Coastal Zone Management: Tools for establishing a set of indicators to assess beach carrying capacity (Costa del Sol – Spain)

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ABSTRACT


Nowadays beaches are playing a major role in basic models of Coastal Zone Management. In recent years, because of the fundamental role of coastal tourism, which has created a remarkable pressure on beaches, recreational carrying capacity of beaches has been studied by several researchers. This paper presents applied research carried out during summer 2007, in one of the most famous Mediterranean tourist destinations, the Costa del Sol (Malaga, Spain). This study was part of a research project that aims to create a set of indicators for coastal zone management, considering different variables (ecological, social, economic and infrastructures). A central point is beach users’ perception, and understanding how they evaluate beach carrying capacity. Two types of beaches were sampled, urban and natural. The methodology uses quantitative tools and qualitative measures (digitized orthophotos, number of beach users, video images and interviews). A novel element is the use of digital photographs manipulated to quantify the maximum number of users that can be comfortable at the beach. The main findings to date are: (i) Development of a methodology to quantify beach carrying capacity (ii) The distinction between types of beach, services, equipment that are valued differently in relation to the threshold of saturation, (iii) The relationship between social carrying capacity of beaches and social carrying capacity of the resort (residents and tourists), which can enable the creation of an integrated system of indicators for coastal areas.

ADDITIONAL INDEX WORDS: Tourism, coastal destinations, perception

INTRODUCTION

The increase of time for leisure and recreation in recent years made the concept of carrying capacity a central research theme for social scientists (GRAEFFE et al. 1984, SHELBY and HEBERLEIN 1984, STANKEY, McCOOL 1984 and PEREIRA da SILVA, 2002, 2003). Problems like crowding and recreation satisfaction have been introduced as research issues, in order to measure the experience felt by people, and to define what has been identified as the recreational carrying capacity of places (CLARK, 1996; MANNING, 1999).

These problems became important in coastal areas, where tourism has increased dramatically, with harsh associated impacts such as traffic congestion, crowding, and pollution. At a first glance, defining the carrying capacity of these places seems to be easy in terms of physical carrying capacity, where the limits are set by the available space for building, the dimensions of the infrastructure (roads, water, electricity, etc.) and not by other kinds of constraints.

The evaluation of social carrying capacity limits is much more difficult to achieve (SCHREYER 1984), although it is clearly defined as the maximum level of recreational use, in terms of numbers and activities, above which there is a decline in the recreational experience, from the point of view of the recreation participant (PIGRAM, 1983). However, while this kind of correlation is easy to assume, i.e. higher densities – less quality, it is much more difficult to demonstrate it in the field, as people’s actual behaviour is often different from what they allege in response to surveys.

Studies of beach carrying capacity have been conducted for over 40 years (ANDRIC et al. 1962; An FORAS FORBATHA 1973, De RUYUCK 1997, YEPES 1998, PEREIRA da SILVA 2002, 2003). Theoretical and practical references exist for measuring beach carrying capacity, the factors that affect the saturation of beaches, periods of peak utilization, and the more intensively used beach zones (PEREIRA, da SILVA 2002), beaches that attract users who reject crowded places (e.g. in nature reserves), whereas others (e.g. urban beaches) may have a more intensive use (ROIG I MUNAR, 2003), attraction for services and support equipment such as security, parking, service installations (showers, rubbish bins etc.), cleanliness of the water and the sand etc.

The purposes of this study are:
1) to provide a users’ perception of what is beach saturation, and of what is important in defining Social Carrying Capacity (SCC1)
2) to establish the number of persons (in m² per person) that users are prepared to tolerate (SCC2) and, based on this, to
establish the maximum number of users that a beach can accommodate (Physical carrying capacity – PCC).

3) to compare the SCC of both residents and tourists in the Costa del Sol Oriental with the SCC1 of beach users and lastly 4) to develop methodologies, in the form of indicators, to evaluate beach carrying capacity.". The chosen method consists of various techniques: digital ortho-photos to define and delimit the sectors of a beach, counting beach users over time, video recording beach usage, and interviews using digitally manipulated photographs to quantify the number of users that can be accommodated on the beach. The importance of the investigation is the combination of methods with the novel use of photographs manipulated to measure beach carrying capacity, besides bringing to the literature a study based in a mature tourist destination of singular importance for being one of the most important in the Mediterranean. The final aim of this study is to help the search for warning indicators to improve beach management and thus meet the second objective of the Andalusian Strategy for the Integrated Management of Coastal Zones (EA-GIZC) which is intended to “have at its disposition appropriate instruments for a more integrated model of coastal management”.

CASE STUDY: THE COSTA DEL SOL

The results presented are part of a research project to develop a dynamic model capable of evaluating the carrying capacity of a resort so as to provide the authorities responsible for the management of the area, with a method that help planning the tourist development of a zone according to sustainable development. It was tried to create a system of indicators that measures the levels of different types of carrying capacity (ecological, physical and infrastructural, economic, and as perceived by residents and tourists). Methodologically, the project has two points of reference: 1) the system of indicators, with special reference to indicators of sustainability and 2) multi-criteria evaluation techniques.

STUDY AREA

The study area is the Eastern Costa del Sol (Malaga, Spain), delimited by the Mediterranean Sea to the south and surrounded by the Sierra Alhama, Tejeda, and Almijara National Park. With an area of 331km², a population of 147,637 and with 55km of coast and 37 beaches, of which 19 are urban, 12 semi-urban, and 6 natural. Of the five ‘county councils in the area Velez Malaga is the largest in area and population, besides being the zonal capital. Gordo.

Of the Costa del Sol, the Natural Park of the Cliffs of Maro-Cerro Gordo.

The physical setting has played a key role to the reputation of the area., thanks to sub-tropical climate (moderate temperatures and limited rainfall) and beaches that are found beneath the cliffs of the Costa del Sol, the Natural Park of the Cliffs of Maro-Cerro Gordo.

The results turned out interesting since the zone’s tourist development is directly linked to urban expansion, a common characteristic to other Spanish Mediterranean resorts. Before the arrival of tourism in the 1970s the economy was basically subsistence, fishing and very limited cottage industries there was a traditional agriculture that was barely profitable because of the physical characteristics of the area and the small properties. Only the development of intensive agriculture under small greenhouses had a future.

The study area did not had a formal planning process as growth was determined by the demands of tourism and, from the 1980s, the urban planning of each council, was unrestricted because of the absence of policies for control (between 1991 and 2007 an increase of 248% in tourist places and 60% in resident population). Nowadays is limited by the Regional Development Plan of the Costa del Sol - Axarquia. As result of that there was a strong transformation of the coastal landscape with environmental impacts that are now irreversible (loss of beach sand, modification of water courses, contamination of aquifers etc.) whereas the economic and social impacts were positive to the point of pulling the zone out of its chronic underdevelopment. Currently, urban planning is linked to Andaluzia Coastal Zone Strategy (EA-GIZC) which aims to create a management model that is more integrated with the territory.

METHODOLOGY

In the first stage of the project the most representative beaches of the resort were selected: urban, semi-urban, or natural (JUNTA DE ANDALUZIA, 2006) with the aim of, in the future, comparing the results obtained with the rest of the listed beaches. With the digital orthophotos integrated into a GIS was studied the characteristics of each beach (dimensions, sand type, accessibility, beach-side services, and support services both on the beach and between the beach and the urban centres. It was chosen the urban beach of Torre del Mar (in Velez Malaga), the semi-urban beach of Peñoncillo (in Torrox) and the natural beach at Cañuelo (Nerja) in the Junta de Andalusia’s designated protected zone at Acantilados de Maro-Cerro Gordo. Weather conditions prevented testing in the semi-urban beach (Aug.22 and 26, Sep.05 of 2007) ; the first two times because of changing weather and in the last due to late summer storms that had removed much of the sand, changing the pattern of demand and level of use making impossible to get a reliable Physical carrying capacity – PCC.

To determine the SCC based on the questionnaires two techniques were used:

1) the SCC1 was obtained by linking two questions, the first estimates congestion, which carries negative connotations i.e. the number of people in a place is too many and thereby a disagreeable experience. The second question concerns possible user attitudes, were they to perceive congestion; in this case the interviewee chose between five replies. Mixing both questions we obtain the users who perceive the congestion and are likely not to return to the beach because it would have reached its capacity. This indication of saturation was called the Current Risk Population (CRP).This indicator is an adjustment of recreational carrying capacity studies in the National Parks of the USA (SHELBY AND HEBERLEIN, 1986) and in Mediterranean coastal resorts (NAVARRO, 2005). Using the same method we measured the SCC of residents and of tourists in the resorts of Costa del Sol Oriental making possible an interesting comparison between the results by beaches and resort.

2) the SCC2 determines in m² how much space each beach user wants. This method was also used to verify the quality of recreational experience in protected areas (MARTIN, 1990; HEYWOOD, 1993; SHELBY E SHINDLER, 1992; MANNING, 2007) and in beaches (PEREIRA da SILVA 2002, ROIG E MUNAR 2003, TEJADA 2005). The innovation of this project is to determine the limit of use acceptable for the users through digitally manipulated photographs that showed the beach with different numbers of people, 5,10,15,20 m² per user.

To determine the PCC it was used the relationship between the number of users of the beach in the area of relaxation (m²/user) and the space desired for a use without detriment to the users of...
the beach (SCC2). To use this method was define 1) the total area of the beach (measured by digital orthophotos and the terrain (Jul 30 2007) 2) count the users of the beach (every hour to determine the frequency of use (in m²/user) using photographs and video recordings to verify the different uses of the beach over two days, in order to establish the distribution of visitors in each of the zones of use, which according to Roig (2003) are: 1) the transit zone; the entry/exit point to the beach, where the supporting services are located. 2) the relaxation zone (area used to define the PCC) where the users occupy a fixed point which is more or less in constant use. 3) the intensive use zone; where recreational activities occur and where users have access to the sea; the strip of sand starting at the water’s edge and reaching back to the relaxation zone.

Based on the results obtained with the questionnaires was analysed 1) the services offered by the beaches 2) the users’ perception of congestion, and 3) users’ preferences as to the limits of use of beaches. 133 questionnaires were made to beach users in the relaxation zones on mixed use days (a Sunday) and tourist use days (Thursday/Friday) in August 2007 (Torre del Mar: Aug 08 and Aug 12; Cañuelo: Aug 16 and Aug 19). To find the number of users, several countings were made to the people who were located in the relaxation zone on each beach at each hour; on the beach of Torre del Mar from 10.30-19.30 and at Cañuelo from 11.30-19.30. At the end of each count digital photographs were taken, in order to analyse the distribution of visitors in the relaxation, intensive use, and transit zones. Lastly, in order to analyse the distribution and use of space throughout the day, video recordings were made (morning and afternoon; 10 minutes each) at a panoramic site on the beach at Cañuelo and in two places on the beach at Torre del Mar where the physical structure (long flat beaches) made it difficult to gain a panoramic view from a single point.

RESULTS

To establish the PCC the use of the beach (photography and video recordings) was analyzed and established that the division of the beach according to Roig (2003) was valid for this study area. This classification does not take tides into because of their low significance in the Mediterranean. After delimiting the relaxation zone of each beach (Torre del Mar 12,129 m² and El Cañuelo 5,856 m²) was analysed the distribution of users by hour, which showed that the greater concentration of people in Torre del Mar occurred on a holiday between 12.00 and 13.30 with 2159 users. Distant from the urban centres and lacking transport connections the beach at Cañuelo requires the use of private vehicles for access and the major concentration of visitors occurs between 14.30 and 16.30. As suggested by Tejada (2005) peaks and troughs in usage are typical of urban and semi-urban beaches, whereas sine curves are characteristic of natural beaches, as shown in figure 2.

With respect to the limit of acceptable use as perceived by beach users (SCC2), the average limit across the study area was 11m²/user with notable differences between the urban beach (6m²/user and 1564 users at a time) and the ‘natural’ beach (15m²/user and 397 users). Based on the data for maximum capacity the PCC was exceeded in Torre del Mar in the middle of the day (1230hrs.) as much on tourist days as on non-tourist days (in this latter case it reached an average user level of 5.6m²/user) and in Cañuelo the PCC limit, which we established at 397 users at a time, was never exceeded. On the urban beach the levels of PCC and SCC2 were very close; enough to make us understand the need to control the levels of use of this beach unlike Cañuelo where the critical levels were far from being reached. These results are comparable with the studies of Roig (2003, 113), Yepes (1999), or Pereira da Silva (2003) amongst others. For example Roig (2003, 113) on the beach of San Laura (Menorca-Spain) observed that the natural beaches were accustomed to have problems with equipment and services for visitors, nonetheless this can mean that ‘natural’ beaches have a more adequate capability to preserve themselves.

To establish the maximum capacity of people on the beach serves as a basis to analyse the perception of users in respect of spatial saturation, an aspect dealt with in other studies (PEREIRA da SILVA 2002, ROIG i MUNAR,) nevertheless, to consider that
Table 1. Beach users’ opinion of services and support

<table>
<thead>
<tr>
<th>Serviços / Praias</th>
<th>Torre Del Mar</th>
<th>Cañuelo</th>
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</thead>
<tbody>
<tr>
<td>Sand cleanliness</td>
<td>3.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Water cleanliness</td>
<td>2.8</td>
<td>4.0</td>
</tr>
<tr>
<td>Public Transport</td>
<td>3.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Entertainment</td>
<td>3.0</td>
<td>2.5</td>
</tr>
<tr>
<td>Landscape</td>
<td>3.7</td>
<td>4.6</td>
</tr>
<tr>
<td>Parking</td>
<td>2.1</td>
<td>3.6</td>
</tr>
<tr>
<td>Life saving equipment</td>
<td>2.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Immediate support</td>
<td>3.0</td>
<td>1.7</td>
</tr>
<tr>
<td>Global satisfaction index</td>
<td>2.9</td>
<td>3.2</td>
</tr>
</tbody>
</table>

a space is congested implies a ‘rejection effect’ from the beach. However, it is necessary to make a more profound analysis and to consider hypothetical reactions to this phenomenon. In this investigation was tried to understand if the users may be pre-disposed to go to a beach although it may have ‘too many people’. That is what was determined in the SCC1 and where the combination of responses defined four groups of users:

1) those who do not perceive the congestion on the beaches and, if they were to see it, would not be influenced to discontinue using the space.
2) those who perceive a level of saturation, but would not let that affect their inclination to continue using the area for tourist or recreational activities.
3) those who do not perceive the congestion of the selected space, but if they were to, would be pre-disposed to cease using the beach.
4) those who perceive the congestion and are inclined to leave the beach because of the saturation of the space they use. This group has lowered the threshold of the social carrying capacity.

The perception of social carrying capacity, as seen by people on the beach (SCC1), shows that 19% of beach users at Torre del Mar and 5% at Cañuelo exceed the perceived capacity level. These people is named “Current Risk Population”. The different perceptions of congestion are objective in that the beach at Torre del Mar has almost 8 times the people at Cañuelo, nonetheless existing data show that other differences depend of the expectations of the type of user and their disposition to accept more or fewer people and therefore group1 amount to 26% in Torre del Mar and group3 is notably greater in Cañuelo given that they do not perceive congestion, and if they were to perceive it, they would be inclined not to return. Also there are physical differences (sizes and form of the beach) between the two beaches and of supporting facilities (see table 1 and 3).

The Integrated Coastal Zone Management of these spaces should not be exclusively orientated towards beach carrying capacity. Given that the restructuring of the coastal areas involves the integration of all the elements of the area, it is necessary to bear in mind all the space, and think of the resort as a whole. It is something of a novelty in this type of study to compare the carrying capacity of beaches with the social carrying capacity of the resort according to the opinions of residents and of tourists. Remembering that the three questionnaires used the same methodology and thus the data are comparable, the result shows that of the three elements analysed, the tourists are the more sensitive to the problems of saturation in the resort (20% of the CRP) according to beach users at Torre del Mar, although the residents are not concerned by the congestion of the area due to tourism, given that more than 43% belong in group 1.

The final objective of this research is to transform these data into indicators that can be extrapolated to other studies and for that was used the DPSIR model. It was propose 18 beach indicators as seen in table 4. These indicators are complemented by other groups of indicators in the study area (ecological, physical and infrastructural, economic and social, of residents and from tourists) making over 100 which provides an excellent source of information for a more integrated management of coastal zones.

CONCLUSIONS

Studies of beach carrying capacity should be applied to coastal zone management policies for two reasons; firstly for the creation of ongoing and efficient diagnostics and secondly to integrate these indicators with reality taking into account other variables that affect the coast directly and indirectly. For this it’s proposed the creation of a system of beach indicators that integrates other indicators of regional carrying capacity. This investigation provides a new advance of integration using a case study in a tourist destination that has all the complexity that this seasonal and spatially strongly aggressive activity implies.

The study also confirmed certain previously published hypotheses e.g. the daily periods of greater use, and the zones of each beach that have the most intensive use (PEREIRA da SILVA, 2002), and that the typologies of beaches determine the profile of demand and the opinions that a user has about the phenomenon of beach congestion (ROIG E MUNAR, 2003) One of the results obtained is that urban beach users accept a usage twice as intensive as in natural beaches an point that is particularly useful for planning, and for extrapolating the results to other study areas.

The debate in the scientific community over whether the carrying capacity is a real workable concept, and whether it should express itself in qualitative and quantitative terms is no longer needed.

This study propose that it is necessary to be able to establish more integrated and sustainable policies, because the final objective is not only to establish some limits but that the methodologies of capacity serve to create more advanced diagnostics and projections.

ACKNOWLEDGEMENTS

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Table 4. DPSIR model of indicators for beach carrying capacity

<table>
<thead>
<tr>
<th>Driving Force</th>
<th>Indicators of Pressure</th>
<th>Indicators of condition</th>
<th>Indicators of impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st. Total number of users of Torre del Mar (Aug.08 and Aug.12 . 2007)</td>
<td>7.947-8.524</td>
<td>7a. Social CC of the beach at Torre del Mar (mt²/user)</td>
<td>7,8</td>
</tr>
<tr>
<td>2nd. Total number of users of Praia de Cañuelo (Aug.16 and Aug.19 . 2007)</td>
<td>874-1.517</td>
<td>7b. Social CC of the beach at Cañuelo (mt²/user)</td>
<td>14,8</td>
</tr>
<tr>
<td>3rd. Resort tourist load (August 2007)</td>
<td>198.241</td>
<td>8a. Physical CC of the beach at Torre del Mar (mt²/user) (12.30h on Aug.12 . 2007)</td>
<td>5,6</td>
</tr>
<tr>
<td>5th. Change in resident load (2002-07) (%)</td>
<td>21,6</td>
<td>9a. Social CC of beach users at Torre del Mar (%)</td>
<td>18,8</td>
</tr>
<tr>
<td>6th. Change in resident load (2002-07) (%)</td>
<td></td>
<td>9b. Social CC of beach users at Praia de Cañuelo (%)</td>
<td>4,8</td>
</tr>
<tr>
<td>7th. Change in resident load (2002-07) (%)</td>
<td></td>
<td>10. Social CC of resort residents (%)</td>
<td>11,9</td>
</tr>
<tr>
<td>8th. Social CC of resort tourists (%)</td>
<td>20,1</td>
<td>11. Social CC of resort tourists (%)</td>
<td></td>
</tr>
<tr>
<td>9th. Social CC of beach users at Praia de Cañuelo (%)</td>
<td>2,9</td>
<td>12a. Satisfaction index of beach users at Torre el Mar</td>
<td></td>
</tr>
<tr>
<td>10th. Social CC of resort residents (%)</td>
<td></td>
<td>12b. Satisfaction index of beach users at Cañuelo</td>
<td>3,1</td>
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<table>
<thead>
<tr>
<th>Indicators of Impact</th>
<th>Indicators of Response</th>
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</thead>
<tbody>
<tr>
<td>13a. Tourist/Resident Ratio at Praia de Torre del Mar (August 2007)</td>
<td>67</td>
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<tr>
<td>13b. Tourist/Resident Ratio at Praia de Cañuelo (August 2007)</td>
<td>8,7</td>
</tr>
<tr>
<td>14. Tourist/Resident Ratio of the resort (August 2007)</td>
<td>1,3</td>
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<tr>
<td>15a. Bathing water quality class at Torre del Mar</td>
<td>2</td>
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<tr>
<td>15b. Bathing water quality class at Cañuelo</td>
<td>2</td>
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<table>
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<tr>
<th>Indicators of Response</th>
<th>Indicators of condition</th>
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<tbody>
<tr>
<td>16. Investment in the coast (Province of Málaga)</td>
<td>5.453.634</td>
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<tr>
<td>17. Number of blue flags</td>
<td>2</td>
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<tr>
<td>18. Number of offences against the norms for use and management of beaches</td>
<td>s/d</td>
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