

## The Management of Beach Carrying Capacity: The case of northern Portugal.

C.P. Silva †, F. L Alves ‡ and R. Rocha ∞

† e-GEO, Geography and Regional Planning  
Research Centre, New University of Lisbon  
Lisboa, 1069-061  
Lisboa, Portugal  
cpsilva@fesh.unl.pt

‡ Centre for Environmental and Marine Studies  
University of Aveiro  
Aveiro, 3810-193  
Aveiro, Portugal  
malves@dao.ua.pt

∞ DHV/FBO Consultants S.A.,  
Lisboa, 1495-131  
Algés, Portugal  
romana.rocha@dhvfbo.pt



### ABSTRACT

SILVA, C. P., ALVES, F. and ROCHA, R., 2007. The Management of Beach Carrying Capacity: The case of northern Portugal. Journal of Coastal Research, SI 50 (Proceedings of the 9th International Coastal Symposium), 135 – 139. Gold Coast, Australia, ISSN 0749.0208

The rapid growth of coastal tourism that has been seen in the last 40 years is frequently described as one of the major reasons for the development of these areas and also as responsible for many current coastal problems.

The beaches perform, in this context, a fundamental role where the issues related to planning and management are increasingly more important when it comes to an implementation of a sustainable development philosophy. In these circumstances, concepts such as carrying capacity need to be used in a careful way.

In Portugal, where coastal tourism plays a major part for the national economy, the management of beaches is crucial for maintaining their quality and therefore continuing to attract tourists. Since the 1990s, with the application of Coastal Zone Management Plans to the whole Portuguese coast, beach plans are now required. In those plans various parameters are considered, from the type and location of equipment and parking lots, to the definition of beach carrying capacity.

This paper explores the results of the implementation of these plans to the beaches of northern Portugal. This part of the coast is very dynamic with high erosion rates. Some of the interventions from the Plans changed part of the characteristics of the beaches making it necessary, in some cases, to re-calculate the carrying capacities that were initially proposed, bringing new challenges to their management. This paper aims to stress the validity of the carrying capacity concept as applied to beaches, taking into account the need to use the concept in a flexible and dynamic way.

**ADDITIONAL INDEX WORDS:** *Beach, Coastal Management, Carrying Capacity*

### INTRODUCTION

The increase in value of coastal areas for the leisure and recreation of millions of tourists worldwide is ever more relevant, this being the most expanding sector in the global economy at over 5% p.a. and 800 million tourists recorded in 2005 (WTO, 2005). The dynamism of this sector is also seen in the income generated which, in 2005, reached over 680 billion dollars, almost 2 billion a day. This income has more than doubled between 1990 and 2005, a rate of increase unknown in any other sector. Much of this is due to coastal tourism which, with its associated activities, represents a major source of wealth for the coastal areas, but at the same time a proportional share of the environmental problems. In Portugal these problems are increasingly a matter of concern because tourism, most notably beach tourism, is a key sector in the economy with over 11 million tourists recorded in 2005 (DGT, 2006). This has led to a major intervention by the State, in particular in relation to the creation of plans to improve the organisation of this space; the Coastal Zone Management Plans (Planos de Ordenamento da Orla Costeira, POOC's). As a result of that the concept of Integrated Coastal Zone Management, and the definition of beach carrying capacity, are two of the most pressing matters to be considered for a sustainable utilisation of beaches.

### COASTAL MANAGEMENT IN PORTUGAL

Portugal has over 900 kilometres of mainland coast; a coast of high environmental and landscape value, as is demonstrated by 35% being classified as protected area and integrated into the National Network of Protected Areas.

It is therefore no surprise to find that this coast is subject to intense pressures. Over the last forty years the concentration of 75% of Portugal's population on the coast and urban, industrial and touristic areas producing 85% of the GNP, has led to profound coast-interior asymmetries (CNADS, 2001).

These pressures can translate into a range of problems in different fields such as:

- **Coastal Planning and Management** – allowing undue chaotic and casuistic construction, at times in hazard areas, with all the problems inherent therein, leading to a landscape degradation and all problems associated;
- **Erosion** – a result of using hazard prone areas, interference with the line of the coast and reduction of the principal rivers' sediment supply. Currently erosion seriously affects over 30% of the Portuguese coastline (CNADS, 2001);
- **Pollution** – rapid urban increase without adequate infrastructure provision, notably a lack of waste-water

treatment plants, is responsible for pollution of coastal and estuarine waters.

Thus the importance of the creation of Coastal Zone Management Plans (POOC's) (Decreto-Lei 309/93) is understandable. These plans have as their objective the definition of conditions, uses and the location of infrastructure in a coastal belt which, for the management of the coast of Portugal, has been determined as being from the 30 metre submarine contour to a line 500 metres inland from the coast.

Despite the great importance of these plans, the results have fallen short of expectations. This was, firstly, because the coastal plans often conflicted with the local authorities' Municipal Master Plans which had already been approved by central government, and secondly, because of the lack of financial capability to implement many of the intended activities. Even so, it is fair to say that without the POOC's the Portuguese coast would be in a much worse condition nowadays.

### THE CARRYING CAPACITY CONCEPT

It was with concern, and recognition of the need to understand coastal systems in terms of developing sustainable tourism, that the concept of carrying capacity arose in the context of tourist areas; the intention being to avoid the saturation levels that both put natural systems at risk and disturbed the users' quality of enjoyment.

The development of various studies of the carrying capacity of tourist areas confirmed the importance of this concept for the understanding of the limits of acceptable development and began to assemble quantitative measures of spatial utilisation suitable for translation into levels of saturation.

In the case of beaches, their planning and management will depend on innumerable factors, but without doubt one that should be a condition in terms of utilisation is the carrying capacity. The importance of this indicator is fundamental in that as the recreational use of a beach intensifies, the quality of enjoyment for the users can diminish.

The already mentioned massification of coastal tourism, beginning in the 1960s, brought about various studies of the carrying capacity of beaches which sought essentially to provide indices of utilisation (PEREIRA DA SILVA, 2003).

Analysis of studies of the carrying capacity of beaches shows that its calculation cannot simply be a division of area of sand available for beach users by a value of  $xm^2/person$ . Many factors are involved, such as:-

- Surroundings – accessibility, parking space, local accommodation, infrastructure and facilities;
- Beach – access, depth, sea frontage, tidal range cleanliness, security and sea conditions;
- External factors – climate, season, date, time and users' expectations

The increasing importance which has come to be attributed to these features means that they have to be seen as determinants in evaluating methods for optimising the social and ecological functions of beaches. Being a very important tourist resource, subject to heavy demand over very short periods of time, and integrated into a competitive market, the aspects of beaches previously referred could, without doubt, serve to identify the qualities most appreciated by users (meeting expectations without

compromising beach equilibrium) and to evaluate the effectiveness of the implementation of management measures.

In effect, the economic importance which beaches have today requires us to consider them as an important productive factor. In Spain, beach tourism is responsible for 74% of foreign tourism (YEPES, 1998) and in the USA it is calculated that the beaches may be responsible for an annual income of over 170,000 million dollars. However these are not limited to a fixed capacity which, in its turn, also conditions the touristic increase in a given locality. In the face of this reality the study of beaches becomes crucial for an understanding their utilisation and from that, gaining better management.

It is the combination of all these factors that is necessary for calculating the carrying capacity of a beach. Clearly, other factors could still be considered subsequently (e.g. the ecological sensitivity of the surroundings of a beach can limit its use) remembering that carrying capacity should be managed in line with planning objectives.

### CASE STUDY – THE COAST OF NORTHERN PORTUGAL

On the basis of specific physical characteristics, the coastal zone of Portugal mainland has been divided into 9 distinct stretches each having its corresponding Coastal Zone Management Plan (Figure 1). The Caminha-Espinho sector is included in the northern coast of Portugal; around 110 kms. of coast with many beaches, over one hundred suitable for bathing and with intense demand in summer. However, because of its geographical location there is an evident climatic instability and the sea-water temperature rarely exceeds 17-18°C. which, in part, affects bathing activity.

This plan was the first to be developed, being approved in 1999, and after seven years of its implementation the number of infrastructures, given the local population's demand for these leisure zones and the condition of equipment available to support the beaches, was clearly not enough. In effect the areas and services predicted for supporting the beaches were inadequate for a sustainable economic development of the activities anticipated in the Coastal Zone Management Plan.

Therefore, in 2006 it was decided that the plan should be under revision in order to adequate the equipments and infrastructures already existing to the actual demand of those beaches, according to more updated criteria's.

According to Law n.º 309/93, of 2<sup>nd</sup>. September beaches are classified in the following way:

- Type 1 – Urban Beach with intensive use;
- Type 2 – Non-Urban Beach with intensive use;
- Type 3 – Infrastructured Beach with conditional use;
- Type 4 – Non Infrastructured Beach with conditional use;
- Type 5 – Restricted use beach;
- Type 6 – Prohibited use beach.

For each classification there is different criteria's, associated to measurement of the carrying capacity of the beach, with the first ones, type 1 and 2, associated to a more heavy demand and so supporting higher densities. The other types are the ones that presented some environmental sensitivity and therefore must be carefully managed. The last one, type 6, is the case of beaches that for some reason are not presented safety conditions for beach users.

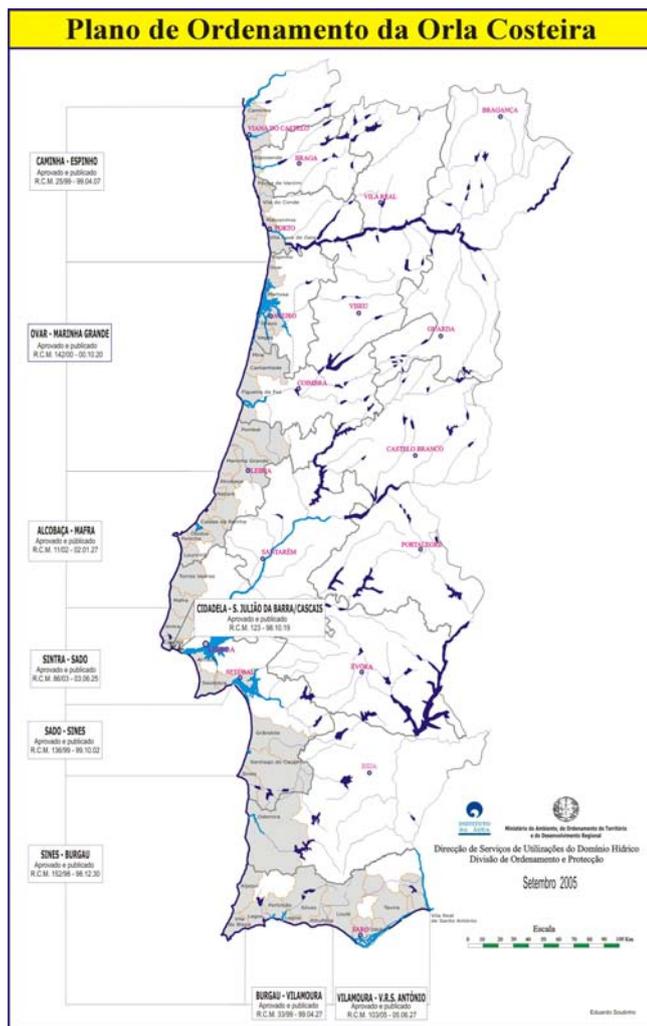


Figure 1- Portugal mainland and the Coastal Zone Management Plans associated

Bearing in mind that the classification of beaches was one of the main factors for the changes needed to the POOC Caminha-Espinho Plan, it was crucial to evaluate the various beach components e.g. the nature of the surroundings, access etc., before recalculating the carrying capacity. In the end it was decided to measure the carrying capacity for all the beaches because of the following factors:

- the coastal zone has a dynamic of its own such that, on returning about eight years after the development of the beach plans, significant differences in the configuration of the beaches were found.
- nowadays, it is possible, by using georeferenced aerial photographs and a cartographic base map at 1:2000, to more rigorously measure the available area of sand and so determine in a more accurate way the carrying capacity of the beach.

The re-evaluation of the classification and capacity of the beaches was carried out using the following methodology:

- 1) Define the available sandy area of all the beaches
- 2) Identify the type of changes proposed (type of beach and equipments and infrastructures required)
- 3) Analyse the re-evaluation of beach type
- 4) Calculate the theoretical carrying capacity for use

The aim of this analysis was to evaluate whether the issues that caused the changes observed were just the result of the methodology previously used, or a result of significant changes in the area.

The definition of the available sandy area of all the beaches was based on aerial photography from 2001 and 2002. Then the available area of sand of each beach was re-delimited to evaluate subsequent changes in this descriptor.

According to the current Coastal Zone Management Plan, the area of sand available for beach users consists of the area measured above the high-water mark, to distinguish the permanently dry sand areas from those under water for part of the day, and excluding sensitive zones and hazard areas. In the majority of cases the width of the beach is the distance from the point of access to the high-water mark.

However, in the Coastal Zone Management Plan approved in 1999 the delimitation of the available area of sand was, in effect, made taking into account only the distribution of beach users and the existence of sand. Given the subjectivity of this criterion an attempt was made to validate and standardise this delimitation, either by inspecting the distribution of the beach users and considering a maximum distance to the point of access of 250m. – a criterion generally used in the field of carrying capacity calculation, this is the maximum distance that beach users are prepared to walk on the beach.

From the measurement of the available area of beaches it was established that, although in some situations this descriptor was reduced, in general it as increased. The increase was found to be associated with greater rigour in delimitation, the result of using more accurate information such as the 1:2000 cartography and georeferenced aerial photography and considering this time the 250 m buffer from the point of access to the beach.

Meaning that the increase in the available area of sand does not imply automatically an increase in the width of the beach that, compared with 1999, is far from having occurred since what was verified was a reduction of sand. The increase in the useful area of the beach (in relation to the current Coastal Zone Management Plan) shows itself not in an increase in the depth of the beach but in its length. This can be clearly seen in Figure 2, where it can be seen the difference between the measurement from the work made in 1999 and the one made in 2006.

Given these new elements, and after the calculation of the available e area of sand, the theoretical carrying capacity was calculated.

The theoretical carrying utilisation capacity of a beach is the maximum number of people that can use the beach without reducing conditions below an appropriate standard. The relevant parameters for calculating the capacity vary according to the type of beach, and take into account areas subject to permission and prohibited areas, as can be seen in the following table.

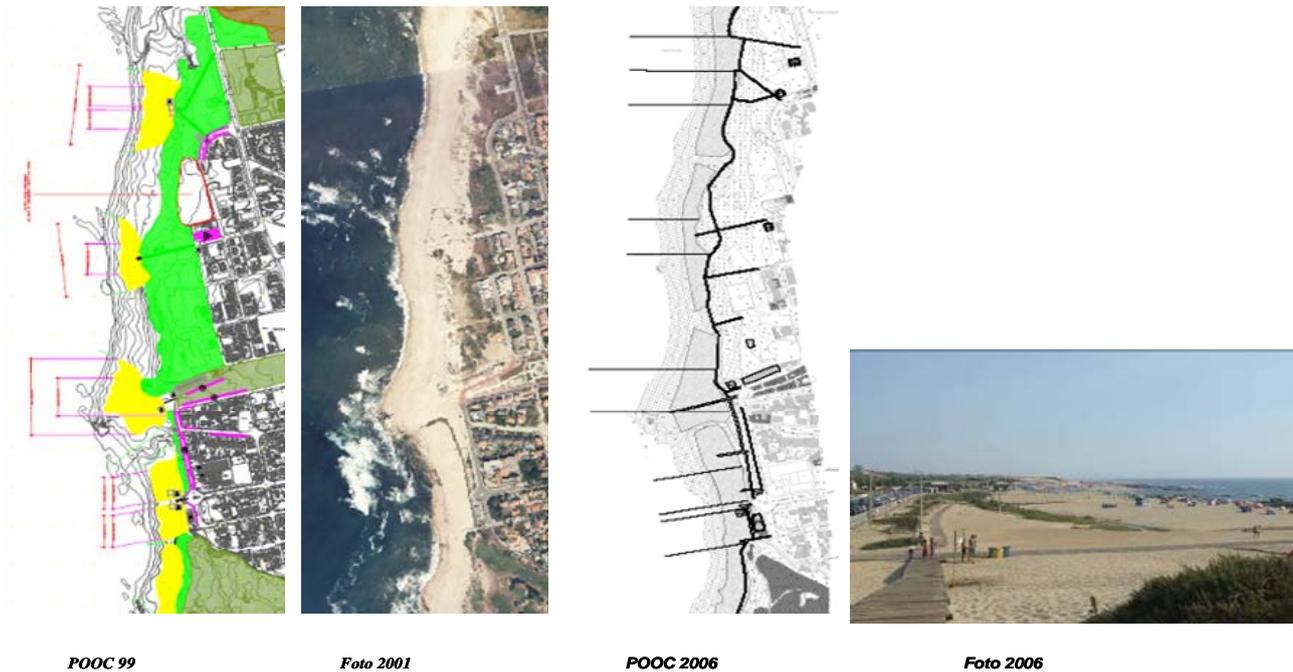


Figure 2- Comparisons between beach areas in the plan of 1999 and the measurements of 2006

Typology	Theoretical beach carrying capacity
I – Urban Beach with intensive use	Available area of sand under commercial concession/ 7,5 m <sup>2</sup> + Other Available area of sand not under commercial concession / 15 m <sup>2</sup>
II– Non-Urban Beach with intensive use	Available area of sand under commercial concession/ 15 m <sup>2</sup> + Other Available area of sand not under commercial concession / 30 m <sup>2</sup>
III, IV – Non Infrastructured Beach with conditional	Available area of sand/15 m <sup>2</sup>

Table 1 – Parameters for assessing beach carrying capacity

From the analysis of these parameters the conclusion was that the carrying capacity of the beaches increased in the majority of the cases. It should nonetheless be mentioned that in some cases the theoretical carrying capacity of a beach is not identical to the carrying capacity proposed in the plan because, for example, in some cases the existing parking facilities is not sufficient to meet the theoretical demand. In such cases the carrying capacity is reduced, based on indices of 3.5 individuals per car and 25 m<sup>2</sup> per car.), as exemplified in Figure 3.

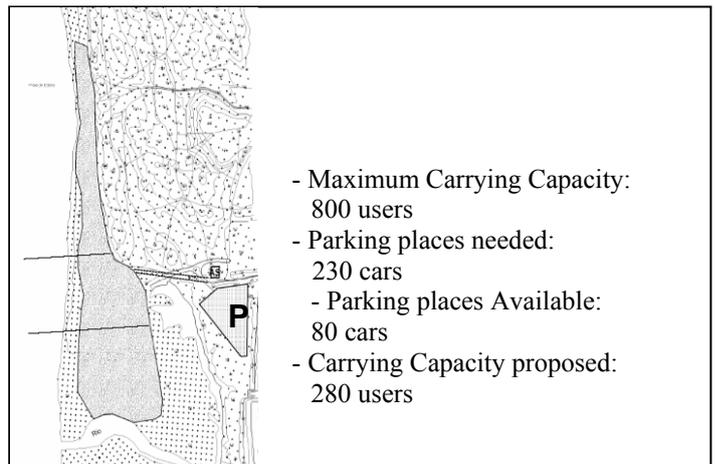


Figure 3 - Example of Carrying Capacity adapted to Parking Capacity

Thus in the example given, a beach with a potential capacity for 800 users sees its capacity reduced to around 280 because its parking capacity is only 80 cars. Obviously, this value could be changed if the parking were to be altered or a policy of public transport were to be adopted.

**CONCLUSION**

Defining the carrying capacity of a beach is undoubtedly a complex issue, where consensus is hard to achieve. From all that's been said, it is clear that the carrying capacity of the beaches cannot be defined only according to the capacity of the sand area of the beach, as carrying capacity can be conditioned by other factors such as parking facilities.

The carrying capacity of a beach cannot be expressed as a fixed and rigid value; on the contrary, as defined by other authors (DE

RUYK *et al.*, 1997), it should oscillate between two tolerable thresholds, allowing management in an integrated, flexible and sustainable way. In the case presented, it's interesting to note that after the Plan had been implemented, the local conditions changed meaning that the carrying capacity of those beaches has changed too. This not only emphasises the importance of the concept of carrying capacity, but also the need for it to be assessed carefully, but flexibly.

### LITERATURE CITED

- CNADS (Conselho Nacional do Ambiente e do Desenvolvimento Sustentável) (2001). Reflexão sobre o Desenvolvimento Sustentável da Zona Costeira. Lisboa, CNADS: 57.
- DE RUYCK, M.C.; SOARES, A.G.; and MCLACHLAN, A. (1997) Social Carrying Capacity as a Management Tool for Sandy Beaches. *Journal of Coastal research* (13) 3 822-830
- DGT (2005) Direção Geral do Turismo. [www.dgt.pt](http://www.dgt.pt)
- HOUSTON, J. R. (1995). "The economic value of beaches." CERCULAR CERC-95-4(December 1995): 1-4.
- INE (2001). Censos 2001. Resultados preliminares da Região do Alentejo.
- IOOC Intergovernmental Oceanographic Commission (1999)
- IOC-SOCA International Workshop on Coastal Megacities- Challenges of Growing Urbanisation of the World's Coastal Areas. Workshop report n°. 166. Paris
- KAY, R., ALDER, J. (1999). *Coastal Planning and Management*. London, Routledge.
- MARTINS, F. (1997). Políticas de Planeamento Ordenamento e Gestão Costeira. Contributo para uma discussão metodológica. Tese de Doutoramento. Universidade de Aveiro, Aveiro.
- PEREIRA DA SILVA (2003) "Gestão Litoral: A Integração de Estudos de Percepção da Paisagem e Imagens Digitais na Definição da Capacidade de Carga de Praias – O Troço Litoral S.Torpes-Ilha do Pessegueiro ". Tese de Doutoramento, Universidade Nova de Lisboa, Lisboa.
- UNESCO (2001) "Oceans and Coasts at Rio + 10. Towards the 2002 World Summit on Sustainable Development at Johannesburg. Ensuring the Sustainable Development of Oceans and Coasts. A Call to Action". Global Conference, Co-Chairs Summary, UNESCO Paris, 3-7 December.
- WRI (World Resources Institute) (2001) *Pilot Analysis of Global Ecosystems – Coastal Ecosystems*, Washington
- YEPES, V. (1998). *Planificación e Gestión Turística de Playas*, Cedex, Madrid.