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THE CARRYING CAPACITY AND ENVIRONMENTAL FRIENDLY PLANS FOR FUTURE TOURISM DEVELOPMENT IN RHODES ISLAND, GREECE

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Abstract

During the last decades, Greece has been emerged as a popular tourist destination providing high quality tourist services. Diverse landscape, extended sandy beaches, numerous archaeological sites, people's hospitality, filling of safety, and adequate infrastructure are some factors that have increased the touristic value of Greece. In particular, Rhodes Island, located in the southeastern Aegean Archipelagos, attracts more than two million (2.000.000) non-residents visitors per year that is approximately 10% of the Greek tourist product. The Carrying Capacity Assessment of Rhodes Island aims in finding different, high standards tourist activities, in order to maintain the growth of this sector. The required data (socio-economic and geographical) were analyzed according to the PAP/RAC methodology. In order to reduce the negative effects of tourism, different activities must be provided such as, hiking, biking, diving tourism, archaeological tourism, excursions in the remarkable natural environment. Furthermore, the redefinition of the urban planning will contribute to the decongestion of the

tourism concentration along with the environmental decompression, and it will contribute to the sustainable development of the island.

Keywords: *Carrying Capacity Assessment, Carrying Capacity indicators, sustainable development, environmental friendly based growth, Island of Rhodes*

1. INTRODUCTION

Greek tourism is one of the main pillars of entrepreneurship and growth of the Greek economy. Through rational practices and studies of the dynamics of tourism, the Greek economy can be helped to overcome successfully the present financial difficulties. Also, the latest Gross National Product (GNP) surveys highlight the need for tourism entrepreneurship to contribute to the sustainable economic, social and cultural development. The promotion and distribution of the tourism services offered, attracts new employees and investors, thus making it a rapidly evolving financial sector.

Over the last 20 years, tourism standards have been trying to match the social requirements for better environmental quality, using novice environmental practices, taking advantage of the cultural specificities for the benefit of the tourist development of the region. In order to determine the beneficial tourist load of a particular area, the World Tourism Organization defines the Carrying Capacity as ***"the maximum number of tourists who may visit a destination at the same time without affecting the economic, physical and social environment and not to limit the satisfaction of tourists"*** (Butler, 1997; UNEP, 1997; Fokiali et al., 2005; Tselentis et al., 2006; Klaric et al., 2007). The contentedness depends on resources, which they need protection. The total participation of Tourism in GDP was close to 9.3% in 2015 (IOBE; KEPE; Ikkos, 2015-SETE) and 18.6% (SETE) in 2016 with small differences but always with a positive impact on the Greek economy (Maroulis and Ikkos, 2016). In particular, tourism contributes positively to the growth and / or containment of the fall of GDP, as in the case of 2013 to -3.2% (SETE).

Greek tourism constitutes a noticeable difference, thus of the coastal areas, which add important criteria to the final decision of the tourists in order to visit a destination. Moreover, high biodiversity emphasizes the uniqueness of the carrying capacity of each region, since Greece is consisted of various landscapes (marine, littoral, coastal, mountainous, etc.). In the case of Greece as tourist destination, there are 9,835 islands and more than 15,000 Km length of coastline. If tourism in these areas will be developed without viable frameworks then the natural environment will be in danger of being degraded and the impact will also be negative in the tourist industry. The overburdened environment is a negative factor for the tourist development of a region. Each region therefore has different tolerance to the impact of tourism.

Rhodes presents diverse landscape; extended sandy, tourist orientated beaches, numerous archaeological sites and adequate infrastructures. It is located in the Southeastern Aegean Sea (Fig. 1) and it is the largest among Dodecanese islands as it covers 1.401 Km^2 (Prokopiou et al., 2014), it has a coastline of 253 Km, of which 151 Km consisted of low inclination, easily accessible beaches, suitable for tourist activities. Its direction is mainly from SW to NE and it lies at the eastern end of the zone where the Nubian plate is subducted under the Anatolian Plate along the Hellenic arc. Also Pliny and Strabo trenches, located in this area, are the result of a strike-slip deformation (Jolivet, 2000; Cornee et al., 2006; Anzidei et al., 2014; Milker et al., 2019). Therefore significant tectonic movements along with the presence of the Rhodes basin lying underwater (in 4000m depth) east of the island of Rhodes have been observed. Evidence of the tectonic activity are the uplifted notches located mainly in the eastern part of the island from 3.8m in height near the city of Rhodes but the decrease towards the Southwest (Stiros & Blackman, 2014) as a result of seismic events during Upper Holocene (Kontogianni

et al., 2002). Thus uplifted shorelines can be found around the island especially in the eastern part (Pirazzoli et al., 1989; Kontogianni et al., 2002; Anzidei et al., 2014; Howell et al., 2015). For this reason in the central-eastern and central-western part of the island high altitudes and steep relief can be found. Coastal cliffs are observed mainly in Monolithos, Siana, Kritinia and Lindos (figure 1) resulted from the local vertical tectonic movements and the relatively low weathering rates of the Alpine and Post-Alpine substrate (Pirazzoli et al., 1989; Higgins & Higgins, 1996; Kontogianni et al., 2002; Cornee et al., 2006; Lekkas et al., 2007). The hydrographic network has limited extend as it is dominated by the tectonic activity of the region. Most directions are from NW to SE and W to E. V-shaped valleys are depicted throughout the island due to the combination of the erosional and tectonic processes (Kontogianni et al., 2002; Verykiou et al., 2004). At the estuaries of the hydrographic network, beaches of different unconsolidated sediments, mainly sands and pebbles can be found due to the deposition from both the torrential and marine processes. Also in coastal areas sand dunes and beachrocks can be observed. All the abovementioned are some significant factors that increase the touristic value of the island and consequently of Greece (Vandarakis et al., 2018).

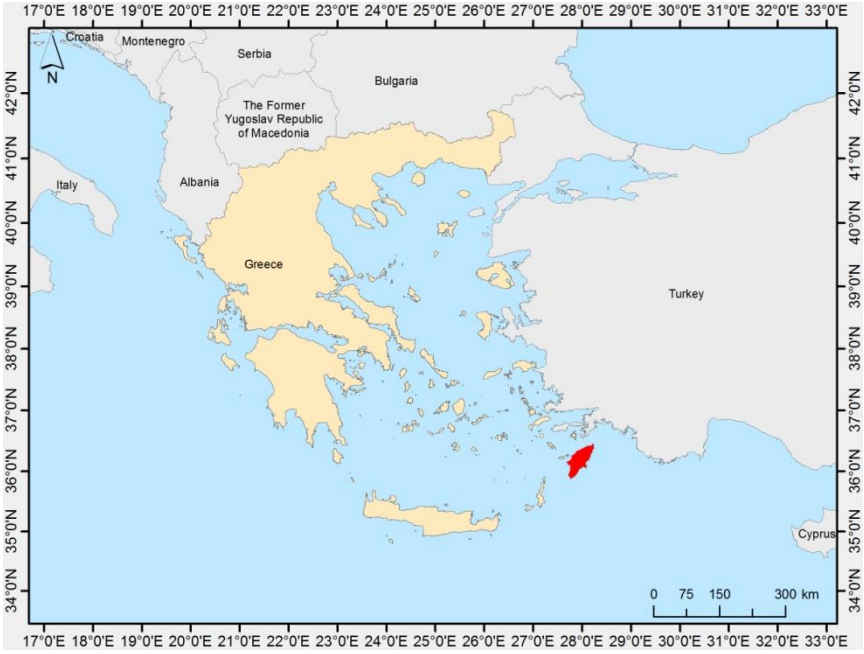

Figure 1: Location Map for Rhodes Island.

Besides the outstanding beauty of the natural environment, the medieval city of Rhodes is currently a UNESCO World Heritage Site enhancing the island's tourist value. Considering the abovementioned can be assumed that the Island of Rhodes is one of the most popular tourist destinations (Vandarakis et al., 2018) worldwide. The municipality of Rhodes is consisted of 10 municipality units after the implementation of Kallikratis law but the 48% of the population are residents of Rhodes town (Kyriakou et al., 2011a). Critical issues are detected at the island, which are related to technical and social infrastructure because of the intense tourism activity (Lazoglou et al., 2015).

Most of the tourist concentrations are observed in the Northern part of the island, which is a very saturated area, with crowded beaches, leading to environmental degradation (Kyriakou et al., 2017; Vandarakis et al., 2018).

In this study the tourism sector of Rhodes Island (Fig. 1) will be calculated and analyzed in relation to the population, the length and quality of the coasts, the tourist services, etc., in order to be integrated to spatial thinking, which is the knowledge, skills, and habits of mind to use

reasonable spatial concepts, maps and graphs, and processes to organize and to overtake issues (Gersmehl, 2005; Gonzalez, 2017). Spatial thinking (see Gersmehl and Gersmehl, 2006; Gonzalez, 2017) is important for investigating a range of environmental issues including land use management in urban environments (Gonzalez, 2017) and in coastal environments too. The determination of the Carrying Capacity of the coastal areas in the island of Rhodes will lead also to the possibilities in developing alternative tourism sectors.

2. METHODS

Carrying Capacity Assessment is one of the main techniques of the calculation of tourism assessment and management. Its main goal is to contribute to the decision making authorities, stakeholders and perfecture administration, for sustainable development of a specific area. Sustainability must fulfill four parameters, a) better environmental quality, b) better economic conditions, c) more engaged society and also d) a society which considers the rights for future generations (Gonzalez & De Lazaro, 2013). Incorporating Carrying Capacity Assessment (CCA) into the planning process of tourism and management is a necessity and should be taken as a set of guidelines for laying out tourism plans at all levels. A set of maximum desirable growth limits, which reflects the optimal use of tourism resources will be proposed.

Understanding the concept of Carrying Capacity Assessment in the field of tourism has evolved over recent years, with the aim of directing research into measurable physical and ecological - environmental parameters through socio-demographic and socio - cultural factors that they are not so easy to quantify (Klaric et al., 2003-UNEP; PAP, RAC, 1997; Fokiali et al., 2005; Tselentis et al., 2006; Tselentis et al., 2012; Lagos & Diakomichalis, 2014). In the context of efforts to strengthen the role of the state-administration in planning of the tourist development, mostly by increasing or restricting the economic measures (tax policy, construction of large-scale public infrastructure systems, etc.) and the handling and utilization of the CCA, especially in developed countries of the Mediterranean, mainly to which these guidelines are addressed. The general context for the quantification of the Carrying Capacity Assessment is based on three sets of parameters for the Mediterranean Tourism. These parameters are mainly (a) physical-ecological parameters; (b) socio-demographic parameters; and (c) political-economic parameters. Regarding the abovemetioned factors, the natural and ecological parameters can be considered as less important and they do not lead to safe conclusions.

The relation between the parameters is what matter most in terms of the overall framework of the Carrying Capacity Assessment, through an Integrated Coastal Area Management (ICAM) program. Therefore, when assessing the Carrying Capacity for Tourism, great importance is given to the relation of the socio-demographic, political and economic parameters, mentioned above, as they have been neglected in the past, mainly due to the significant difficulties encountered in their precise definition, as opposed to ecological parameters which, on the contrary, they are easily measurable. The research approach is based on the quantification, analysis and evaluation of PAP / RAC data (1991) (UNEP-PAP / RAC, 1997; Tselentis et al., 2012; Lagos & Diakomichalis, 2014; Panoussi & Soklis, 2015; Kyriakou et al. 2017), in order to come up with safer results - conclusions about the Carrying Capacity for Tourism of the island of Rhodes. The types of data collected for the current research were mainly, population data (permanent residents, non-residents, seasonal population, physical characteristics, geomorphological characteristics of the island, environmental data, total length of coastal area, environmental quality, infrastructures etc., economic data, available beds and number of arrived tourists in Rhodes per peak day). Therefore, the calculation of the Carrying Capacity of Tourism for the island of Rhodes, was carried out through five indexes. In particular, the indexes are: a) the total number of beds and their distribution per Square

Kilometer, b) Beach Impact Factor and the distribution of the inhabitants per Kilometer of Beach (length), c) Tourism Operation Index, d) Tourism Density Index, and e) Tourism Tolerance Population Index for the whole island.

Finally, the data gathered for the purpose of the current research, was quantified and calculated through the equations proposed by Tselentis et al., (2012), Lagos & Diakomichalis, (2014) and Panoussi & Soklis (2015). After statistical processing, the results presented and analyzed, as well as possible scenarios of sustainable development proposed for short and long term, for the island of Rhodes.

3. RESULTS

3.1. Total Number of beds of the island of Rhodes and their distribution per Km2

The total number of beds (per hotel and tourist accommodation) on the island of Rhodes is presented in Table 1, along with information on the total population and the area of the island. The total number of permanent residents (115.490) (census 2011, ELSTAT) were recorded on the island. The total number of Hotel beds (2016) and beds in different tourist accommodation types (2016) were about 101.608 in total. By making the calculations the result corresponds to 0,88 beds per person. So, if the number of beds is divided by the total surface of the island, it is estimated that in one (1) square kilometer (Km^2), up to 72,9 beds are located. At this point it should be noted that this indicator is generalized for the entire island, since in some areas with a higher concentration of hotel units or units of different tourist accommodation type (Rhodes, Afandou, Ialyssos, Kallithea, Kamiros etc.) (Tselentis et al., 2012) this result may vary. In some cases, hotel and tourist beds are far outnumbering the permanent residents of a specific region. In general, as shown in table 1, the number of beds per km^2 is high (Tselentis et al., 2012), indicating the great interest for the island of Rhodes during the last decades, making it one of its most valuable tourist destinations in Greece.

Table 1: Total beds and their distribution over the total area of the island of Rhodes (sources, ELSTAT, SETE, Tselentis et al., 2012).

Island of Rhodes	Permanent Residents (2011)	Hotel beds (2016)	Beds in different accommodation type (2016)	Total beds	Beds per inhabitant	Total area of Rhodes in km^2	Beds per km^2
	115490	87020	14588	101608	0,88	1398	72,9

3.2. Beach impact factor of the island of Rhodes, inhabitants per km of beach

Table 2 demonstrates the number of the permanent population, the total number of beds, the total length of the coastline, the total beds per km^2 as well as an indicator of the environmental impact of the beach, which is calculated by dividing the total number of people at the peak of the tourist season by the total length of the coastline.

The seasonal population at the peak of the tourist season is defined by the sum of the permanent residents and the possible maximum number of tourists which can be accommodated on the island, ie the total number of beds in hotel or non-hotel units. Consequently, 115.490 (permanent residents) plus 101.608 (beds-potential population that can be hosted) the result is 217.098 people (seasonal population of the island). The current beach

impact factor is defined by the fraction of the total seasonal population at the peak of the tourist season, to the total length of the coastline of the island. Thus, 217.098 (total seasonal population of the island) / 151.000 m (total coastline) = 1,44 people per meter of beach.

Table 2: Ratio of the number of inhabitants and tourists in terms of the length of the island's beaches (sources, ELSTAT, SETE, Tselentis et al., 2012).

Island of Rhodes	Beach length in Km	Permanent Residents (2011)	Hotel Beds (2016)	Beds in different accommodation type (2016)	Total Beds	Seasonal population	Total area of Rhodes (in km^2)	Beds per km^2	Beds per km of beach	Indicator of beach environmental impact (people-users per m of beach)	Tourists per kilometer of beach
	151	115490	87020	14588	101608	217098	1398	72,9	1092	1,44	673

At this point, it should be noted that this indicator is indicative and broadly describes the load on the total coastline of Rhodes. However, as it is known, the coastline is not accessible in its totality, as it divided in inaccessible or accessible beaches (depends on different geomorphology). These variations significantly affect the load ratio, as the number of people who are concentrated in each beach changes accordingly. This indicator also varies according to the tourist traffic and eligibility of each of them (areas with intense tourism or not). Thus, in a significant tourist area, the beach impact factor will be much higher than in another with limited tourist traffic.

Nevertheless, this indicator is already high (Tselentis et al., 2012) for the study area, if it is been considered that people is concentrated at certain sites, whose extent is quite limited due to the boundaries imposed by the natural relief (geomorphology), i.e. the coastal areas.

3.3. Tourism Operation Index (T.O.I.)

Tourism Operation Index is defined, as the indicator determined by dividing the total number of the available beds on the island of Rhodes with the total population, multiplied by one hundred (100) (Lagos & Diakomichalis, 2014; Panoussi & Soklis, 2015). This is calculated by the equation:

$$TOI = \frac{\text{Total Beds}}{\text{Population}} \text{ x } 100.$$

If the data is been replaced by the appropriate numbers, then the fraction is presented as follows:

$$TOI = \frac{101608}{115490} \text{ x } 100 = \mathbf{88}.$$

According to the limits proposed by Lagos & Diakomichalis (2014) the result of TOI indicating an area of significant tourism development compared with other economic sectors.

3.4. Tourism Density Index (T.D.I.)

The Tourism Density Index (T.D.I.) is defined by dividing the number of beds with the population (Lagos & Diakomihalis, 2014; Panoussi & Soklis, 2015). So the TDI is calculated by the equation:

$$TDI = \frac{\text{Beds}}{\text{Population}}$$

By doing the calculations, the result is:

$$TDI = \frac{101608}{115490} = \mathbf{0,88}$$

The result describes low level of tourist services and highlights the potential of more extensive tourist development (Lagos & Diakomichalis, 2014).

3.5. Tourism Tolerance Population Index (T.T.P.I.)

Tourism Tolerance Population Index (T.T.P.I.) is defined by the division of the number of tourists per peak day, with the total population of Rhodes (Lagos & Diakomichalis, 2014; Panoussi & Soklis, 2015). The Indicator of Tourist Tolerant Population is calculated by the equation of:

$$TTPI = \frac{\text{Number of tourists per peak day}}{\text{Population}}$$

The number of tourists per peak day is defined as the maximum number of beds on the island, since it corresponds to the number of tourists which can be received. Visitors owning holiday homes have not been calculated.

Thus, by replacing the data, the results can be calculated through the equation:

$$\text{TTPI} = \frac{101608}{115490} = \mathbf{0,88}$$

The results from TTPI correspond to an area that can receive large amount of tourists (Lagos & Diakomichalis, 2014)

4. CONCLUSIONS

Since the main occupations of the inhabitants of the island is linked to the tourism industry, as shown also by TOI, the calculation of the Rhodes Tourism Capacity is crucial. It is based on international and local reference standards and methods as described by the World Tourism Organization (WTO) and by corresponding work in various parts of the country (UNEP- PAP / RAC, 1997; Klaric et al., 2003; Lagos & Diakomichalis, 2014). The determination of the Carrying Capacity Indicators contribute to the delimitation and programming of suitable techniques and policies for the optimal and sustainable development of tourism. The designation of Carrying Capacity through indicators is based to a typology (Kyriakou et al., 2017), but is adapted according to the social-economic-geomorphological characteristics. The results of the data processing, which are presented as indicators, reflect the tourist reality of the island of Rhodes. According to the latter, Rhodes and, in particular, its northern part, receives the largest number of tourists, in terms of total tourist accommodation and foodservice (Tselentis et al., 2006; Tselentis et al., 2012; ELSTAT; Kyriakou et al., 2017, Vandarakis et al., 2018).

However, the growth of tourism can lead to a major environmental degradation (Kyriakou et al., 2017; Vandarakis et al., 2018), the limited coverage of the island by sewage treatment plants and landfill sites (70%) (ELSTAT) is also taken into account. This risk is visible; especially during periods of intense tourist concentration. Although the low values of TTPI indicate that larger number of tourists can be received (Lagos & Diakomichalis, 2014). Nevertheless, the tourist development and, as a result, the tourist load is not the same throughout the island but it is concentrated mainly in specific regions (Kyriakou et al, 2017). This is been delineated also by TDI, which in general, indicates the potential for tourism

development in Rhodes but not for the tourist overcrowded areas. Obviously, the indicators work best in the different regions individually, according to their distinctive features.

Various concerns are expressed regarding the need to find and apply new models of tourism development in areas that have not been developed (Kyriakou et al., 2017). It is necessary to design and implement a tourism development program based on environmental based tactics (Tselentis et al., 2012; Kyriakou et al., 2017). In particular, emphasis should be placed on the natural and cultural wealth of the island, as visitations to archaeological sites and museums, which have fallen lately (ELSTAT, SETE). A noticeable difference is present in the coastal areas where the highest environmental pressure is observed, as shown in the results. However, the littoral areas are those that should be protected since they are used intensively in Rhodes at a percentage of 5.4% of the generalized coastline and 3.7% of the measured coastline (from four and five stars hotels only) (Ikkos, 2016, SETE, Kyriakou et al., 2017). At the same time, the use and exploitation of the beaches and the seaside in general, bring enormous revenues to the local community and, to the state mostly through taxation. For this reason, modern strategies for the promotion and development of tourism follow socially and financially multidimensional axes in order not only to protect the natural wealth of a region, but also to achieve different types of tourism throughout the year. Apart from the natural environment, tourism development, should follow such axes as cultural tourism, diving tourism, health tourism, luxury tourism, sea tourism, conference tourism MICE (Mazoor, 2015), etc. (EOT, KEPE, Kyriakou et al., 2017).

From the calculation of the environmental indicators (Beach Impact Factor), a difficulty is arising mainly in the "environmental shift" of the tourist product of Rhodes. Which is however, necessary for the preservation of the high quality of the physical environment; this is the primary factor for the maintenance of the satisfaction of visitors-tourists, as well as to the inhabitants of the island.

Finally, in order to achieve good environmental policies in tourism activities, obstacles are present, such as the pressure in the coastal environment (Economou, 2007; Bianchi et al., 2014; Kyriakou et al., 2017). As a consequence, a reduction is obvious in its added value due to inadequate environmental protection (lack of waste-water management etc.), lack of political will, limited - nonexistent spatial planning. The high quality of the services provided (in terms of human resources and infrastructures) in relation to the environmental and natural advantage of the island, according to studies and surveys in the tourist preferences, place Rhodes as a desirable destination compared to its competitors (SETE). It is necessary, therefore, to have a concerted effort by the state and local factors on the island to adopt or use models of alternative tourism development (Kyriakou et al., 2011) from similar regions of Europe, or to implement a Greek model customized to the needs and the character of the island.

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