and 3. Beds per sq km and beds per km of beach.

Table 5: Beach impact factor and beds per kilometers.

BEACH IMPACT FACTOR AMD BEDS PER SQUARE KILOMETRES					
	BEDS/ SQ KM	BEDS/ KM OF BEACH		BEDS/ SQ KM	BEDS/ M OF BEACH
<b>PREFECTURE OF HERAKLION</b>			<b>PREFECTURE OF CHANIA</b>		
HERAKLION(town)	24,26944	2205	CHANIA (town)	243,7918	3063
AGIA VARVARA			ACROTIRIOU	8,850893	433,4783
ARCALOHORI	0,580835		AN.SELINOU	0,380799	104
ARCHANES	3,268181		ARMENVN	7,288577	183,1818
ASTTEROUSION	0,063907	13	VAMOU	9,040054	1010
VIANNOU	0,099305	2,650602	VOUKOLION	2,049021	790
GAZI	113,9338	2227,755	GEORGIOPOLIS	105,032	1123,8
GOGROLAINI	0,868349		EL VENIZELOU	0	
GORTYNAS	0,499021	34,34783	THERISOU	0,755674	
GOUVES	98,13296	2329,75	INAHORIOU	0	0
EPISKOPI	0		KANTANOU	0,930474	
ZAROS	2,367589		KERAMION	0	
THRAPSANO	0		KISSAMO	7,72307	230,2
KASTELI	0,308129		KYLYMVARIOU	14,18723	
KOFINA	0,276304	40	KRYONERIDAS	0,680866	
KROUSONAS	0		MOUSOURON	0,526744	
MALIA	187,8788	2852	MYTHIMNIS	1,954114	27
MIRES	0,324381	13,11111	NEAS KYDONIAS	619,6113	2215,833
NEA ALIKARNASOS	15,40564	496	PELEKANOU	3,481016	98,30508
NIKOU KAZATZAKI	0,088062		PLATANIA	243,7918	3063
ROUVA	0		SOYDA	8,850893	433,4783
TEMENOUS	0		SFAKION	0,380799	104
TETRACHORIOU	0,980255		FRE	0	0
TYLISSOU	0,473051		ASIGVNIA	0	0
CHERSONISOS	9,222133	128,2301	<b>PREFECTURE OF RETHYMNO</b>		
<b>PREFECTURE OF LASITHI</b>			<b>PREFECTURE OF RETHYMNO</b>		
AGIOS NIKOLAOS	38,87564	3530,286	RETHIMNO (town)	106,1239	2631,373
IERAPETRA	10,73526	365,3448	ANOZIA	0,442353	
ITANO	1,393068	45,83333	ARKADIOU	59,10898	909
LAYKI	0	0	GEROPOTAMO	29,28722	5699
MAKRY GIALOS	7,504914	265,5556	KOYLOYKONA	0,958	
NEAPOLI	0,154751	150	KOYRITON	0,023859	
OROPEDIO LASITIOU	0,78476		LAMBIS	5,823326	347,5676
			LAPPAION	0,234687	1,875
			NIKOFOROU FOKA	3,502682	
			SYVRITOU	88,55339	
GAVDOS	1,115698		FOINIKA	14,09622	609,375
			ZONIANA		

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. From the data presented in Table 5, Gazi 2227, Gouves 2329, 75 with tourists per km as Platania and Nea Kydonia 2215 and Rethimno 2631 as Agios Nicolaos 3530 and Geropotamos 5699 concentrates the most serious pressures at the coasts.



Table 6: Shore and marine pollution in Heralcion [14].

	Illegal buildings	Hotels (urban waste)	Oil press (residuals)	Ships (oil residuals)	Urban waste
1997	7	1	43	5	
1998	4	2	25	1	
1999	9	7	29	0	
2000	8	15	19	7	
2001	14	6	18	6	
2002	8	12	22	4	
2003	18	6	35	1	
2004	14	9	11	5	
2005	25	7	19	5	
2006	9	5	19	2	
2007	34	4	8	4	2
2008	30	2	3	8	5

Urban waste management (solid and liquid) on Crete is characterized by lack of efficiency regarding the waste treatment in the small cities and villages. Only the large urban centres fulfil 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.

Table 7: Waste management in Crete.

(UC= under construction)

PREFECTURE OF HERAKLION		PREFECTURE OF CHANIA	
HERAKLION	100%	CHANIA	97%
AGIA VARVARA	UC	AKROTIRIO	NO
ARKAOLOCHORI	NO	ANATOLIKO SELINO	UC
ARCHANES	100%	ARMENON	50%
ASTTEROUSION	NO	VAMOY	NO
VIANNOU	UC	VOUKOLION	NO
GAZI	IS WORKING	GEORGIPOULI	NO
GOGROLAINI	UC	ELEFTHRIOU VENIZELOY	NO
GORTYNAS	NO	THERISOU	100%
GOUVES	UC	INAHORIOU	UC
EPISKOPI	50-%	KANTANOU	UC
ZAROS	NO	KERAMION	NO
THRAPSANOY	80%	KISAMOY	UC
KASTELI	25%	KOLYMVARIOY	70%
KOFINA	25%	KRYONERIDA	UC
KROUSONAS	NO	MOUSOURON	NO
MALIA	IS WORKING	MYTHIMNIS	NO
MIRES	NO	NEAS KYDONIAS	100%
NEA ALIKARNASOS	80%	PELEKANOU	NO
NIKOY KAZATZAKI	100%	PLATANIA	70%
ROUYA	NO	SOUDA	100 %
TEMENOUS	NO	SFAKION	80%



Table 7: Continued.

(UC= under construction)

PREFECTURE OF HERAKLION		PREFECTURE OF CHANIA	
TETRACHORIOU	UC	FRE	
TYLISSOU	UC	ASI GONIA	NO
TYMPAKI	50%	<b>GAVDOS ISLAND</b>	NO
CHERSONISOS	100%	PREFECTURE OF RETHIMNO	
PREFECTURE OF LASITHI		RETHIMNO	100%
AGIOS NIKOLAOS	90%	ANOGIA	90%
IERAPETRA	75%	ARKADIOU	100%
ITANOU	70%	GEROPOTAMOU	90%
LAYKI	45-50%	KOYLOYKONA	UC
MAKRY GIALOS	NO	KOYRITON	NO
NEAPOLI	NO	LAMBIS	UC
OROPEDIO LASITIOU	50%	LAPPAION	15%
SITIA	80%	NIKOFOROU FOKA	NO
VRACHASI	NO	SYVRITOU	NO

Table 8: Shore and marine pollution in Agios Nicolaos [15].

	Illegal buildings	Oil press (residuals)	Ships (oil residuals)	Urban waste
1998	7	1		
1999	5	3		
2000	4	1		
2001	16	4		
2002	1			
2003	9			
2004	10			
2005				
2006	15	1		2
2007	4		1	
2008	12		1	

Table 9: Shore and marine pollution in Rethimno [16].

	Illegal buildings	Oil press (residuals)	Ships (oil residuals)	Urban waste
1998	.2			
1999				
2000		1		
2001	.6	6		.1
2002	18	7		.1
2003	.4	2		12
2004	.8		1	
2005	54	7		.8
2006	.4			.2
2007	.5			.1



## 6 Tourism impacts

Impacts of tourism in coastal areas are: urban tourism enterprises, improper solid waste and garbage treatment, reduction of water resources, loss of free space in the towns,

Tourism can generate both positive and environmental impacts depending on how well development is planned and controlled. The principal impacts are outlined below [17]:

### 6.1 Negative impacts

Water pollution, air pollution, noise pollution, visual pollution, overcrowding and congestion, land use problems, environmental hazards, landslides, flooding and sedimentation of rivers, damage to historic and archaeological sites, improper waste disposal

### 6.2 Positive impacts

Conservation of important natural areas, conservation of important historic sites, improvement of environmental quality, enhancement of the environment, improvement of infrastructural, tourism carrying capacity assessment is the most important analytical technique to estimate the environmental pressures of uncontrollable tourist development.

## 7 Proposals

Tourist development indicators for Crete lead us to conclude that the tourist industry should aim at extending the tourist season to include more months, attain occupancy well over 50% for April, October, and probably more visitors with varied interests and expectations of the island.

Organization for the protection and development of environmentally sensitive areas. Due to the increased tourist demand, it is suggested that all the areas with environmental interests must be protected by a special organization [18] that, does not as yet exist now in Crete except the National Park of Samaria [19]. Natura 2000 Network areas are a step in the right direction, but must be supported with effective management schemes [20].

Extension of tourist services for the winter season months by developing and marketing novel tourist activities particular for the island (mountaineering, cultural events, conferences etc).

Completion of urban waste treatment plants and network, appropriate garbage handling (urban garbage treatment - olive oil press residuals management)

Restriction of illegal buildings at cities and coasts

Control of hotels' urban waste management systems

This concept of linking visitors with culture, nature and the environment in a harmonious way is not a new idea, but one that is now viewed on a global scale. Long-term, successful community involvement has preserved many popular rural



tourist destinations such as the wine regions of Europe and the United States. Many rural communities have acted on instinct, rather than governmental directives or support, and usually with enough individual investment to achieve results [21].

Alternative tourist development.- Planning is conceptually related to sustainable development [22]. It includes approaches to deal with development and economic options, to prevent environmental damage and to involve public and stakeholders in decision-making processes. It is proposed that serious efforts have to be made in the direction of formulating viable policies and developing tools for effective implementation and control [23] as till now alternative tourism is not massively developed in Crete.

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