



UNIVERSITY OF ALGARVE
Faculty of Science and Technology

**TOURISM CARRYING CAPACITY ASSESSMENT AS A
TOOL TO SUPPORT COASTAL MANAGEMENT**

A pilot survey at two mass tourism beaches

ERASMUS MUNDUS EUROPEAN JOINT MASTER IN
WATER AND COASTAL MANAGEMENT

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**TOURISM CARRYING CAPACITY ASSESSMENT AND MANAGEMENT AS
A TOOL TO SUPPORT COASTAL MANAGEMENT: a pilot survey at two mass
tourism beaches**

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“Life cannot be sustained under the wanton destruction that is occurring along this precious coastline and around the World in general” (Unknown Author, Unknown Place)

TO ALL CARING FOR THE EARTH

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DECLARATION

I declare that the thesis hereby submitted in partial fulfilment for the requirements of the degree of Master of Science at the University of Algarve has not been submitted for any other degree at any other institution.

Faro, 19th April 2010

(Daniel Augusta Zacarias)

RESUMO

Os recursos costeiros são um componente importante para actividades recreativas. Com as actividades turísticas se desenvolvendo no mundo inteiro, as praias ficam cada vez mais lotadas, com as conseqüentes ameaças aos ecossistemas locais e as populações locais, o que exige medidas apropriadas de gestão dos recursos, garantindo a qualidade da experiência e a satisfação dos usuários. Este projecto teve como objectivo determinar a capacidade de carga turística da Praia de Faro (Portugal) e da Praia do Tofo (Moçambique), baseando-se na combinação do modelo da avaliação da capacidade de carga de Cifuentes (1992) e abordagem PAOT (Manning, 2002) e fundamentando-se em levantamentos de campo, contagens de turistas, características biofísicas intrínsecas aos locais e questionários. Os resultados demonstram que a capacidade de carga físico-ecológica encontra-se entre 1,491 e 3,558 visitas/dia (na Praia de Faro) e entre 5,301 e 10,601 visitantes/dia (na Praia do Tofo) com curvas de aceitabilidade de impacto variando entre 305 e 608 usuários (respectivamente para a população local e turistas na Praia de Faro) e entre 358 e 714 usuários (respectivamente para a população local e turistas na Praia do Tofo). Os resultados deste projecto demonstram que a capacidade de carga físico-ecológica pode ser aplicada num contexto de gestão de ecossistemas, enquanto a capacidade de carga sócio-cultural possui melhor enquadramento quando os objectivos de gestão são os usuários da praia. Importante, ainda neste trabalho, foi o elevado nível de apoio demonstrado pelos usuários em ambas as praias com relação a potenciais opções de gestão dos espaços.

Palavras-chave: recreação, gestão de praias, capacidade de carga, Praia do Tofo, Praia de Faro

ABSTRACT

Coastal resources are an important component for recreational activities. With increasing tourism activities in the world, beaches in several parts of the world are getting each time much crowded with the resulting threats to local ecosystems and local people, what calls for a much appropriate resource management practices. This project attempted to outline and describe the carrying capacity process as a support tool for coastal management. This research aimed to determine the recreational carrying capacity of Faro Beach (Portugal) and Tofo Beach (Mozambique), based on the combination of the tourist carrying capacity assessment framework developed by Cifuentes (1992) and the PAOT approach (Manning, 2002) and supported by field surveys, tourist counts, on-site biophysical characteristics and questionnaires. Results showed that physico-ecological carrying capacity should be between 1,491 and 2,982 visits/day (at Faro Beach) and between 5,301 and 10,601 visits/day (at Tofo Beach) with impact acceptability curves being 305 and 608 tourists (for local people and tourists respectively, at Faro Beach), and 358 and 714 (for local people and tourists respectively, at Tofo Beach). These results suggest that the physico-ecological carrying can be applied for ecosystem management, whilst the socio-cultural carrying capacity should be addressed when management objectives are tourists and beach users. Importantly it is necessary to address the highest level of support showed to prospective managerial options.

Keywords: recreation, beach management, carrying capacity, Tofo beach, Faro Beach

LIST OF UNITS, ABBREVIATIONS AND ACRONYMS

3S	Sun-Sea-Sand (a tourism segment)
CCA	Carrying Capacity Assessment
CDS-ZC	<i>Centro de Desenvolvimento Sustentável de Zonas Costeiras</i> (Centre for Sustainable Development of Coastal Zones)
DPCA	<i>Direcção Provincial para a Coordenação da Acção Ambiental</i> (Provincial Directorate for Environmental Affairs Coordination)
e.g.	example
EEA	European Environment Agency
EMWCM	Erasmus Mundus Water and Coastal Management
et al.	<i>et alli</i> (and others)
EUROSTAT	European Statistics
GB£	Great Britain Pound
GDP	Gross Domestic Product
i.e.	in example
ICAM	Integrated Coastal Areas Management
ICT	Image Capture Technology
ICZM	Integrated Coastal Zone Management
IUCN	International Union for Nature Conservation
km	kilometre
MAOT	<i>Ministério do Ambiente e do Ordenamento do Território</i> (Ministry of Environment and Spatial Planning)
MITUR	<i>Ministério do Turismo</i> (Ministry of Tourism)
n/d	no data
NET	new era of tourism
NGO'S	Non-Governmental Organizations
NORAD	Norwegian Agency for Development Cooperation
PAP/RAC	Priority Actions Program/ Regional Activity Centre
PhECC	Physico-Ecological Carrying Capacity
SCCC	Socio-Cultural Carrying Capacity
SIDA	Swedish International Development Cooperation Agency
SPSS	Statistical Package for the Social Sciences
UK	United Kingdom
UN	United Nations
UNEP	United Nations Environmental Program
UNEP/PAP	United Nations Environmental Program/ Priority Actions Program
US\$	United States Dollars
WTO	World Tourism Organization
WTTC	World Tourism and Travel Council
WWF	World Wide Fund for Nature

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CHAPTER 1: INTRODUCTION

This thesis is in partial fulfilment of the academic requirements of the Erasmus Mundus Master in Water and Coastal Management (EMWCM). The topic chosen is appropriate because it presents and applies a tool to support coastal management (especially for beach management), by means of assessing how many people should be allowed in a specific beach without jeopardizing the surrounding ecological, social and cultural environments.

1.1 Introduction and background

Tourism is increasingly the largest economic activity in the World. From a phenomenon that was created as an entertainment for a group of friends¹, today this activity is known worldwide and is the vehicle for economic prosperity. With projections raising this activity to increasing growth (Kanji, 2006 after Burke and Kura *et al.*, 2001; Secretariat of the Convention on Biological Diversity, 2004; UN Atlas of the Ocean, 2004; World Travel and Tourism Council, 2006; UNEP Division of Technology, Industry, and Economics, 2006), the run-out for attracting more and more tourists is the actual “hobby” of many tourism destinations.

The interrelation between tourism and natural resource use is well documented. As suggested by Holden (2009), the use of natural settings for recreational tourism is something that is axiomatic in holiday advertising and is reflected in the major spatial flows of tourism, but this flow has inevitable implications for how tourism interacts with natural resources. Examples can be found at Mbaiwa (1992) related to the Okavango delta; Roe *et al.*, (1997) related to wildlife tourism; Rogers (1990) concerned with coral reef responses to sedimentation; Sunlu

¹ Initially created by Thomas Cook in 1841

(2003) on environmental impacts of tourism; Turner *et al.*, (1996) on the interaction between socio-economic and natural systems, among several others.

All authors are unanimous in highlighting that pressure on water resources, widespread development, pollution, outstanding population growth and ecosystem destruction are among the main consequences of tourism (e.g. Benoit and Corneau, 2005) and that avoidance of the degradation of the natural base can be met by sustainable coastal management (Phillips and Jones, 2006).

Driven mostly by economic gains and “blind” to the environmental and social benefits, small island nations, mountain ecosystems and fragile coastal ecosystem are being heavily targeted as destinations (Manning, 1998), with some nations doubling their population by outnumber in the peak tourist season. This situation would not be a problem if appropriate measures to control these flows were provided. It gains particular importance in beach ecosystems defined as multidimensional environmental systems that are nested within larger coastal systems and comprised of interacting natural, socio-cultural and management systems (Figure 1.1), with such interactions resulting in a flow of resources and hazards from the natural to the socio-cultural systems of beach environments.

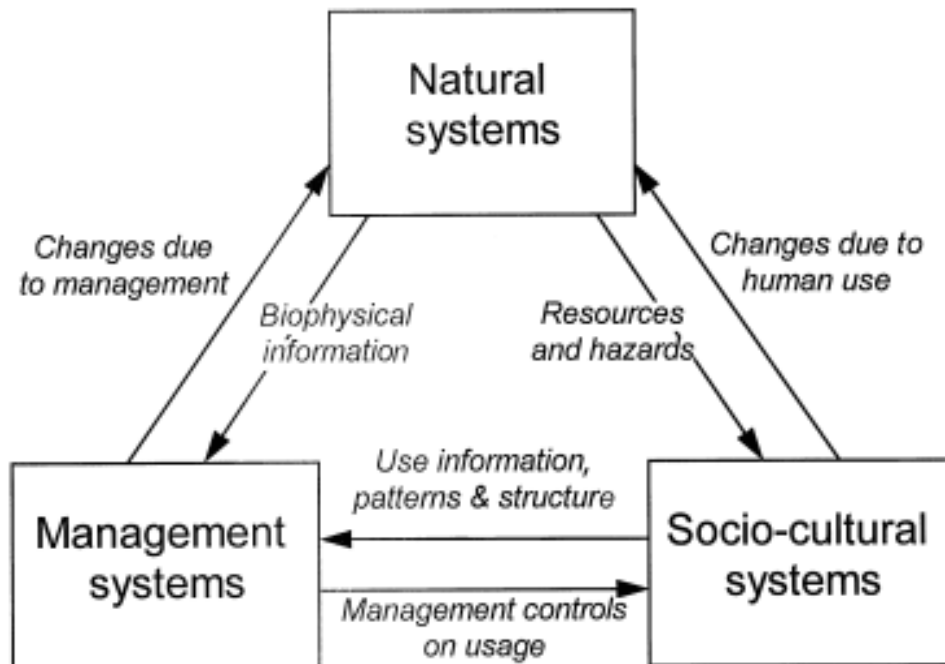


Figure 1. 1: Beach environments (James, 2000, after Platt, 1994)

Unfortunately, these destinations usually do not have enough capacity to manage tourist flows and detrimental impacts occur in the environment and local communities living around major destinations. In 1987, a broad framework (sustainable development) was built as a means to provide guidance on how to conduct and promote development. According to this concept, “*economic growth is not a panacea for human development*” (Khanna *et al.*, 1999:104) and development should be “*a process in which the exploitation of resources, the direction of investments and institutional changes are all made consistent with future and present needs based on symbiotic relationships between consumer human race and producer systems and on compatibility between ecology and economics*” (Khanna *et al.*, 1991:13).

By raising the need of keeping life-supporting ecosystems and interrelated socio-economic systems resilient for avoiding irreversibility and for keeping the scale and impact of human activities within supportive and assimilative scenarios (Khanna *et al.*, 1991; Khanna *et al.*, 1999), the tourism sustainability challenge would be to create a carrying-capacity-based

developmental planning process based on a preventive environmental policy, that would stand for trade-offs between the production-consumption levels through exploitation of supportive capacity and environmental quality of the ecosystem. The main environmental protection and tourism agencies (International Union for Nature Conservation – IUCN; World Wildlife Fund for Nature – WWF, World Tourism Organization – WTO; and the United Nations Environment Program – UNEP) have given significant steps towards this objective by assimilating and introducing the carrying capacity framework into the decision-making process for tourism development. Actually, the challenge is how to incorporate this concept into governmental and local planning levels.

In Portugal, tourism is a very important sector of the economy, not only accommodating nearly 76% of the total population, but also by contributing to the Gross Domestic Product (GDP) in 85% (Serra Delgado, 2001). In this country, beach tourism is the oldest and still the most sought tourism product, occurring on a long coastline which records more than 500 sites, 162 of which qualified as Blue flag beaches (Silva, 2008). The tourist demand in continental Portugal focuses on two crucial areas - Algarve and Lisbon. Taken together, these areas include more than two thirds of the accommodation capacity nationwide.

The stakes in beach tourism have completely changed several portions of the Portuguese coast, especially in the Algarve which has a large part of the supply and demand for tourism and remains as the leading summer destination for the Portuguese people and also foreign tourists from various European countries (Silva, 2008). This situation, which was responsible for a strong economic dynamism in the region, has created serious problems of land use, thanks to rampant and unplanned construction and resulted in severe distortion of the landscape, with the obvious loss of environmental quality.

In Mozambique, tourism is viewed as the growing power that can sustain development and poverty reduction (MITUR, 2003) and this activity is being increasingly publicized in the international market as a source of foreign inputs to the country. With inland resources still in rehabilitation (a recent 16 years civil war destroyed most infrastructures and stopped inland development), most of these tourists are driven to the coast where they can enjoy the well-known 3S (sun-sand-sea) environment of tropical countries.

Similar to other regions of the world, as a result of tourism activities, beaches in Mozambique are at threat from extensive erosion rates, mangrove destruction and to some extent disruption of the local socio-cultural environment with the introduction of new lifestyles and price speculations. No previous study has been conducted on the carrying capacity of the local ecosystems although several reports have recommended its application (Motta and Truta, 1996; MICOA, IUCN and NORAD, 1998; UNEP/PAP, MICOA and SIDA, 2000; Fiege *et al.*, 2002; MITUR, 2003; CDS-ZC and DPCA, 2005).

1.2 Objectives and research questions

Although the carrying capacity concept can be evaluated in several dimensions, this dissertation covers two of them considered as the basis for resource management: the physico-ecological and socio-cultural dimensions. These segments are framed in the context of providing practical insights of socio-ecological knowledge relevant to the science and practice of coastal management, especially the interaction between tourism activities, coastal ecosystems and local communities. Therefore, the main objective of this dissertation is to assess the recreational carrying capacity of two mass tourism beaches, one in Portugal (Faro Beach) and another in Mozambique (Tofo Beach), by means of:

a) Assessing the physico-ecological carrying capacity or the physical and ecological threshold of the study areas

This objective is based on the assumption that any space has a limiting size of people that it can accommodate. In beaches (or coastal areas in general), this assumption becomes real in the sense that an uncontrolled flow of people can not only exceed this threshold, but also damage the surrounding ecological environment and as a result, reduce recreational quality. To answer this objective, two research questions are addressed: (1) *what is the maximum number of people that should be allowed at each beach;* and (2) *has the physical carrying capacity at the beach been exceeded or is it still in the optimum range?*

b) Assessing the socio-cultural carrying capacity or the interaction between local communities and visitors and responses to crowding

The interaction among people in space determines their level of acceptance and enjoyment. While tourists flow to a destination to enjoy, local communities create a set of expectations, mainly concerning economic benefits and visitors behaviours. In case these boundaries are not reached or are overcome, local people can start behaving contrary to tourism activities creating a conflicting environment that can reduce the visitors' experiences and the necessary outcomes from tourism activities. But levels of crowding can also reduce visitors' experiences as in most cases a huge number of tourists' encounters and reduced available space creates conflicts between tourists.

Being key stakeholders in the tourism and beach management context, understanding their level of interaction and responses is crucial because it will determine the success and sustainability of these activities (Gursoy and Rutherford, 2004). Therefore, to cover this issue, two research questions are addressed: (1) *what is the level of interaction between tourists and*

local communities and among tourists themselves; and (2) what is the optimum allowed number of people on the beach suggested by these two groups?

1.3 Significance of the study

Tourism is seen by many Governments, as the possibility of economic development and poverty reduction. The attraction of beaches, associated by their abundance of natural resources amenities, is bringing an increasing number of tourists, demanding more infrastructures and facilities, calling for the real possibility of reaching the limits of the sustainability in a short time. One of the most important questions which have emerged in this period is the search of a balance between environment (compatibility) and economic growth (sustainability).

Trying to establish the carrying capacity of a tourism destination may facilitate an understanding as to when resource limits are reached or outgrown and can enable the establishment of quality standards that may be used to monitor coastal areas. The coastal areas under consideration are undergoing extensive exploitation for recreational activities with increasing number of tourists. Therefore, both beaches constitute unique and great research field to check the different aspects of tourist flows, tourism development and beach management.

This project hopes to contribute to evaluation of the environmental and socio-cultural value of coastal areas and to establish a baseline and framework to be applied in other areas involved in tourism for increasing awareness of sustainable development through an alternative fully sympathetic form of tourism in fragile ecosystems.

1.4 Research outline

This thesis is divided in two main parts, the first comprising theoretical and methodological issues and the second considering the development and final results outputs. In Chapter one, a background on tourism and coastal tourism trends is presented, associated to the need of developing this research, the main objectives and research questions and significance of this kind of study. In chapter two, a discussion of the interrelations between tourism development and sustainability of the coastal area is presented, incorporating the assessment of carrying capacity and the key element. This chapter concludes that with the current levels of tourism activities, the probability of increasing the rate of environmental hazards in coastal destinations will increase and that when properly applied, carrying capacity (with its all components) is a powerful tool to mainstream economic benefits and the negative impacts resulting from tourism activities.

Whilst chapter three presents a theoretical background on carrying capacity and its components (physico-ecological and socio-cultural) and consequent background studies, chapter four presents Faro and Tofo Beach as the studied areas for this report. In chapter five, the conceptual framework and research methods applied are presented and in chapter six the outcomes from application of chapter five are presented and discussed, with chapter seven being a summary of the report.

CHAPTER 2: COASTAL TOURISM, CARRYING CAPACITY AND THE SUSTAINABILITY OF COASTAL AREAS

Based on the assumption that increasing tourism development, especially in coastal areas, can hinder the sustainability of coastal natural resources and reduce its value for recreational activities, this chapter aims to answer the question whether assessment of tourism carrying capacity can ensure long-term sustainability of both tourism and coastal areas.

As stated in chapter 1, tourism is a growing activity that has been perceived by many countries as a *panacea* for economic growth (Hazebroucg, 1999; Swarbrooke and Horner, 2001; Henriques, 2003; WTO, 2006). Within this activity, the segment represented by movement of people to the coast (coastal tourism) is the most representative and fastest growing.

Some 50% of the world coastline is currently under threat from development and it is estimated by Finkl and Kruempfel, (2005) that by 2025, *circa 75%* of the world's population will live within 60 km of the sea; Povh (2000) stated the same percentage by the year 2020. This will result in a major thrust for coastal tourism, one of the world's largest industries (Klein *et al.*, 2004). Currently, in several coastal areas of France, Italy and Spain, the built up area exceeds 45% (EEA, 2006), and in these plus Greece and Turkey, tourism receipts account for some 5% of the gross domestic product (WTO, 2006).

These countries account for "*the most significant flow of tourists.... a sun, sea and sand (3S) market*" (Dodds and Kelman, 2008:58). In 2006, global tourism was worth US\$733 billion, employed 8% of the global workforce and estimates were for 1.6 billion international tourists

by 2020 (www.Tourism.concern). 'Travel & Tourism' worldwide, is expected to grow at a level of 4.0 % per year over the next ten years and is one of the largest growth industries in the world (www.wttc.org).

The beauty and environmental quality of tourist destinations are seemingly what attracts tourists, and local people are increasingly anxious to participate in and draw the benefits of tourism while preserving their own identities, the natural environment, and the historic and cultural heritage from the impact of uncontrolled tourism (Manning, 1998). Therefore, management of coastal tourism has become not only a matter of managing common and sensitive resources, but also meeting community goals, perceptions and attitudes in order to provide long-term sustainability of not only the activity, but also the preservation (a hard approach to conservation) of the coastal area.

With a large dependency in relation to the natural resource base², tourism activities are most prosperous in attractive coastal landscapes such as sandy beaches, dune areas, estuaries and coastal lakes. Unfortunately, uncontrolled and ill planned tourism significantly degrades coastal ecosystems, especially with the imposition of new infrastructures and construction activities and wetland drainage; demanding that governments, the tourism industry and all stakeholders assume proactive roles and implement a mix of management strategies to shape and guide the industry in an environmentally suitable manner (UNEP, n/d; Manning, 1998; UNEP/PAP, 1999; UNEP/PAP, 2004). In this effort, self-regulation schemes are likely to be more effective and knowledge of the environmental potential of each coastal stretch can be of valuable use.

² In this point it must be acknowledged that other resources are also important for tourism activities. The relative importance of the natural resource base is here highlighted just to give room to the sun-sea-sand tourism segment.

Based on literature surveys and discussion with authors of previously published papers, reports and White Papers regarding tourism, coastal areas and sustainability of natural resources-based activities, it appears that tourism carrying capacity assessment is a powerful tool to ensure the sustainability of tourism and coastal areas (Papageorgiou and Brotherton, 1999), because it:

- assesses the average number of people a coastal stretch can accommodate;
- assesses attitudes and perception of users and local communities (interaction between hosts and visitors);
- suggests management mechanisms that can be adopted by the three levels of governance (Government, market forces and NGO's) in appropriate management;
- is an integral part of integrated coastal zone management process.

2.1 Tourism development and its incidence in coastal areas

The tourism sector has experienced great development in recent years, motivated by several aspects, mainly economic and demographic (Caballero *et al.*, 2002). From an economic viewpoint, the tourism sector benefits from the increase of personal income that enables people to travel and experience other cultures; on the demographic side it benefits with the general increase of the average lifespan, which creates much leisure time (Henriques, 2003). Communication technological advances, particularly of the internet, has also created a globalized world where information about different parts of the world rapidly spreads, attracting people or allowing a wide range for travelling choices.

Away from the traditional type of leisure activities, the New Era of Tourism (NET) is mostly characterized by *“a continuous search for new and concrete niches for greater*

competitiveness, intensive use of know-how, introduction of new products, adoption of total quality strategies, development of information system for demand and supply and investments in maximum quality levels for the tourist area, sustainable development and a mix of public-private-voluntary actors” (Mendez and Espinosa, 2006:27). These strategies reinforce product quality and destinations have significant impacts on the perceptions and attitudes of people who are increasingly more informed, more experienced, motivated and searching for new experiences and a better quality of services and more flexibility.

Statistics from international organization and White-Papers on tourism reveal a clear growing trend of the activity, with developing countries starting to receive more than in previous decades (Willms, 2007). According to these institutions, tourism is the most important industry on a global scale and continues to grow at an expected 100% over the next 10 years (Kanji, 2006 after Burke *et al.*, 2001:22; Secretariat of the Convention on Biological Diversity, 2004; UN Atlas of the Ocean, 2004; World Travel & Tourism Council, 2006; UNEP Division of Technology, Industry and Economics, 2006).

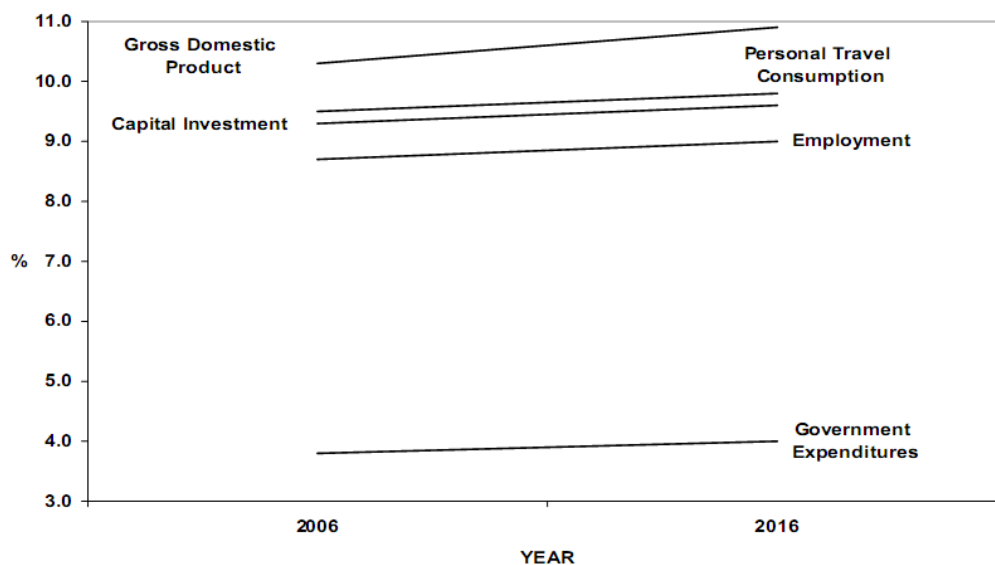


Figure 2. 1: Tourism growth indicators displaying the expected growth trend of the global tourism industry over 10 years. World Travel & Tourism Council (2006)

2.2 Coastal areas and beaches as attractions for coastal tourism

A beach can be defined either as “*the zone of unconsolidated material that extends landward from the low water line to the place where there is a marked change in material or physiographic form, or to the line of permanent vegetation ... having the mean low water line as the seaward limit*” (Shore Protection Manual, 1984:10) or as “*a littoral³ system of accumulation of sediments, sand and gravel, deposited and maintained free by the sea*” (Ramos-Pereira, 2008:14). In general, beaches can be understood as geological formations consisting of loose rock particles such as sand, gravel, sand or pebbles along the shore of a body of water, i.e., the sea, a river or a lake (<http://pt.wikipedia.org/wiki/Praia>).

Its mobility is dependent on a series of modifying agents such as waves, their incidence on the coastline, the constant variation of sea-level position as a result of tides, morphological parameters i.e. slope, micro-morphology of the beach and sediment size (*idem*). As natural systems, “*beaches display a variety of functions, such as coastal defence, recreation (swimming, surfing, sand yachting, fishing, jet skiing and so on) and conservation, and frequently a conflict of interest arises*” (Williams and Micallef, 2009:2).

This means that beaches will be in even greater demand – they are big business and good beaches are worth billions of tourist dollars (Clark, 1996). As beaches worldwide take huge numbers of tourists, in order to accommodate this development, a sound infrastructure should be in place to realise the real economic and social values of the ‘beach industry’, otherwise unregulated tourism development will continue to devastate environments, degrade cultures and destroy traditional livelihoods. From a number of coastal-marine ecosystems peer-

³ Understood as “*the entire environment – the zone extending across the exposed beach into the water to a depth at which the sediments are less actively transported by surface waters*” (Komar, 1998). Although this definition is valid, still it is imprecise since waves occasionally transport sediments at considerable depths, but in general it is taken into consideration as a depth limit of the littoral zone 10-20 metres.

reviewed non-market valuation studies (1970-2006) carried out by Wilson and Liu (2008:130), beach recreation “*got inordinate attention in the economic literature*”. This emphasises that environmental scientists should be very involved in tourism issues (Hall, 1997).

Examples of the relevance of coasts to tourism and local economies can be found everywhere. In the Mediterranean region, tourism is the most important activity with 298 million international tourist arrivals in 2008, followed by approximately 400 million domestic tourism arrivals. However, it is highly seasonal, being just three months and mainly concentrated upon the coastal strip which has a permanent population of circa 460 million, a figure which is postulated to grow to 520 million by 2025 (EUROSTAT, 2009).

Visitors to the coastal zone were estimated as some 250 millions (international and domestic) in 2008 and this number will increase substantially, in line with a forecasted 368 million tourists by 2020 (UNEP and UNWTO, 2008). In the UK, tourism surveys show that >40% of all tourism is motivated by visits to the coast; is worth GB£110 billion and employs more than 1.3 million people – some 5% of all employed people (www.visitbritain.co.uk).

In California, beaches have >567 million visits compared to 286 million to all US National Park Service lands and the Government between 1995-1999 received US\$14 billion in tax revenues annually from tourists (King, 1999). Houston (2002) stated that travel and tourism is the USA’s largest industry, employer, and earner of foreign exchange and beaches were the major factor in this tourism market. At Miami beach (Florida) for example, expenditure of *circa* US\$65 million for an initial beach nourishment scheme has produced some US\$2.4 billion annually in foreign exchange from tourists and each year, some 85 million tourists to

Florida contribute US\$65 billion to the state's economy (Houston, 2002). In Barbados, local beaches are deemed to be worth >US\$13 million to the local economy (Dharmaratne and Braithwaite, 1998).

As around 40% of the human population live on or near the coast, coastal tourism (Burke *et al.*, 2001), increases pressure on the physical, socio-economic and cultural environments of host communities and the challenge is how to integrate the needs of all coastal zone stakeholders in a sustainable planning process that considers environmental, socio-economic and cultural dimensions (European Commission Tourism Unit, 2000; Kline, 2001; Garrod and Wilson, 2003; UNEP Division of Technology, Industry and Economics, 2006).

In this case, and despite severe limitations, *“the assessment of carrying capacity remains a useful concept for environmental management, especially in providing insights about the interaction of human activities with the environment”* (Papageorgiou and Brotherton, 1999:272). In recreational contexts, central to all definitions of carrying capacity, is the idea of maintenance of the resource base integrity and provision of a high-quality recreation experience to users (Sowman, 1987). This can be integrated with a range of social and economic indicators to achieve an optimal solution whereby the environment remains intact for sustained output (Hutman, 1978).

2.3 The theory and practice of carrying capacity assessment

The release of the Brundtland Report (1987) brought about an expression – ‘Sustainability’, that provided a new vision over natural resource uses and exploitation. With sustainability efforts being outlined as the main target to be achieved by humanity as a way of saving the planet, increasing debates are being established in order to understand the effects of tourism

and to outline measures which would mitigate the effects. Bimonte and Punzo (2005:1) suggested that, “*tourism has an interface role between resources, on which it is based, and the tourist that enjoys them*” and “*the relationship between the anthropogenic activity and environment assumes a peculiar connotation by the complexity of the sector and the particularity of the involved resource*”.

As the coast is used for a multitude of purposes, trends are moving towards better management of coastal resources. With increased tourism, pressure over coastal area’s natural resources will increase as a result of extreme tourist flows and reduced capacity of governments (at all levels) to control them. While equilibrium between economic costs and tourism benefits are local and country specific, it is widely accepted that negative social, cultural and environmental impacts of tourism are significant and may, in some cases, exceed the positive (Grange and Odendall, 1999), especially when tourism destinations (in this case beaches) become much popular.

The balance between these three structures (tourism, coastal areas and sustainability) has yet to be achieved and extensive debates have been released around this topic, giving rise to concepts such as the carrying capacity and the ecological footprint (Lime and Stankey, 1971; Wackernagel, 1994; O’Brien, 2002). In assessing the relationship between tourism development and sustainability of the coastal area, three points need to be outlined:

a) the **dynamic element**, which involves making decisions on tourist circulation and selection of a desired destination, as well as a series of social, economic and institutional factors of relevance to making such a decision;

b) the **tourist destination**, element, which includes tourist sojourn in the largest area as well as interactions with economic, social and natural subsystems of the given area;

c) the **consequential element**, which derives from the previous two and is manifest in economic, socio-cultural and natural-ecological effects that directly or indirectly affect the quality of a tourist's experience in a given destination (Mathieson and Wall, 2006).

Given that participants in tourism trends exhibit their needs and expectations in various manners (Jovicic and Dragin, 2008), assessment of tourism carrying capacity can be used to assess tourism impact on space and the environment, as it is a sustainability measure or mechanism for establishing standards for sustainable tourism (Lim, 1998; UNEP, 1998; O'Brien, 2002; Jovicic and Dragin, 2008). Considering the viewpoint presented at the *Caring for the Earth* report (IUCN/UNEP/WWF, 1991), the carrying capacity is the capacity of an ecosystem to support healthy organisms while maintaining its productivity, adaptability, and capability of renewal (Ceballos-Lascuráin, 1998:), i.e. it represents a threshold level of human activity that when exceeded, will deteriorate the resource base (Wolters, 1991).

The concept of carrying capacity mainstreams the question of how much public use can be accommodated in a park or related tourist attraction (in this case a beach) (Manning *et al.*, 2002). Originally developed and applied in the field of rangeland management (Dasmann, 1964), this concept rapidly evolved and was adapted to other fields, especially in the management of tourist destinations (Stankey and Manning, 1986; Mitchell, 1994; Manning, 2001).

Although controversy exists on the real foundations of this concept, agreement exist among several authors that carrying capacity relies on Darwin's theory of natural selection and the Malthus's (1968) theory of population and limits of resources (Seidl and Tisdell, 1998). During the 60's and 70's (last century) extensive debates over consumption patterns and resource uses caused the introduction of the concept of carrying capacity to be mainstream in addressing the rapid decline and deterioration of natural resources and the overuse of ecological sinks. It has played a significant role in promotion of public and politic awareness and understanding of approaching and existing limits to economic activities (Siedl and Tisdell, 1998).

By the 70's, this concept gained large space in management of rangelands or pastoral areas, but attempts to adapt this concept to socio-economic sectors, such as tourism has had successive failures, mainly as a result of the misunderstanding of the exact meaning and framework of carrying capacity. Originally defined as the maximum number of users that an area can support, it was only "*determined in terms of ecology and the deterioration of areas, but soon became obvious that the resource-oriented point of view would be augmented by consideration of human values*" (Manning *et al.*, 2002:389 after Wagar, 1964).

To solve this situation and facilitate application to recreational settings, the World Tourism Organization (WTO) drafted an explanation of carrying capacity as "*the maximum number of people that may visit a tourist destination at the same time, without causing destruction of the physical, economic and socio-cultural environment and an unacceptable decrease in the quality of the visitors' satisfaction*" (WTO, 1981; 1999).

From the above concept (WTO, 1981; 1999), three main aspects of the carrying capacity assessment can be derived and these have been extensively developed by several authors (PAP/RAC, 1997; O'Brien, 2002; Manning, 2002, Lankford *et al.*, 2006, Castellani *et al.*, 2007, Pereira da Silva *et al.*, 2007): the physical environment, the economic setting and users' perception and based on these three attributes, the concept of carrying capacity can be split in four main tasks: the physical-environmental carrying capacity, the institutional carrying capacity, the socio-cultural carrying capacity and the economic carrying capacity (Figure 2.2).

Carrying Capacity	Institutional carrying capacity	Measures the capacity of the governance system (Governments, NGO's and the Market Sector) to mitigate adverse impacts of tourism
	Physico-ecological carrying capacity	Measures the maximum number of visits that a tourism destination can accommodate
	Socio-cultural carrying capacity	Measures perceptions and attitudes of users towards different levels of crowding
	Economic carrying capacity	Mainstreams the level of utilization that a resource needs to generate economic compensation or generate profit
	Typology	Meaning

Figure 2.2: Carrying capacity assessment sub-setting (based on PAP/RAC, 1997; O'Brien, 2002; Manning, 2002; Lankford *et al.*, 2006; Castellani *et al.*, 2007; Pereira da Silva, 2002; Pereira da Silva *et al.*, 2007)

Meanwhile, the calculation of beach, recreational or tourist carrying capacity is not an easy task, as it requires information pertaining to the resources themselves and the available infrastructure, being specific for: each area and time, extremely influenced by the type of activity, season, time of day, health status of resources being exploited, existing facilities and

satisfaction of users (Clark, 1996; Ceballos-Lascurain, 1998). As there are various parameters for CCA, the simple sum of the final results should be considered equivalent to the carrying capacity of the whole area (Ceballos-Lascurain, 1999) and the actual carrying capacity can be a judgement of the acceptable level of change both in terms of the resource and the satisfaction of the tourists or visitors.

Therefore carrying capacity should not be seen as the end point. According to Coccossis and Parpairis (1999); Batha (2000); Coccossis (2004); Kallis and Coccossis (2004), the carrying capacity of an area must be considered as a means to an end and not as an absolute limit that is vulnerable for each type of environment under discussion and should be defined, as the point where the minimum infrastructure/ superstructure requirements, as well as the natural asset which create demand, become insufficient to meet the needs of both the resident population and the visiting tourists, whereupon the threat of environmental hazards appears.

2.4 Can carrying capacity assessment ensure the sustainability of tourism and coastal areas?

The Brundtland Report (1987) brought to world attention an old but consolidated view of environmental problems, linking them to economic aspects and communities' welfare. By raising the concept of sustainable development (wise use of resources to allow access to future generations), this report brought a new type of management of natural resources in which economic development was intrinsically associated to conservation of the natural resource base targeting local communities' welfare. The original outline of the concept of sustainable development addressed by the Brundtland report has been extensively translated to several situation and activities that attempt to explain and enhance its meaning. Related to tourism, this concept was turned into the "sustainable tourism" approach based on the view

that resource problems are not really environmental problems; they are human-made problems (Sharpley, 2000).

For countries which rely heavily on tourism activities, concerns about the environmental as well socio-cultural problems associated to “irregular” tourism activities are increasing (Neto, 2003). There is now increasing agreement on the need to promote sustainable tourism in order to minimize threats to the environment and maximize communities welfare leading to management of all resources in such a way that economic, social and aesthetic needs and values can be fulfilled while maintaining cultural integrity, essential ecological processes, biological diversity and life support systems (UN, 2001). Under this last concept, there is an urgent need to reinforce resource management in tourist places, as explained by Manning (1998):

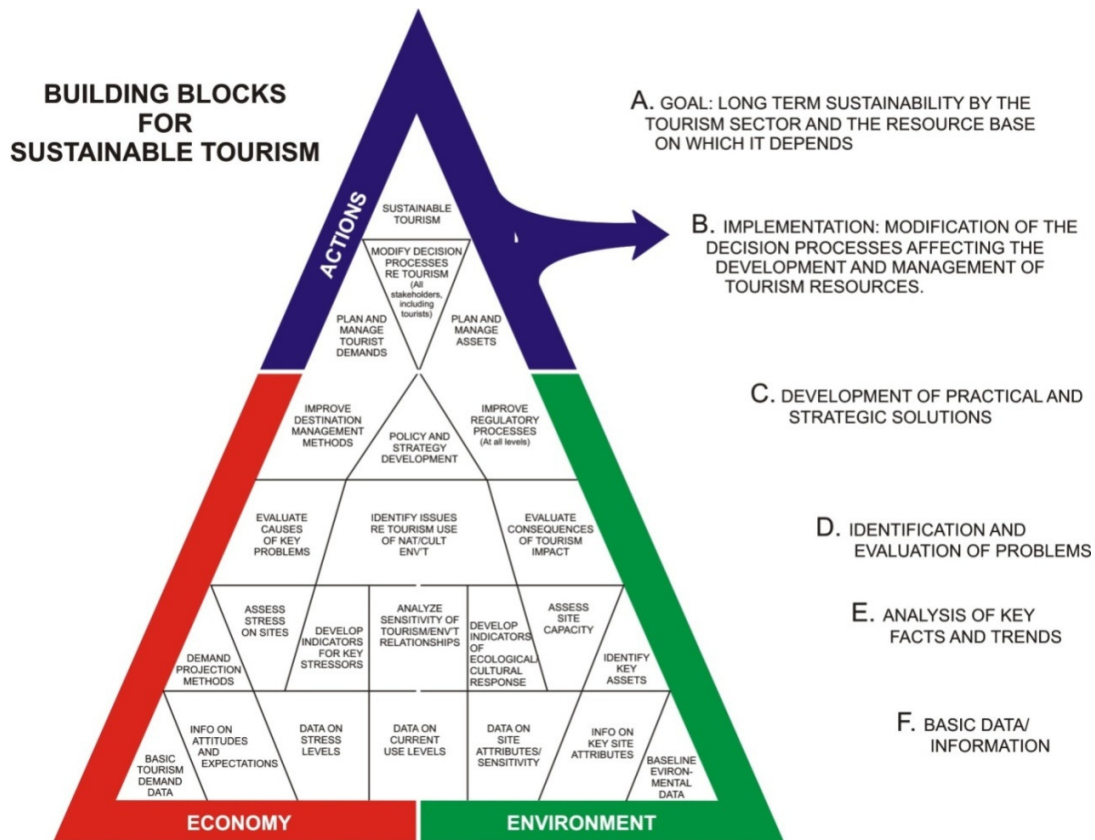


Figure 2. 3: Patterns, steps and issues towards sustainable tourism development (Manning, 1998)

In this model (Figure 2.3), the baseline for sustainable tourism development is data availability of how many people visit the area, their values, attitudes and perceptions, the ecological threshold and the major factors that could to a certain extent threaten the health of the ecosystem. This information can only be easily accommodated with significant changes in the governance system with new environmentally-friendly policies and strategies and regulatory systems that will enable appropriate planning of tourists and spaces (Manning, 1998). Several approaches can be employed to assess pathway towards this goal and several instruments have been employed. Of all, the concept of carrying appears to be the most applied framework especially in the context of coastal tourism and ecotourism.

According to Adams (1991:22), the concepts of sustainable development have been helpful in *“laying out principles for peasant agriculture, or expounding the benefits of appropriate technology and the importance of indigenous value systems and technical knowledge”* and together with recreational settings, it has been useful for ecotourism and “new tourism” (Pons, 1993). Such tourism uses “wilderness” or “authentic” cultural landscapes as their primary product. However, because its scope and scale is necessarily small, “new tourism” cannot serve as a development pole for a national economy. It is mass tourism that has served as a growth pole for the national economies of many states, and it is mass tourism that must concern the planners in places where the tourism industry has already matured (Baldwin, 2007).

As suggested by Baldwin (2007) the primary question that should be addressed in truly sustainable development of sun, sand, and sea tourism is *“how can human projects co-exist with the non-human projects whose products (e.g. colourful reefs) and by-products (e.g. fine sand beaches) are also valued by humans?”* Carrying capacity assessment in beaches can

answer this question as suggested by Sinden (1975); UNEP/PAP (1997; 1999); Ceballos-Lascurain (1998); Papageorgious and Brotherton (1999); Khanna *et al.*, (1999); Pereira da Silva (2002); O'Brien (2002); Nghi *et al.*, (2007); Needham *et al.*, (2008). Although the concept of tourism capacity is difficult to quantify, it provides insights on user behaviour, facility design, patterns and levels of management and the dynamic character of the environments themselves.

Nevertheless, coastal management can benefit from attempts to define tourism carrying capacity for a specific site or sites since these will offer an indication of the limits and limitations to tourism development and if visitor satisfaction is to remain at a constant level, the quality of the environment visited must be maintained. Sustainable coastal tourism management plans are a necessity for mitigating coastal community degradation and must consider the physical environment, economy, and culture of the local community, and must also incorporate the other local industries (Burke and Kura *et al.*, 2001; Kline, 2001; Dobson, 2003; Garrod and Wilson, 2003; Secretariat of the Convention on Biological Diversity, 2004; Yunis, 2006).

A tourism development plan should be integrated into an overall policy for sustainable development and involve policy and decision-makers, and developers and managers from government, non-government, and other organisations, the private sector, and the local and native community. According to UNEP/PAP (1997:7), "*the incorporation of CCA in the tourism planning and management process is a necessity and should be taken as a set of instructions for the formulation of tourist plans at all levels*". When incorporated as part of an integrated coastal zone management (ICZM) program (table 1), CCA "*enables the preservation of the high quality and quantity of coastal resources whilst meeting not only the*

current needs, but also securing long-term economic and ecological benefits for future generations” (ibid, pg.8). The measurement, assessment and implementation of carrying capacity may be considered as a process within a process for planning in coastal areas, requiring the definition of goals and objectives and policy measures, as well as the elaboration of a vision about local development. The process is cyclical and repetitive comprising various steps (identification of issues, definition of critical factors, indicators, thresholds and desired levels, formulation of goals and objectives, elaboration of alternative courses of action, impact assessment, etc).

Table 2. 1: Positioning of the CCA process in the ICAM process

ICAM Process		Model of Tourism Planning	CCA according to WTO	CCA according to UNEP/ PAP
Initiation	Initiation of ICAM			
Planning	Preparatory activities	Basic analysis	Initial CCA	Initial CCA
	Analyses and forecasts	Detailed analysis	Detailed analysis of CCA	CCA analysis
		Synthesis		Tourism development scenarios
	Definition of goals and strategies	Goals and strategies		CCA synthesis
	Integration of detailed plans and management policies	Plan		
Implementation	Plan implementation, monitoring and evaluation	Implementation	Monitoring, evaluation and feed-back effects of CCA	Monitoring, evaluation and feed-back effects of CCA

Source: UNEP/PAP (1997:14)

Carrying capacity assessment needs to be considered in the context of a democratic community strategic planning, which requires participation of all major actors (Coccosis and Mexa, 2004). Determining the carrying capacity gives guidance in the process of developing

adaptive management for a given project or activity and requires a clear decision making process, in which all parties are involved in an early stage (scientists, stakeholders from industry, NGO's, general public, policy makers).

Unfortunately, most research in this field has an attempt to solve problems using a scarcely understood framework as suggested by Burch Jr. (1984: 487): "*In short, we have a large amount of research driven by a poorly understood concept whose main function is to help managers to control something they do not understand*".

CHAPTER 3: LITERATURE REVIEW

This chapter attempts to provide an understanding of the two dimensions outlined in this report: the physico-ecological carrying capacity and the socio-cultural carrying capacity. It provides not only relevant concepts, but also previous paper and theories beyond these topics.

3.1 The physico-ecological carrying capacity (PhECC)

The growth and dynamism of international tourism has led this sector to be one of the most highlighted social and economic sector of the past century (Altes, 2006), especially after the second half of the century where occurred a great expansion of movement of travellers and income generation (WTO, 2009). According to World Tourism Organization (WTO, 2003) forecasts, long-distance travel worldwide will grow faster (5.4% each year) in the next decades than travel within regions (3.8%) and statistics for 2002 estimated international tourist receipts of US\$ 463 billion, a total of 693 million tourist arrivals across the globe and forecast over one billion arrivals by 2010 (Figure 3.1).

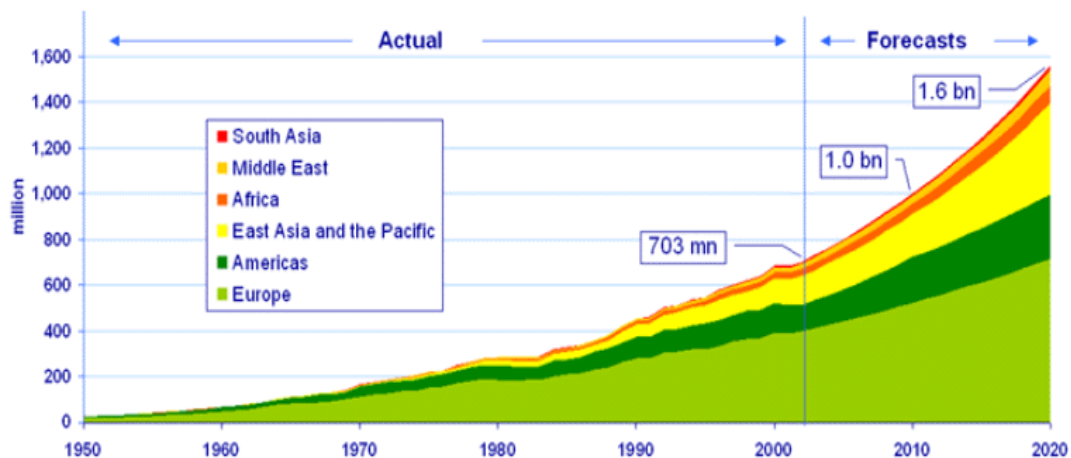


Figure 3. 1: Global tourism forecasts (WTO, 2003)

A great percentage of these travellers are directed towards coastal areas. Among all segments of tourism, coastal tourism is one of the oldest with some resorts catering for tourists since the

19th century and beaches have been since long the main tourist attraction. Because of this attractiveness, some beaches started to face negative impacts such as destruction of ecosystems, disruption of coastal processes, coastal erosion and consequently loss of their aesthetic and recreational quality, calling for sound beach management approaches (Williams and Micallef, 2009). As suggested by Segrado *et al.*, (2008), management of visitors in beaches should be rigorously planned in order to achieve conservation and management goals and ensure that tourists have a quality experience and meet their expectations. In this sense, it is necessary to establish the tourist carrying capacity in order to know the number of people that the area can support.

The physical (or/ and ecological) carrying capacity can be defined as “*the threshold limit beyond which natural and cultural heritage of a destination are damaged by tourism*” (Castellani *et al.*, 2007:366; Jovicic and Dragin, 2008). It can also be defined as the total amount of suitable land available for tourist activities, which includes accommodation, tourist facilities and infrastructure such as road, water and sewage, which is a space impact measurement (Shelby and Heberlein, 1989). In this definition, capacity is exceeded when delineated tourism space with associated tourism activities is saturated (O’Brien, 2002, after Pearce, 1989), denoted by the point at which not one more person can be accommodated by the tourism destination, which acts as a constraint on visitor use by limiting access to sites (Martin and Uysal, 1990). As suggested by Mexa and Coccossis (2004), in any locality there is a strong relationship between society and all environmental and geographic features create locational advantages attracting people and economic activities.

As human activities and living patterns are based on local environmental conditions and resources, their degradation may have significant impacts on people, disturbing the structure

and dynamics of local human and natural ecosystems (Hexa and Coccossis, 2004). In this perspective, the physical carrying capacity relates to a “*quantitative measurement of the total number of people or the usage a site can support with actual tourism provisions, primarily in relation to zoning and bylaw formulations by the local governments*” (Hall and Page, 2005:148) which is linked to density and ratio measurements (O’Brien, 2002).

Apart from measurements of the density and ratios between resident populations and the number of tourist arrivals, measurements can include the tourism infrastructure, the maximum use and frequency of tourist activities and the maximum load that sewage, road and water infrastructure could maintain. In this sense, the physical capacity provides a defined boundary of tourism activity and within these boundaries the risks to the natural environment become more prominent with the associated increase to a tourism destination (O’Brien, 2002). Identification of variables relating to the physical environment that will be affected by tourism can help determine the threshold or limits to growth that may be withstood without significant degradation to the environment, which is ultimately influenced by the number and characteristics of visitors to a tourism destination.

3.2 The socio-cultural carrying capacity (SCCC)

Hunter (2002) suggested that the debate into tourism sustainability cannot be disentangled from the sustainable development concept (Clark, 1996; Hardy *et al.*, 2002). In the tourism and coastal management division, this concept cannot be seen individually, as the demand for tourist values is especially - if not exclusively - a demand for environmental and cultural resources (Bimonte, 2003; Bimonte and Punzo, 2005). As an activity involving the human dimension, tourism activities in coastal areas may have severe impacts on the cultural aspects

not only of local communities but also in the tourists themselves, therefore, calling for the need of assessing these groups' interactions and responses.

In this sense, a new field in the tourism carrying capacity was developed: the socio-cultural carrying capacity (Tarrant and English, 1996; Saveriades, 2000; Manning *et al.*, 2000; McCool and Lime, 2001; Manning *et al.*, 2002; Riganti, 2006; Lopez-Bonilla and Lopez-Bonilla, 2008). According to these authors, the socio-cultural carrying capacity is “*the threshold beyond which social aspects of the host community are badly influenced and damage by tourism activities and life's quality of residents is no more granted*” (Castellani *et al.*, 2007:366; Jovicic and Dragin, 2008) leading to conflicts between tourists and resident population and/ or generating social tensions (Saveriades, 2000; Brandolini and Mosetti, 2005; Mansfeld and Jonas, 2006; Leujak and Ormond, 2007; Castellani *et al.*, 2008; Lopez-Bonilla and Lopez-Bonilla, 2008).

This component recognizes that detrimental socio-cultural impacts on local people will occur if tourism exceeds a certain level (Ceballos-Lascurain, 1998). In the process of its evaluation, there is a need to distinguish impacts caused by tourism and those resulting from other activities. Its primary concern is related to the host community, as perceptions of what constitutes an unacceptable impact or effect vary between indigenous populations and tourists, and also within these two groups, therefore attention must be given to prioritizing issues (Wolters, 1991).

As suggested by Bimonte and Punzo (n/d), assessment of the socio-cultural capacity of tourism destinations is not easy as it implies understanding tourism encounter and the interaction between two (main) populations: residents (or groups of residents) and tourists. On

this issue, extensive literature has been produced (Shelby and Heberlein, 1986; Lime and Stankey, 1971; Stankey and Lime, 1973; Kuss *et al.*, 1990; Tarrant and English, 1996; Saveriades, 2000; Manning *et al.*, 2000; McCool and Lime, 2001; Manning *et al.*, 2002; Riganti, 2006; Lopez-Bonilla and Lopez-Bonilla, 2008) but all faced the same difficult on how to determine how much impact, such as crowding, is too much (Manning *et al.*, 2002).

Social carrying capacity consists of multiple indicators such as encounters, crowding, conflict, noise and satisfaction (Vaske and Donnelly, 2002; Needham *et al.*, 2008). While reported encounters describe a subjective count of the number of other people that an individual remembers observing in a setting, perceived levels of crowding is a subjective negative evaluation that this number of people observed or the number of encounters with other people, groups or activities is too many (Needham *et al.*, 2004; Needham *et al.*, 2008). These two values are very subjective and depending on the number of people interviewed, results can be completely biased and understanding user's reported encounters and perceived crowding may not reveal maximum acceptable use levels or an understanding of how use should be managed and monitored.

In assessing the socio-cultural carrying capacity it is crucial to understand the main characteristics of the surrounding community and their respective attitudes (Bimonte and Punzo, 2005; Bimonte and Punzo, n/d). While their interaction between these distinct populations (local people – endogenous species; tourists – alien species⁴) is in most cases pacific, problems occur when at a destination, the aspiration or desire to use any resource creates competition (congestion effect) or opposition (externality effect).

⁴ See Bimonte and Punzo, 2005:5

This problem of utilization of common scarce resource becomes more evident or acute as the availability of the resource is much reduced, when existing groups are mixed and with the arrival of the “alien” species’ (tourists) interests that in most cases are against those of the endogenous species (Figure 3.2).

		Residents	
		Good	Bad
Tourists	Good	Symbiotic coexistence (the lichen model)	Conflicting coexistence with adverse selection
	Bad	Conflicting coexistence with crowding-out effect	Entropic coexistence (the locust model)

Figure 3. 2: Qualitative matrix of communities’ interaction (Bimonte and Punzo, 2005; Bimonte and Punzo, n/d)

As suggested by Figure 3.2, the encounter between the two components of the two communities may give rise to different forms of co-existence which can lead to equilibrium alternate endings. In a symbiotic co-existence (lichen model), the community is suitable for tourists, sharing, rules of local communities and both communities help reduce the environmental impact surroundings (Bimonte and Punzo, 2005). In this situation, tourists maximize the value of the experience by contributing to the maximization of visit to the local community, within which no positions generate conflicting. Because the lichen model⁵ (in which each population accepts and adjusts to local rules) maximizes the total benefit of a visit, it has been described as the only situation in which the conditions for sustainable tourism can be pursued with a reduced external intervention as a result of sheer private interests (Bimonte and Punzo, 2005; Bimonte and Punzo, n/d).

⁵ Named by Bimonte and Punzo (2005) in analogy to the lichen (plant) behaviour attaching and accommodating itself to the trees and walls where it grows.

The second case, “coexistence of conflict with adverse selection”, is related to two communities which do not share the same values and norms (Bimonte and Punzo, 2005) or where a tolerant community meets and intransigent exogenous community, for example, “*an environmentally tolerant local community that encounters tourists who are uncompromisingly committed to environmental protection*” (*idem*, pg.9). In this case, the outcome of the interaction depends on which population will prevail upon the other, and upon the ensuing level of environmental degradation. Logically, the tourist population can induce virtuous behaviour in the residents, but the opposite is more likely and if this happens the less tolerant component of the tourist population would be crowded out by the more tolerant (with, hence, adverse selection), or the same component could even end up modifying its own codes of conduct to the worse (*idem*, pg.9).

In the case of “conflicting coexistence with crowding out effect”, no determined equilibrium can be foreseen as the outcome can be characterized by a conflicting coexistence with the expulsion of residents with the final result depending upon the relative strength of both populations (Bimonte and Punzo, 2005). Major outcomes of this interaction are the modification of ‘bad’ tourists’ behaviour adapting to local norms or the crowding out of residents causing possible emigration tendency.

The most dangerous situation is the entropic coexistence or the “locust model”⁶ where, although a certain degree of stability is expected as a result of cooperative behaviour, it comes in a negative sense as both populations “*participate in an exploitation strategy tolerating an impoverishment of local space resource for the sake of easy short run profits*” (Bimonte and Punzo, 2005:8; Bimonte and Punzo, n/d:8). After having cooperatively destroyed the

⁶ In analogy to the aggressive, devastating and rapidly moving behaviour of grasshoppers

resources that were the basis for tourists attraction, alien (tourists) and local (speculators) grasshoppers migrate to other destinations, leaving the pre-existing communities to “to tend to their wounds by themselves” (Bimonte and Punzo, 2005:9)

In this matrix (Figure 3.2) the matching of two played strategies gives rise to different forms of co-existence between the two populations, each associated with a qualitatively different equilibrium state, dependent upon a set of variables like the type of contact being established, the relative sizes of the two populations (one measured by stock and the other by flow measure) and the degree of internal cohesion of the two populations (Bimonte and Punzo, n/d).

To elucidate the question on how much impacts or changes are acceptable or appropriate, Manning *et al.*, (2002) applied a model based on the social impact of crowding, and two hypothetical relationships between visitor use and crowding (Figure 3.3). From this it is possible to see that visitor use and crowding are related or that with an increase in the number of tourists, visitors start feeling increasingly crowded, but it does not show the exact point where carrying capacity has been reached (Allderedge, 1972; Manning *et al.*, 2002).

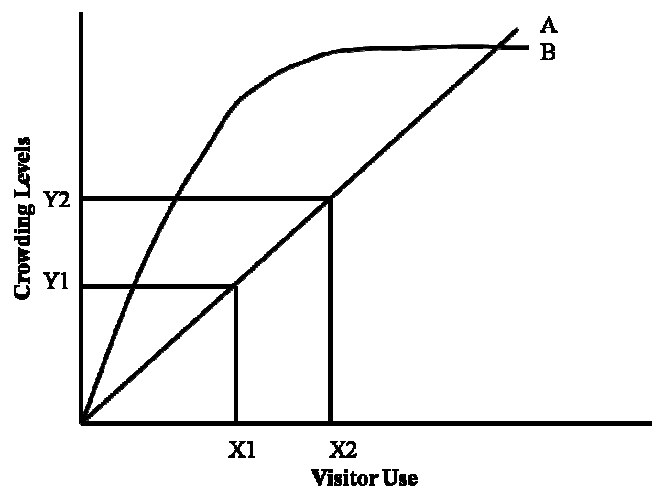


Figure 3. 3: Hypothetical relationships between visitor use and crowding (Manning *et al.*, 2002)

This hypothetical relationship shows that although some crowding is inevitable it must be tolerated if the tourism destination has to remain open for public use. But which levels of crowding should be tolerated? “As X_1 and X_2 represent levels of visitor use that result in different levels of crowding as defined by points $Y1$ and $Y2$, which of these last points represent the maximum amount of crowding that is acceptable?” (Manning *et al.*, 2002:390). This question might be difficult to answer, as the relationship between these variables (X and Y) is not always proportional and might also be difficult to manage. As suggested in the model, in a first situation the level of visitor use can be proportional to the level of crowding providing a linear rate of change (A) meaning that the level of change is dependent upon the number of visitors, whilst in a second point, the rate of change is not much influenced by the number of people, but by the sense of crowding that people feel (B).

As suggested by Manning *et al.*, (2002:389), “*how much decline or change is acceptable or appropriate before management intervention is warranted?*” In the first case (A), managers can control decline or change of resources by limiting the number of users; otherwise (B) they need other approaches to cope with the situation.

Based on the tourism lifecycle theory (Butler, 1974; 1980), Saveriades (2000) developed a framework in an attempt to answer the above presented problems. This framework (Figure 3.4) is based on the economic approach assumption that visitor satisfaction declines as use level increases and the result is that the optimum level (threshold) beyond which satisfaction begins to decline is an interaction between the marginal, average and total satisfaction levels.

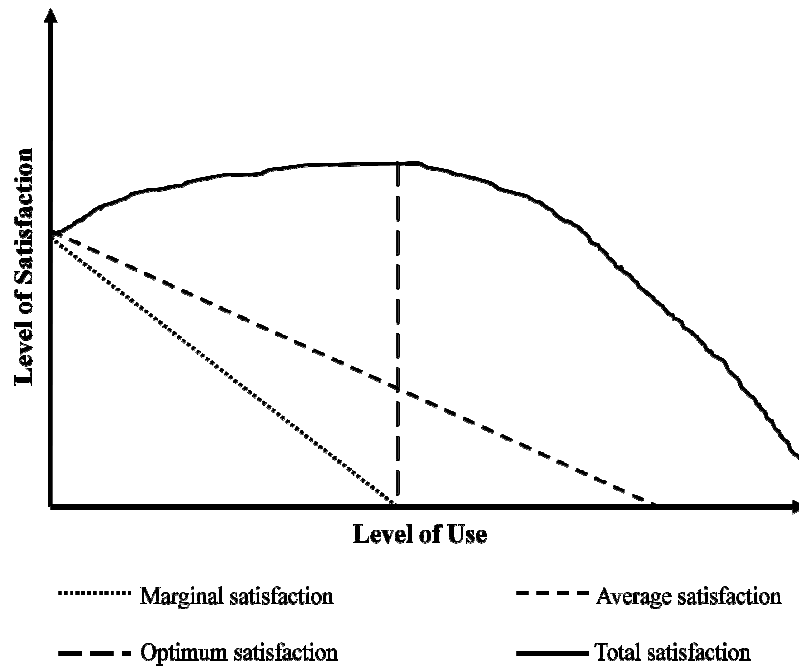


Figure 3. 4: Optimum level beyond which satisfaction declines (Saveriades, 2000 after Allderedge, 1972)

According to this model, in any tourism destination there is an optimum level of resource use that enables complete satisfaction of tourists. But this point does not mean that low levels of resource use are the most favourable. As may be seen, the level of satisfaction increases as resources are being used until it reaches a point where no more visitors are allowed. As the number of tourists increase, the feeling of crowding starts to be felt and satisfaction with the destination starts to decrease and conflicts get rise or the tourist demand decreases.

Although the problem was partially solved with this framework, concerns over theoretical responses still remained. To provide a much comprehensive mathematical solution, Manning *et al.*, (2002) introduced the people-at-one-time (PAOT) concept as a tool for social carrying capacity assessment. According to this framework, the maximum acceptable level of change (social threshold) for both groups is determined by asking people to rate different crowding

scenarios that are then processed in a computer environment to provide insights on the maximum number of people accepted (Figure 3.5).

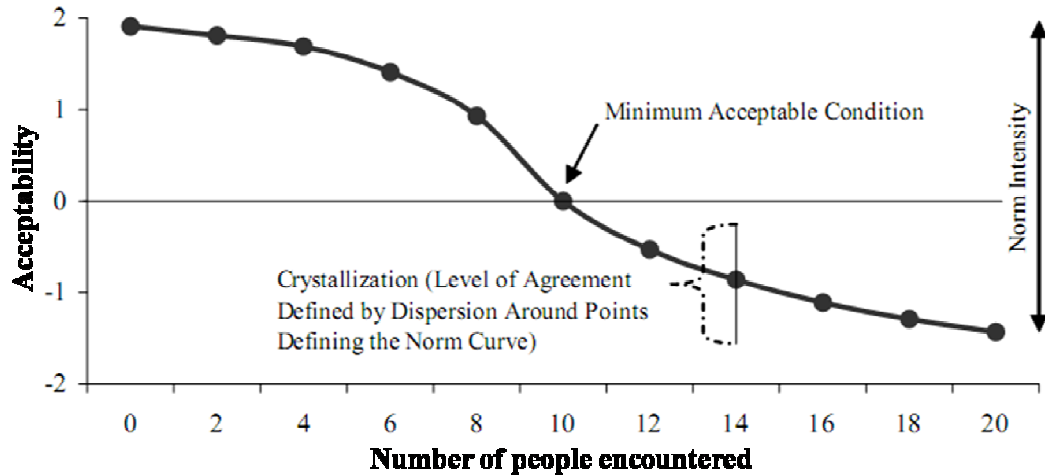


Figure 3. 5: Hypothetical social norm curve (modified from Manning *et al.*, 2002)

With the vertical axis representing evaluative responses and the horizontal axis representing the number of people encountered, the minimum acceptable condition refers to “*the point where the norm curve crosses the neutral line and indicator conditions become unacceptable*” (Needham *et al.*, 2008:6), usually representing the standard of quality of the measured indicator. To represent this change, a norm intensity curve is designed, measuring the relative distance from the neutral line at each point on the curve, independent of the direction of evaluation, a flat curve close to the neutral line suggesting that few people will be upset if the standard is violated, whereas a sharply declining or negative curve implies that more people may be impacted (Shelby *et al.*, 1996).

After applying this model, it is necessary to assess the confidence of future plans or actions. This is possible by determining the crystallization point or measure of consensus or agreement among respondents for the indicator conditions (Needham *et al.*, 2008:6). If

crystallization (average standard deviations of the points comprising each norm curve) is high, managers may have confidence in using normative data to help formulate standards of quality for carrying capacity indicators that can then be monitored and managed (Needham *et al.*, 2008 after Manning, 1999, 2007).

CHAPTER 4: PRAIA DE FARO (FARO BEACH) AND PRAIA DO TOFO (TOFO BEACH) AS SUBJECTS OF CARRYING CAPACITY ASSESSMENT

This chapter presents the research sites for this report (Faro and Tofo beaches). It starts by briefly describing the coastal zone of Portugal and Mozambique and then outlines the main characteristics of the beaches in relation to the history, physical characteristics and man-made parameters.

4.1 The coastal zone of Portugal

According to Veloso Gomes *et al.*, (2007:7), the coastal zone of Portugal is “*the most complex and environmentally rich complex in the country, with great concentration of habitats and important biological diversity*”.....“*Its biophysical support has its own peculiarities that are examples estuaries, lagoons, dunes, cliffs, the hydrological environment, groups of islands and beaches*” (idem, pg.84). It stretches for approximately 1853 km – distributed by 950 km for the continental area, 691 km for the Azores Islands and 212 km for the Madeira Islands (Figure 4.1). Of this length, cliffs and beaches are the dominant features forming around 348 and 591 km respectively (Andrade and Freitas, 2002).

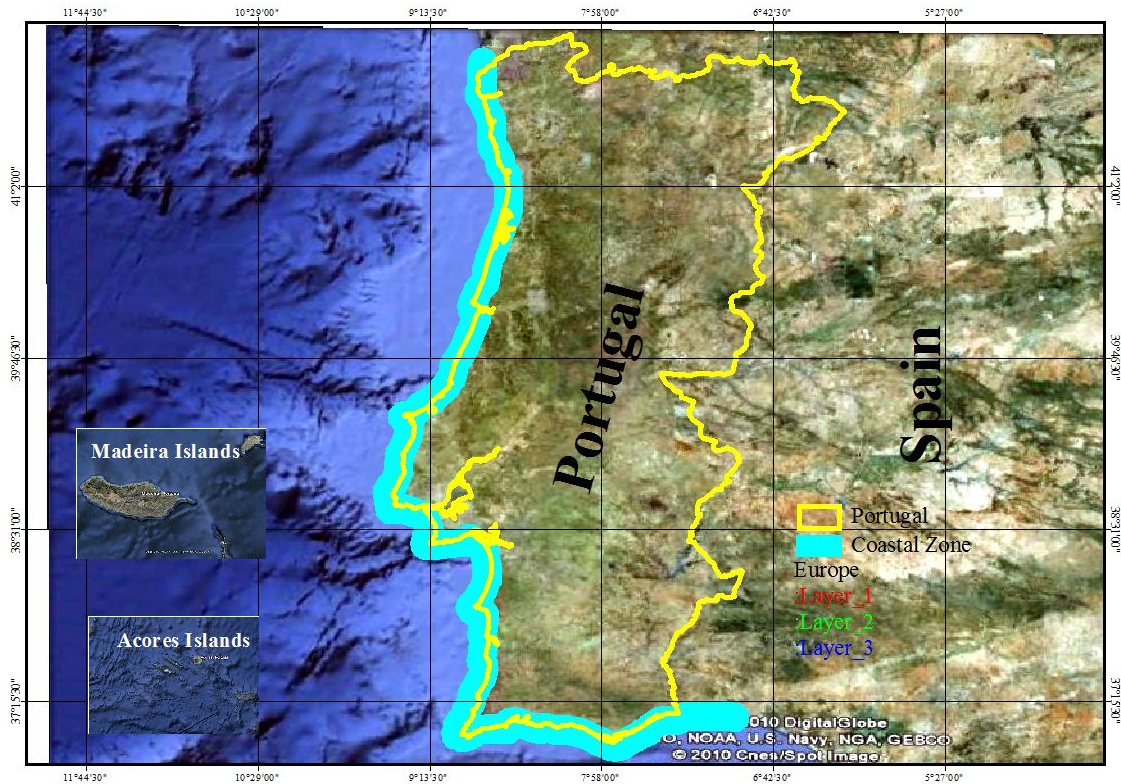


Figure 4. 1: The Portuguese coastal zone (Instituto da Agua, n/d)

The Portuguese coastal zone has high geomorphological dynamics resulting from marine processes (waves and currents) and also as a result of human intervention in river basins (major sources of sediments) and coastal defense (stabilization of the coast for occupation purposes). The Algarve coast (where Faro beach is found) is sheltered from the main maritime storms from west and northwest, registering, however, situations of sea waves from southeast that must not be overlooked (Instituto da Agua, n/d).

4.1.1 Praia de Faro (Faro Beach)

The Faro Beach (Praia de Faro) is located in the Ancão Península, the most western system of barrier islands of the Ria Formosa (Figure 4.2). It is located in the middle zone of the Ancão Inlet which tends to migrate eastwards (Dias *et al.*, 2004 after Weinholtz, 1978).

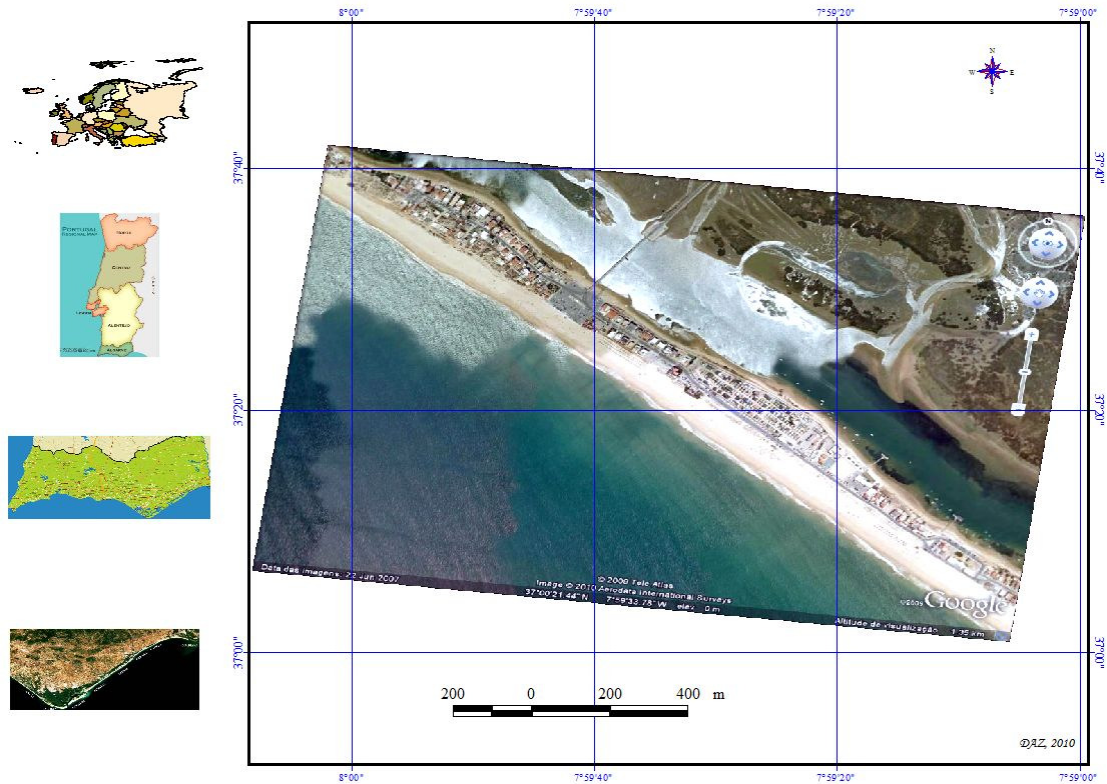


Figure 4. 2: Geographic representation of Praia de Faro (Faro Beach)

The Ancão spit is approximately 10 km length but changes temporarily with migration of the Ancão tidal inlet (Ciavola *et al.*, 1998). Average wind speeds rarely exceed 60 km/hour, blowing dominantly from the southwest, although high-energy events sometimes occur from the northeast and from southeast. Pessanha and Pires (1981) indicated that the typical average values of significant wave height and periods are 0.9m and 5.0 s. Faro beach consists mainly of quartz sands with a smaller fraction of small pebbles and biogenic material.

From the northern “tip” to the urbanized area, the dune is elevated (in some points >10 meters) with some evidences of some overwash that can reach 35 meters in length. The urbanized area (the ‘proper’ Praia de Faro) constitutes the central part of the Ancão Peninsula and is the only place of the system easily accessible by car. Here, the dune chain is totally destroyed; buildings have been disorderly placed so that in times of high waters some houses

can be flooded. Between the urbanized area and the Ancão Inlet, the dune chain becomes narrower until it completely disappears.

According to Dias (1993), Bernardo and Dias (2003), this area is very dynamic because for long periods the area was not heavily occupied. Problems began with the construction of a bridge linking the beach to the continental area. As a result, legal or illegally, the human population increased without any observation of aesthetic and urbanity principles.

4.2 The coastal zone of Mozambique

The coastal zone of Mozambique extends from the Rovuma River in the northern tip of the country (bordering with the Republic of Tanzania), to the southern tip at Ponta do Ouro (bordering with South Africa), encompassing all districts that have any kind of sea contact (Figure 4.1). Two criteria are used to define the Mozambican coastal area: first, the 12 miles of territorial waters and second, the abundance of marine resources, particularly valuable economically (Massinga and Hatton, 1996; MICOA/IUCN/NORAD, 1998; Hogueane, 2007).

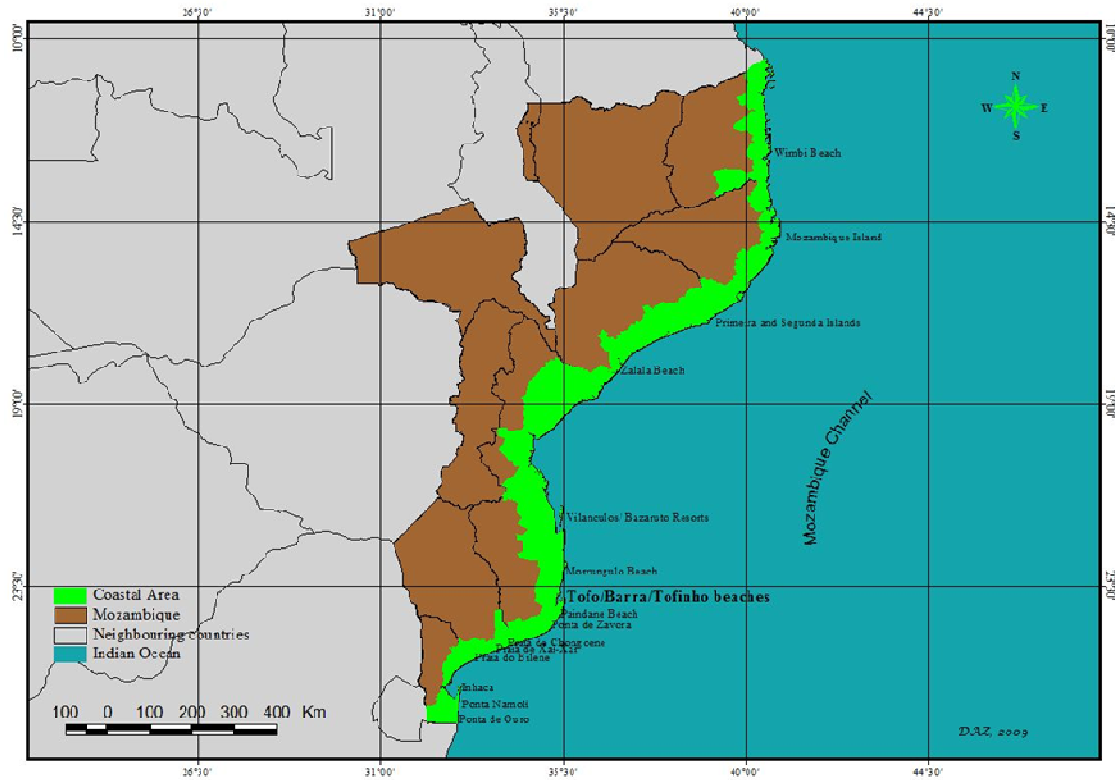


Figure 4. 3: Coastal Zone of Mozambique (the author, based on MICOA/IUCN/NORAD, 1998)

Mozambique has a wealth of beaches along the 2700 km of coastline. At the northern tip (from the Rovuma River to Angoche; Figure 4.3), it is characterized by rock beaches that safeguard many species of fish, lobsters and prawns which play an important role in coastal area stabilization. In the central part of the country, beaches are composed of mud as a result of many rivers and abundance of mangroves. In the southern region (parabolic dunes coast), beaches are sand with dunes reaching >100 meters, that are considered as being among the highest vegetated dunes in the World (Tinley, 1971; Hatton, 1995; Massinga and Hatton, 1996).

This composition makes northern beaches stable with respect to the southern beaches with sand beaches with very high sand dunes covered by fragile vegetation (MICOA/IUCN/NORAD, 1998; Fiege *et al.*, 2002). Beaches act as nurseries for many fish

and molluscs' species and are important areas for turtle nesting. In this habitat it is possible to find several animal species, such as turtles and sea mammals, some of them in risk of extinction.

4.2.1 Praia do Tofo (Tofo Beach)

Tofo Beach is a small stretch of the littoral zone of Mozambique, located in Inhambane province just 500 km from the main city (Maputo). It is part of the Tofo-Barra-Tofinho microregion (MICOA, 2002) with the Indian Ocean (east and north), the district of Jangamo (south) and Inhamua cottages (west) as main boundaries (Figure 4.4).

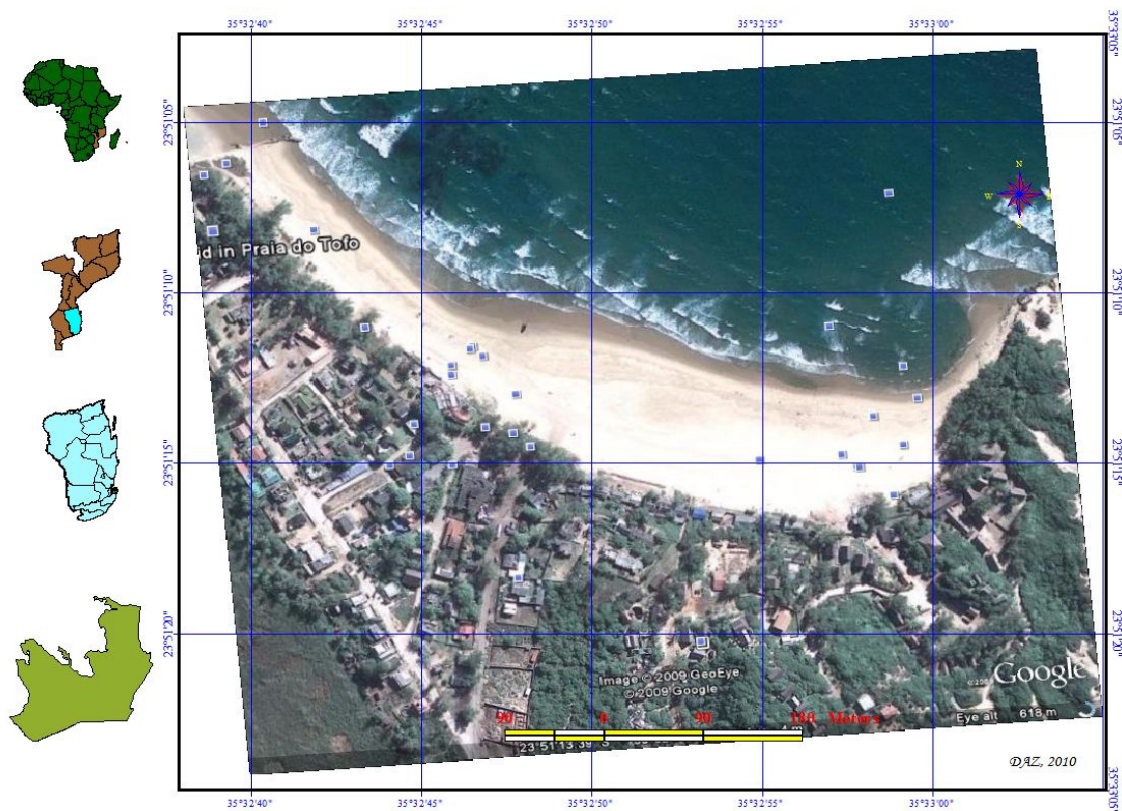


Figure 4. 4: Geographic location of Tofo Beach

It is a rural, natural and wave-dominated beach with relative tide range (RTR) <3m and with massive coral reefs just a few meters onshore. In addition, it is a dissipative log spiral sand

beach⁷. It is located in the parabolic dune coast ranging from the Bazaruto Islands southwards to Ponta de Ouro, characterized by north-oriented capes and barrier lakes and high parabolic dunes, attaining heights >120 m. This stretch of the coast has grey sand and very deep soils with low water retention capacity (Gulube *et al.*, 2004).

The dune vegetation can be divided into three sections from the sea to the mainland:

- first, there is a pioneer community adapted to direct sea action and extreme salinity conditions, wind and morphologic changes of the soil, that works as a dune fixator;
- then a second community characterized by dense shrubs that progressively mix with other species less tolerant to extreme conditions and,
- finally trees and herbs adapted to shadowed environments. Although they are the boundary and natural defence of the mainland habitats from the sea and winds, the dunes at Tofo Beach are severely affected in some places by construction of tourist infrastructures and houses, car driving and small cultivation fields that are by themselves a potential source of erosion.

Some small mammals can be found in this ecosystem such as the blue monkey (*Cercopithecus aethiops*) and dune hairy-footed gerbil (*Gerbillurus tytonis*); 72 species of birds such as the brown-headed parrot, abyssinian ground-hornbill (*Bucorvus abyssinicus*), peregrine hawk (*Falco peregrinus*) and several species of shrikes and doves. Corals are distributed all over the study area with some abundance as coral reefs or aggregated communities and rock platforms. There are several soft corals from the genus *Lobophytum* and *Cladiela* that according to dive operators and divers are of good quality and the diversity

⁷ For clear understanding of beach classification, see Komar (1976) and Williams and Micallef (2009)

of resident organisms is very high. Sea mammals are abundant and are a great attraction in this area. Jubarta whales (*Megaptera novaeangliae*) and *Balaenaoptera acutorostrata*, indo-pacific humpback dolphin (*Sousa chinensis*) and bottlenose dolphin (*Tursiops truncatus*) are easy and regularly seen. Spontaneously, it is possible to see dugongs (*Dugon dugon*), a rare and CITES species.

Other species of great importance are sea turtles that nest in the beach. Five species are believed to occur in or near Tofo Beach with emphasis on the hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*) and the green turtle (*Chelonia mydas*), but their appearances are reducing as a result of hunting and increased difficulties to nest due to dune destruction, beach trampling, animals, and coastal erosion (natural and man-made).

Whilst the marine zone is under the influence of the warm currents of the Mozambique Channel, the mainland is naturally limited by a coastal lagoon, providing this beach with just a longitudinal development perspective. The climate is warm and tropical with the average temperature ranging from 26 to 30° Celsius with sunny and warm days even in coarse midwinter when is chilling elsewhere. Summer months ranges from October to April (rainy, humid, and very hot) and winter months are from April to September (cooler and drier but providing the most comfortable tenure for travel) with average annual rainfall ranging 800 to 900 mm (Louro, 2005).

It was 'discovered' by the colonial regime during the 60's. During this period, holiday houses were built and in 1970 the first hotel was constructed. In the same period a permanent road linking the beach with the main city centre (Inhambane) was concluded with an extension of

21 km. In 1972 the first urbanization plan was designed but as a result of political changes, no first class infrastructure was developed and the area remained in its natural state.

During the civil war (1986-1992), beach urbanization was interrupted and many houses abandoned. After the peace accord (1992) and especially after 1994, tourism restarted in the area mainly through foreign investments that created lodges, bars, diving schools and new holiday houses, all following the ancient plan, but with low investments, no accessibility improvements and using local materials. In the following years, beach urbanization created a heterogeneous situation with isolated lodges, abandoned houses and new diversified houses appearing over the vegetated dunes and occupying the most attractive places. As a result, this beach turned into an attractive place for many tourists from South Africa, Zimbabwe and Europe coexisting with swimmers, divers, artisanal fishers and sport fishers in a small, public and multicultural holiday *villa*.

Compared to other tourist centres in the province, Tofo has a low level of developed infrastructure. It has a permanent road, electric supply network, water supply and communications through mobile and landlines. Unfortunately, these parameters do not reach the standards designed for a public beach that attracts thousands of people in high season.

CHAPTER 5: CONCEPTUAL FRAMEWORKS AND RESEARCH METHODS

Several methods and approaches have been extensively used to assess carrying capacity in coastal areas (Pereira da Silva, 2002; UNEP/MAP, 2003; Caneday, 2005). Unfortunately, none of these methods have been utilised in the study areas, as no previous studies have ever been conducted. To develop this study a combination of literature analysis, field surveys, structured interviews, stakeholders' mapping tool and scenario analysis were employed as outlined in Figure 5.1.

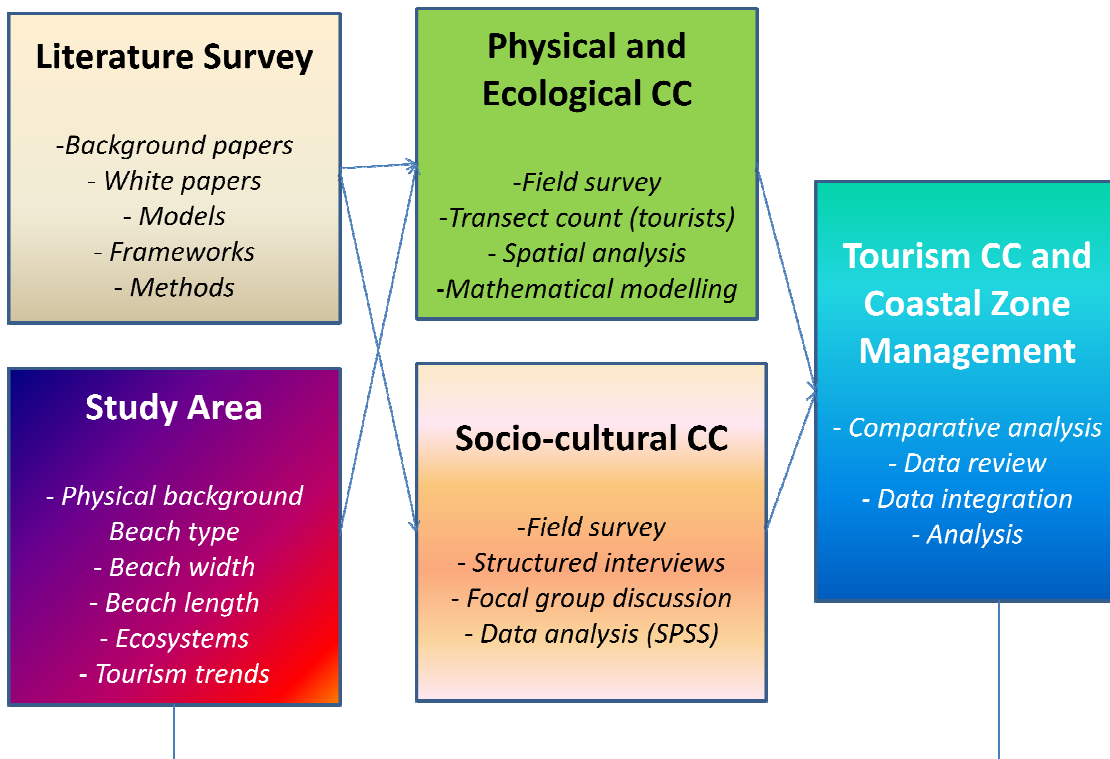


Figure 5. 1: Diagrammatic representation of the methodological approach

Application of the carrying capacity method in a broad way involves a decision-making context for definition of policies and strategies of recreational settings, covering the development of six main phases (analysis of the system; analysis of tourism development;

definition of total carrying capacity; strategy formulation; implementation and monitoring and evaluation), as suggested by figure 5.2 (Coccossis *et al.*, 2001; 2002; Beni, 2003 after Cifuentes, 1992).

From Figure 5.1 and based upon a review of methods used in previous tourism and recreation studies, a combination of field surveys, survey designs and analyses were incorporated. Whilst field surveys were used to assess the physico-ecological carrying capacity, other surveys were used to assess opinions and perceptions of different stakeholders in order to determine the how the usage of tourism space has exceeded or not the carrying capacity.

5.1 Physico-ecological carrying capacity

To assess the physical and ecological carrying capacity, the approach developed by Cifuentes (1992), and further explained and applied by Ceballos-Lascurain (1996), Amador *et al.*, (1996), Cifuentes (1999), Cifuentes, *et al.*, (1999), Munar (2002), Brenes *et al.*, (2004), Davila (2005), Vasquez (2005), Lincoqueo (2005), Antillo *et al.* (2008), Serrano and Alarte (2008), Aranguren *et al.*, (2008), Lobo (2008); Segrado *et al.*, (2008), Serrano and Alarte (2009), Sargent *et al.*, (2009), Pavon and Arroyo (2009), Dominguez and Condoy (n/d), Porto *et al.*, (n/d), was used.

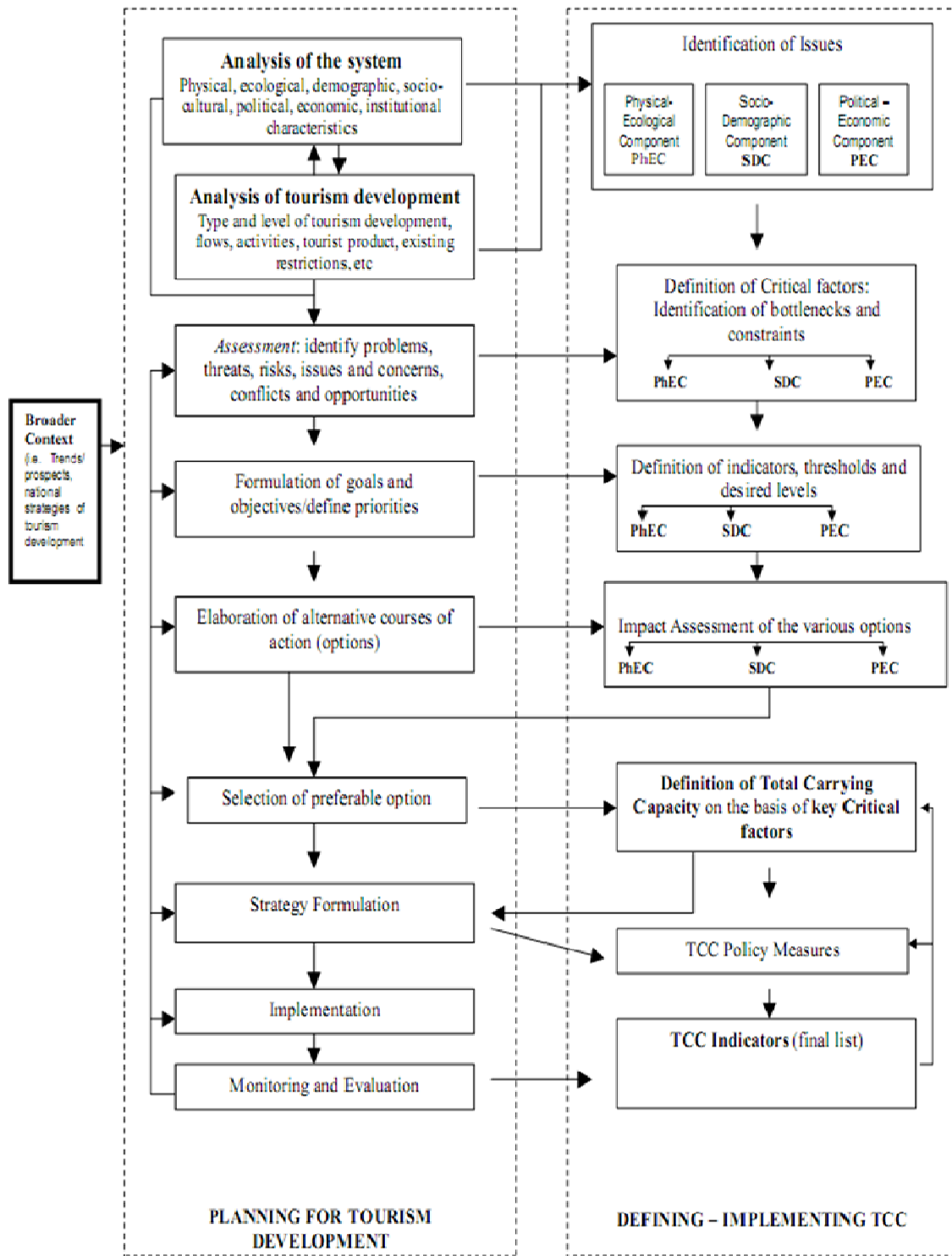


Figure 5. 2: Tourism carrying capacity assessment as part of a planning process. In this model, PhEC stands for physical-ecological carrying capacity, SDC for socio-demographic carrying capacity and PEC stands for political-economic carrying capacity

This approach tries to establish the maximum number of visits that an area can have based on the physical, biological and management conditions of the area, considering three main levels: the physical carrying capacity, the real carrying capacity and the effective or permissible carrying capacity (Cifuentes *et al.*, 1996; 1999). To apply this method (Figure 5.3), it is important to consider tourist flows, the size of the area, the optimum space available for each tourist to move freely and the visiting time (Cifuentes, 1992).

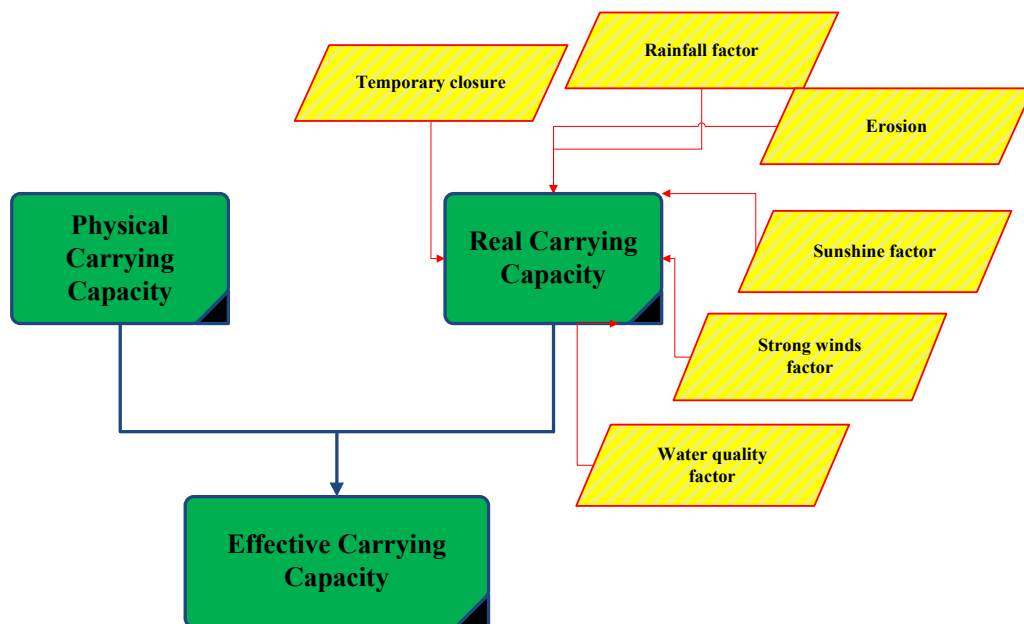


Figure 5. 3: Dimensions of the physico-ecological carrying capacity (adapted from Cifuentes, 1992; Cifuentes *et al.*, 1999; Serrano and Alarte, 2008)

Based in this model, the physical carrying capacity or the maximum number of visitors that can physically fit into a defined area over a particular time (Cifuentes *et al.*, 1999), was determined by the Equation:

$$PCC = \frac{A}{A_u} \times R_f$$

Equation 1

Where:

PCC = physical carrying capacity

A = size of the study/ visited area

A_u = area required per user

Rf = rotation factor (number of visits per day). Due to time constraints and because no previous research had been conducted in either beach, this value was adapted from areas with similar characteristics. As such, the rotation factor for Faro Beach was established as 4 based on research results provided by Solé (2007) for Spanish beaches and at Tofo Beach the rotation factor was 3 based on results provided by Silva *et al.* (2008) for Brazilian beaches and DeRuyck *et al.* (1997) for South African beaches.

Because the carrying capacity is intrinsically related to the impact of users at a destination, an attempt to assess the spatial distribution of beach users was conducted based on a modification of the linear transect method (Loya and Slobodkin, 1971; Loya, 1972; Porter, 1972; Rogers *et al.*, 2003) originally employed for ecological studies was used (similar approach applied by Silva *et al.* 2008). Therefore, thirty seven transects (twenty four at Praia de Faro and thirteen at Tofo Beach respectively) were designed and tourist counts taken every 15 metres with the first count being observed in the water, as shown in Figure 5.4 and Figure 5.5. All data were processed in a geographic information system environment using ArcView 3.2 with the aid of the Home Range Extension tool.

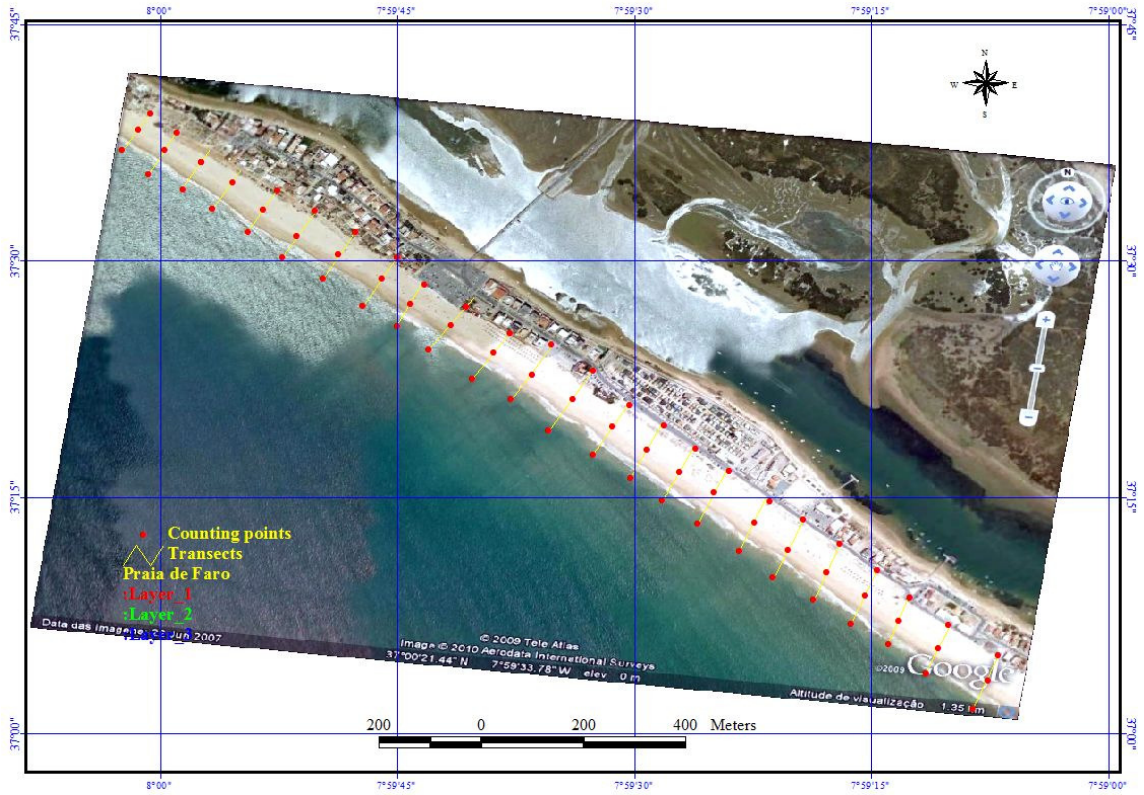


Figure 5. 4: Transects and counting points of tourists at Praia de Faro (Faro Beach)

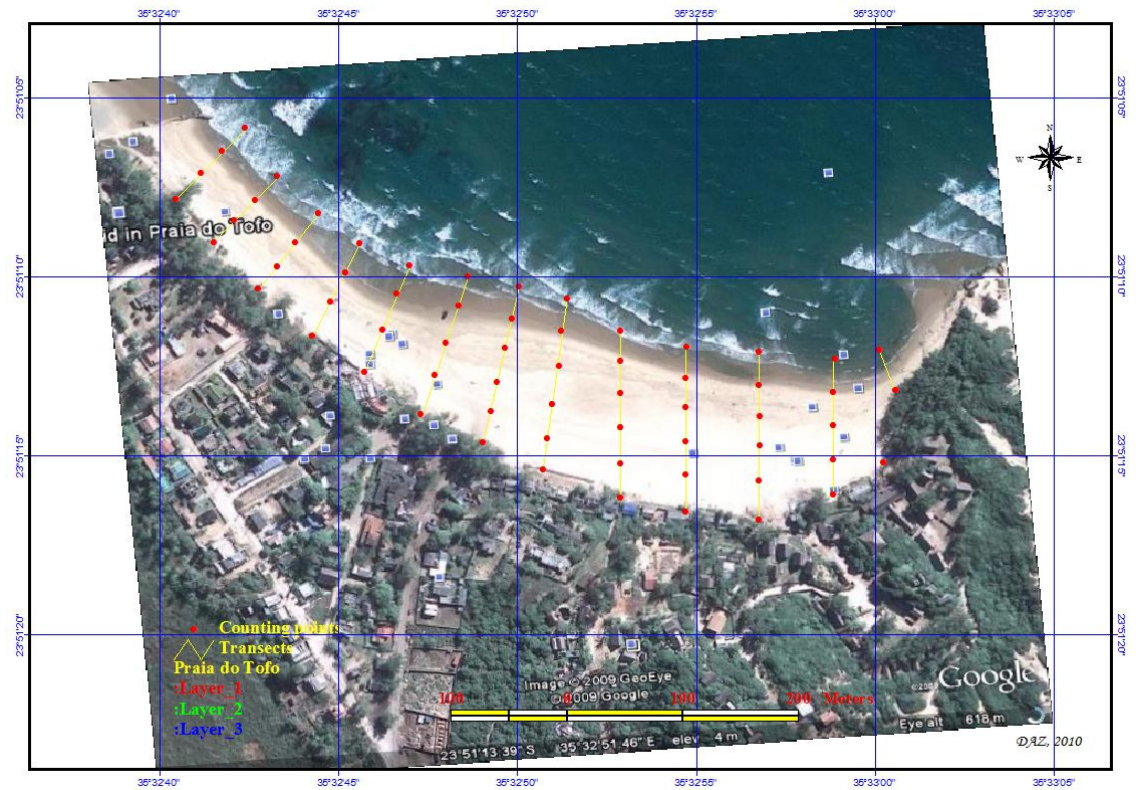


Figure 5. 5: Transects and counting points of tourists at Tofo Beach

The real carrying capacity or the maximum permissible number of visits to a specific site, once correction factors derived from the particular characteristics of the site have been applied to the PCC, was determined by the Equation:

$$RCC = PCC \times (cf1 \times cf2 \times cf3 \times \dots \times cfn)$$

Equation 2

Where:

RCC = real carrying capacity

PCC = physical carrying capacity

cf₁...cf_n = correction factors, determined by the Equation:

$$Cf_x = 1 - \frac{Lm_x}{Tm_x}$$

Equation 2.1

Where:

Cf_x = correction factor of variable x

Lm_x = limiting magnitude of variable x

Tm_x = total magnitude of variable x

The effective carrying capacity or the maximum number of visits that a site can sustain considering the RCC and the management capacity is a result of the combination of the real carrying capacity with the management capacity of the area, as described by Equation (3):

$$ECC = RCC \times Mc$$

Equation 3

Where:

ECC = effective carrying capacity

RCC = real carrying capacity

Mc = management capacity

All these attributes are computed in such a way that the physical carrying capacity is higher or similar to the real carrying capacity which is thereof higher or similar to the effective carrying capacity as outlined by the relation below.

$$PCC \geq RCC \geq ECC$$

5.2 Socio-cultural carrying capacity

With both beaches continuing to develop as a community and tourism destination, there is a need for preserving the nature and values of local people. One way to address this issue is to capture the perceptions and opinions of multiple stakeholder groups to build a holistic view of tourism conditions and obtain an insight as to whether future problems may occur.

Data was obtained from surveys⁸ administered at Faro Beach (8th July – 15th August) and at Tofo Beach (29th August – 25th October). During these weeks, following a random procedure for days of the week and periods of time, visitors to the beach were approached and asked to fill in a questionnaire. Standard procedures were applied in order to obtain 10% of the total number of tourists in the beach (Needham *et al.*, 2008). Questionnaires included a wide range of topics, from prior visitation, activities involved, the level of satisfaction, encounters, crowding, norms, values and potential support to management strategies in a combination of close-ended questions and five-point Likert-scaled questions. All questionnaires were incorporated in a Microsoft Excel datasheet for data collapsing and integration and, where necessary, analysis were conducted using the Statistical Package for Social Sciences (SPSS version 17.0) looking for percentages, cross-tabulations and multivariate statistical techniques (chi-square, t-tests conjoint modelling).

⁸ Applied questionnaires are in Appendices 1 and 2

Chapter 6: RESULTS AND DISCUSSION

This chapter outlines the main outcomes from applications of the conceptual framework and research methods explained in chapter 5. It commences by presenting results of the physico-ecological carrying capacity (how many tourists should be allowed at the beach considering its ecological values) and then presents the socio-cultural carrying capacity (what is the perceived interaction between tourists and local people and among tourists and what is the maximum number of people that should be allowed considering these groups' views). Finally, it outlines the management capacity for coastal tourism management at both countries (Portugal and Mozambique).

6.1 Physico-ecological carrying capacity

Whilst Faro Beach covers an area of 90,000 m² (1800 m long and 50 m wide), Tofo Beach is a small stretch of the littoral zone of Mozambique covering an area of 95,496 m² (a length of 692 m and width of 138 m). Both beaches are very seasonal for tourists, with tourist flows concentrated in the summer season, although at Tofo Beach it is possible to find tourists almost all year round, reaching the peak during holidays and in the last and first two weeks of each year.

To assess the average number of tourists found in the beach and their spatial distribution, a field count of tourists was undertaken everyday from 8th July to 15th August (at Faro Beach) and every weekend from 29th August to 25th October (at Tofo Beach). Results of this procedure show a concentration of tourists ranging from 7 to 112 beach users with an average estimation of 102 tourists per day at Faro Beach (Portugal) and from 1 to 135 with an average estimation of 46 tourists per day at Tofo Beach (Mozambique). Integration of the results from the above method into a Geographic Information System (GIS, ArcView 3.2 software)

showed an irregular distribution pattern for beach users at Faro Beach with tourists occupying the entire extent of the beach with a preference to be near water (Figure 6.1); whilst at Tofo Beach tourists have a concentrated pattern with most staying near the main entrance of the beach or swimming in the first 5 meters of water (Figure 6.2).

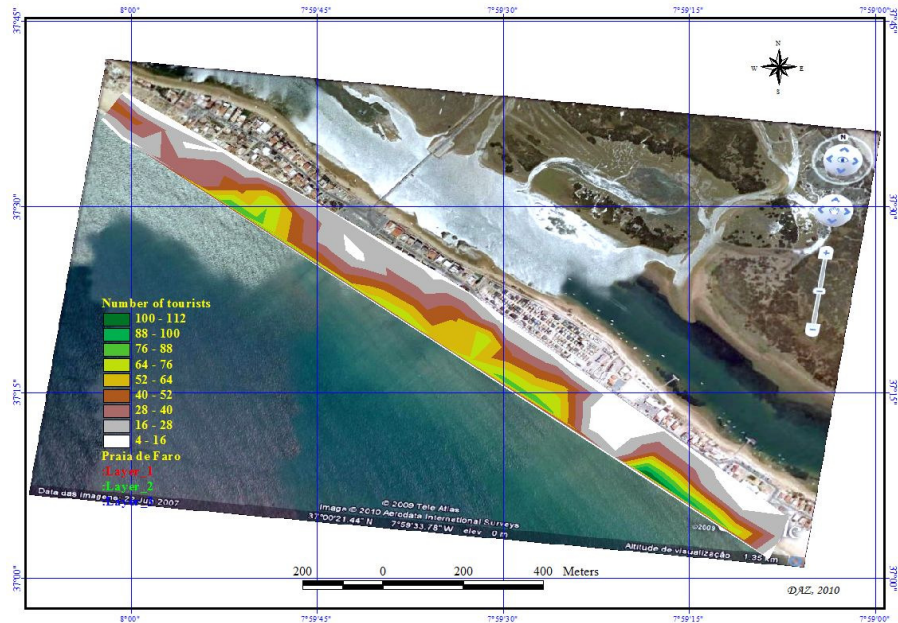


Figure 6. 1: Spatial distribution of tourists at Faro Beach between 8th July to 14th August, 2009

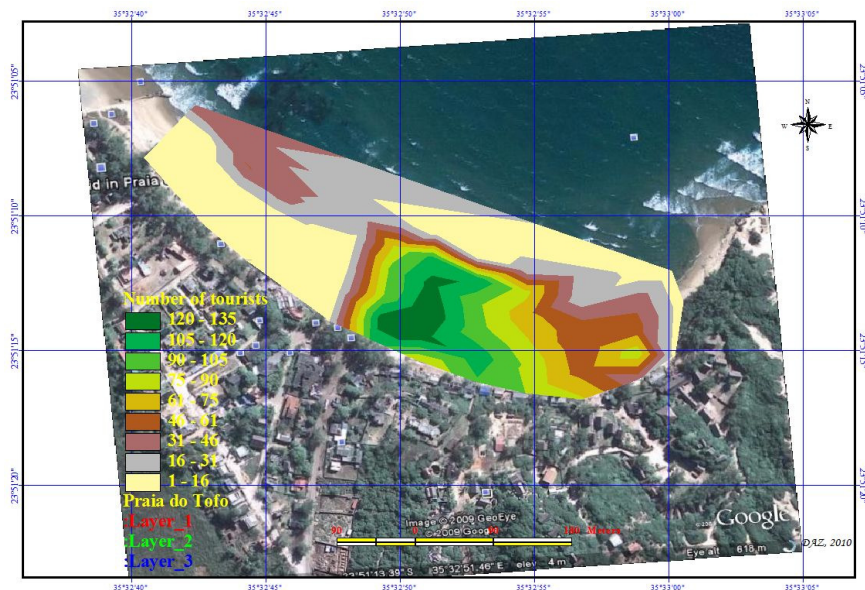


Figure 6. 2: Spatial distribution of tourists at Tofo Beach between 29th August and 25th October, 2009

Considering the levels of tourism use and the physical and ecological characteristics of the study areas, associated to planning indicators, the carrying capacity is as outlined in Table 4.1 (for further details see appendix 3A and 3B):

Table 4. 1: Carrying capacity indicators at Faro and Tofo Beaches

Carrying Capacity	Faro Beach (Praia de Faro)		Tofo Beach (Praia do Tofo)	
	Scenario 1 (5 m ² / user)	Scenario 2 (10 m ² / user)	Scenario 1 (5 m ² / user)	Scenario 2 (10 m ² / user)
PCC	72,000 visits	36,000 visits	57,298 visits	28,649 visits
Correction Factors				
Rainfall	0,6712		0,6712	
Winds	0,6658		0,75	
A. Sunshine	0,3425		0,5	
Water quality	N.A.		0,980	
Beach Erosion	0,966		N.A.	
T. Closure	0,3342		N.A.	
RCC	3,558	1,779	14,134	7,067
Mc	83.8%		75%	
ECC	2,982	1,491	10,601	5,301

Source: The author based on fieldwork data

To establish carrying capacity indicators, the Protected Area Carrying Capacity Estimation Framework (Cifuentes, 1992) adapted to the intrinsic characteristics of the study areas, was used. Although it has been extensively used in protected areas, under some modifications, this method becomes a great tool for beaches considering tourist demand, its complexity and other relevant variables. Another reason for adopting this method is consideration of the models of the evolution of tourism destinations of Cohen (1972), Butler (1980) and Smith (1989), that suggested that mature tourism destination (in this case mass tourism beaches) should apply

direct techniques of tourism planning, especially in those where there is little contact with local people.

The rotation factor was estimated as being 4 times at Faro beach and 3 times at Tofo beach (see chapter 5), meaning that beach users at Faro beach stay less time than these at Tofo Beach (these values are only theoretical as smaller and larger values can be found during peak seasons, winter and summer, respectively). Considering the area of each respective beach (90,000 m² and 95,496 m²) and an optimum area available per user (5 m² for scenario 1 and 10 m² for scenario 2), the physical carrying capacity was estimated at 72,000 and 36,000 visits/day (scenario 1 and 2 for Faro Beach) and 57,298 and 28,649 visits/day (scenario 1 and 2 for Tofo Beach). This means that the maximum number of visits at the beach should never exceed this range and demonstrates the importance of the rotation factor as a management indicator for beach tourism management strategies development.

Hence, these numbers are only theoretical; an understanding of the complexity of accommodating huge numbers of people in a small and sensitive piece of land is much more complex. In such a case, the above number of people would be a great danger to the physical beach setting and the recreation activity would be in great danger. Considering that tourism activities are dependent on environmental characteristics, six correction factors were considered for this study: rainfall, strong winds, absence of sun (applied for both beaches), water quality (only applicable at Tofo Beach) and beach erosion and temporary closure (only applied for Faro Beach). These indicators were selected because of their limiting power in the tourism activity, facility of analysis and because they enable the measurement of the sustainability level of a tourist destination.

Data for these parameters were obtained from White Papers and papers published regarding these two areas. For Faro Beach, these were found in MAOT (2000), Dias *et al.*, (2004) and Ciavola *et al.*, (1998), whilst for Tofo Beach data were collected from Reddy (1984), Westerink (1996) and Reddy (1986) using data from the Inhambane Municipality' Meteorological Station (the nearest to the study area).

Rainfall: Four months are of particular interest in the climatic pattern of the southern tip of Portugal and Mozambique, affecting mainly the coastal zone: November, December, January and February. Although these months are the coldest in Portugal, they register the highest rain patterns with more than 400 mm on average (MAOT, 2000), whilst in Mozambique are associated with high temperatures (above 30°C) and excessive rains (Westerink, 1996). The limiting magnitude for rainfall was determined as 120 days/year, while the total magnitude was the total days of the year (assumed as 365). Therefore, the correction factor for rainfall was determined as 0.6712 or 67.12% (see Appendix 3).

Strong winds: this factor was included as it can largely influence the recreational satisfaction of people on the beach by transporting large amounts of sand and or by creating strong waves that can reduce satisfaction of many beach users (except beach surfers that might enjoy these times). Whilst in Portugal four months are particular importance as a result of the eastern (Levante) winds (June, July, August and September), three particular months are important for these attributes in Mozambique: December, January and August (Reddy, 1986). The limiting magnitude was determined as 122 days/year for Faro Beach and 90 days/year for Tofo Beach while the total magnitude remained all days of the year (365 days). The corrective factor for this parameter was 0.6658 (66.58%) for Faro Beach and 0.75 (75%) for Tofo Beach (see Appendix 3).

Water quality: this factor is considered as being one of the most important factors in beach tourism (McKenna *et al.*, 2000; Micallef and Williams, 2009). Although water quality is exceptionally good at Tofo Beach, there are times of the year when the water becomes relatively turbid as a result of strong winds and natural upwelling, particularly visible during the last week of October. During this week, beach attendance reduces significantly as many people go to the beach for swimming⁹. The limiting magnitude was 7 days/year, the total magnitude was 365 days and the correction factor for poor water quality was calculated as 0.9808 (98%). Because Faro Beach was awarded a Blue Flag, this parameter was not considered in this beach (details are available in Appendix 3).

Sunshine: this can be the most important factor for beach tourism as without sunshine few people go to the beach for recreational activities. Whilst at Faro Beach the bathing season is from 1st June to 30th September, at Tofo Beach people can go at anytime of the year, but the absence of sunshine can act as a limiting factor, mainly during the night (when it is relatively cold). According to MAOT (2000), The Algarve region has 3,000 hours of sun per year meaning that in 5,760 hours there is no sunshine. The limiting magnitude for the absence of sunshine was determined as 5,760 hours at Faro Beach and 4,380 hours for Tofo Beach, with the total magnitude remaining the entire number of hours of the year (8,760). As a result, the correction factor of this parameter was determined as 0.3425 (Faro Beach) and 0.5 (Tofo Beach (see Appendix 3).

Temporary closure: According to the Act 44/2004 of 19th August, the bathing season for Faro Beach is established from 1st June to 30th September. This parameter means that the beach is officially closed for the entire eight months of the year (January, February, March, April,

⁹ See point 6.2, this dissertation

May, October, November and December). This is a real limiting factor for tourism at Faro Beach, although at Tofo Beach this parameter is not applicable. The limiting factor for this parameter was determined as 243 days and the total magnitude was also 365. As a result, the correction factor was calculated as 0.3342 (33.42%) only applicable to Faro Beach (Appendix 3).

Erosion: this parameter is of great importance for beach tourism, as it reduces available space for recreation. For the study areas it has a great importance as both face the same problem, but because of data absence it was only applied to the Faro Beach. Considering results provided by Dias *et al.*, (2004) and Ciavola *et al.*, (1998), Faro Beach faces an erosion index of 1.7 m/year. Using this parameter and ignoring beach nourishment, it may be assumed that Faro Beach is losing 3,060 m²/year (1,7 m width x 1,800 m long). Therefore, the limiting factor was determined as 3,060 m², the total magnitude was the total area of the beach (90,000 m²) and the corrective factor was calculated as 0.966 (96.6%). Details can be seen in Appendix 3.

Considering the above values and as a result of application of Equation 2¹⁰, the real carrying capacity was estimated at 3,558 and 1,779 visits/day (scenario 1 and 2 respectively, at Faro Beach) and 14,134 and 7,067 visits/day (scenario 1 and 2 respectively, at Tofo Beach)¹¹. This means that although a certain amount of tourists can fit in at the beach, reality shows a different situation, because as the number of beach tourists increases, visitors feel that the destination is losing quality, the capacity to recover the beach is costly and the environmental quality smoothly decreases its natural properties (Aranguren *et al.*, 2008).

¹⁰ See point 5.1, this report

¹¹ The procedures to achieve these results were based on formula 2, 2.1 and 3. Every step can be followed in Appendix 3.

Although the carrying capacity has significantly decreased, an important aspect should be included: the management capacity of the beach. According to Cifuentes (1992), to measure management capacity it is necessary to address several variables such as the juridical background, policies and regulations, equipment, personnel, funding, infrastructure and facilities and the management capacity would be defined as “*the best status or conditions that beach administrators should keep in order to develop their activities and meet proposed objectives*” (Cifuentes, 1992:22; Cifuentes *et al.*, 1999:23).

For the case of Tofo Beach, many of these parameters were not used, mainly because it is an open beach with public access classified by the Ministry of Tourism of Mozambique (MITUR) as a priority area for tourism investments (Governo de Moçambique, 2004) included in four major tourist routes and as a result the beach is purposely open to massive domestic and international tourism (*ibid*, p.59-65).

Considering these arguments, the management capacity was determined using only infrastructure and equipments available (for Tofo Beach), while other parameters were included for Faro Beach. These parameters were assessed based on beach users’ perception and evaluation¹² during the survey period. As a result, the management capacity was only 83.8% and 75% (Faro and Tofo beaches respectively) and the effective carrying capacity was calculated as 2,982 and 1,491 visits/day (scenario 1 and 2 at Faro Beach) and 10,621 and 5,301 visits/day (scenario 1 and 2 at Tofo Beach).

As suggested by Cifuentes (1992), Cifuentes *et al.*, (1999), Arangunen (2008) and Segrado *et al.*, (2008), these results should not be accepted easily, as interpretation can assume several

¹² See point 6.2, this report and Appendix 2

forms. The 1,491-2,982 and 5,301-10,601 range/day respectively for Faro and Tofo beaches respectively indicates the number of people that should be allowed in the beach with existing conditions and management capacity, but, during one season there are days with much more people and days without people in the beach.

Generally, tourism as a vehicle of culture, prosperity and peace (Patil and Patil, 2008) must conserve without damaging, protect without plundering and create without destroying. Especially in coastal areas, this statement achieves greater significance if we understand beaches as eco-social landscapes (Baldwin, 2009) where use patterns, perceptions and behavioural attitudes are completely dependent on the users or tourists. As a result of these patterns, there is a need to preserve and protect these fragile natural sites but at the same time enabling full enjoyment of people.

By determining the usage level of an area without exceeding certain levels, the physical carrying capacity has been extensively viewed as a panacea for beach management and a tool to reduce impacts from tourism (Patil and Patil, 2008). However, Lindberg and McCool (1998) do not share this same view basing their arguments on the subjectivity when identifying the desired level of each indicator and the difficulties of establishing the relationship between number of visitors and each indicator. Another point that generates controversy around physical carrying capacity is that it does not consider the level of interaction between tourists themselves and between tourists and local communities.

6.2 Socio-cultural carrying capacity

Five hundred and fifteen questionnaires were administered at the study area. Of these, 492 were returned, representing a return rate of 96% (see Appendix 2). Assuming that local people

are more attracted to their beaches, no question were asked on personal and trip characteristics, whilst for tourists this was the prime parameter.

6.2.1 Demographic and trip characteristics

Demographic data for the sampled population is presented in Table 6.1 and Table 6.2. As can be seen, most of beach users interviewed in this survey were females (249 in total) whilst males were 243, with the highest number of females observed at Faro Beach with 151 females and the highest number of males at Tofo Beach with 119 (Table 6.1).

Table 6. 1: Gender distribution of surveyed beach users

Beach	User type	Female		Male		Total
		n	%	n	%	
Faro	Community	75	59	53	41	128
	Tourist	76	51	71	49	147
Tofo	Community	72	52	67	48	139
	Tourist	26	33	52	67	78
Total		249		243		492

Source: Results from the questionnaire survey

Only people above 18 years old were asked to answer the questionnaire, although in several cases, children helped their parents, with the overall age ranges presented in table 6.2.

Table 6. 2: Age range of the respondents at each study site

Age Range	Praia de Faro		Praia do Tofo	
	Community	Tourists	Community	Tourists
Less than 20	11	8	10	9
20-24	11	17	21	20
25-29	21	34	31	11
30-34	11	17	15	9
35-39	0	17	15	8
40-44	21	21	21	6
45-49	0	21	10	7
50 +	53	13	15	8

Source: Results from the questionnaire survey

At both sites, tourists were asked to answer whether it was a first visit or they had been at each beach in the past, with results showing that 57% (84) had never been to Faro Beach and 23% (18) had never been at Tofo beach (see Appendix 3). Tourists that had previously been at these beaches were additionally asked to state the average times they been there and results show an average of 5 visits to Faro Beach (n=63; mean = 5±3.3) and 7 visits to Tofo Beach (n=60; mean = 7±3.3).

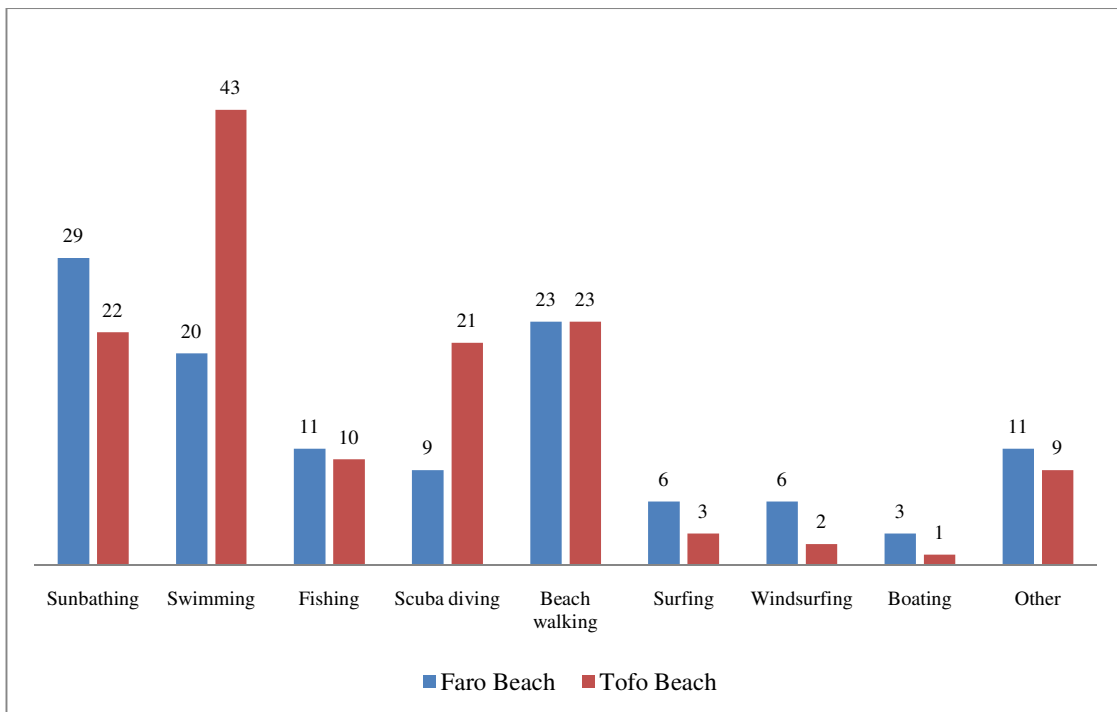


Figure 6. 3: Activities in which respondents participated during the survey. Numbers on column tops represent the percentage of respondents who participate in each activity

These tourists participated in several activities (Figure 6.3) with the main activities (Figure 6.4) at Faro Beach being beach walking (20%), sunbathing (26%), and swimming (23%) and at Tofo Beach being swimming (23%), beach walking (28%), sunbathing (33%) with a greater amount of people engaged in other activities or not being able to specify one of them (26%).

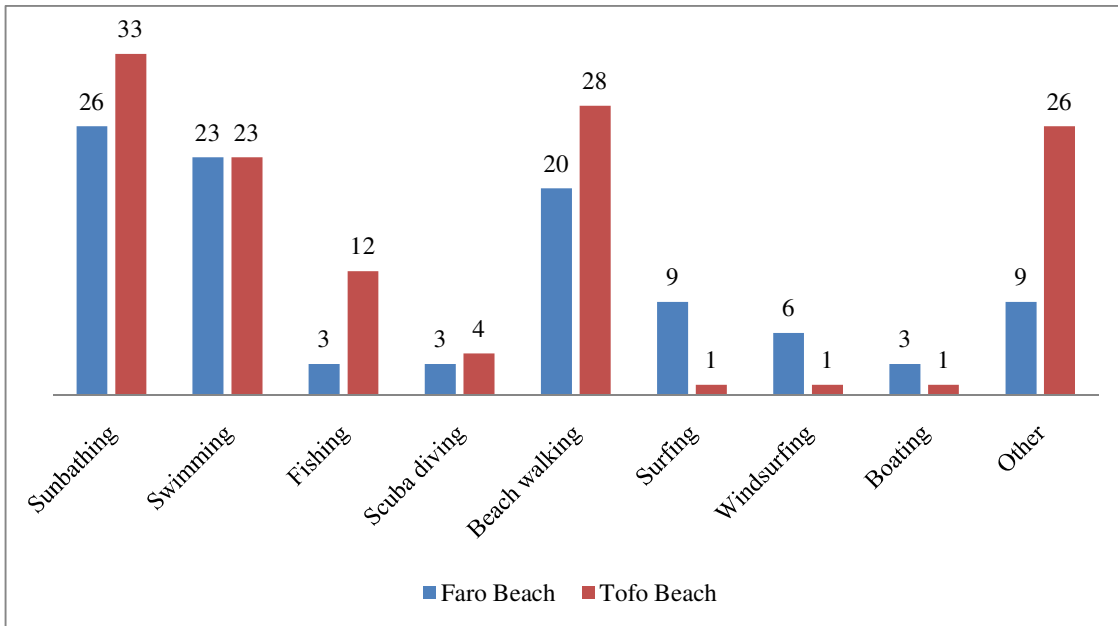


Figure 6. 4: Main activity respondents participated during the survey. Numbers on column tops represent the percentage of respondents for each activity as the main one

The skill level in the main activity participating (Figure 6.5) was mostly beginner (26%), novice (20%) and intermediate (20%) for tourists at Faro Beach and intermediate (33%) and novice (23%) for tourists at Tofo Beach).

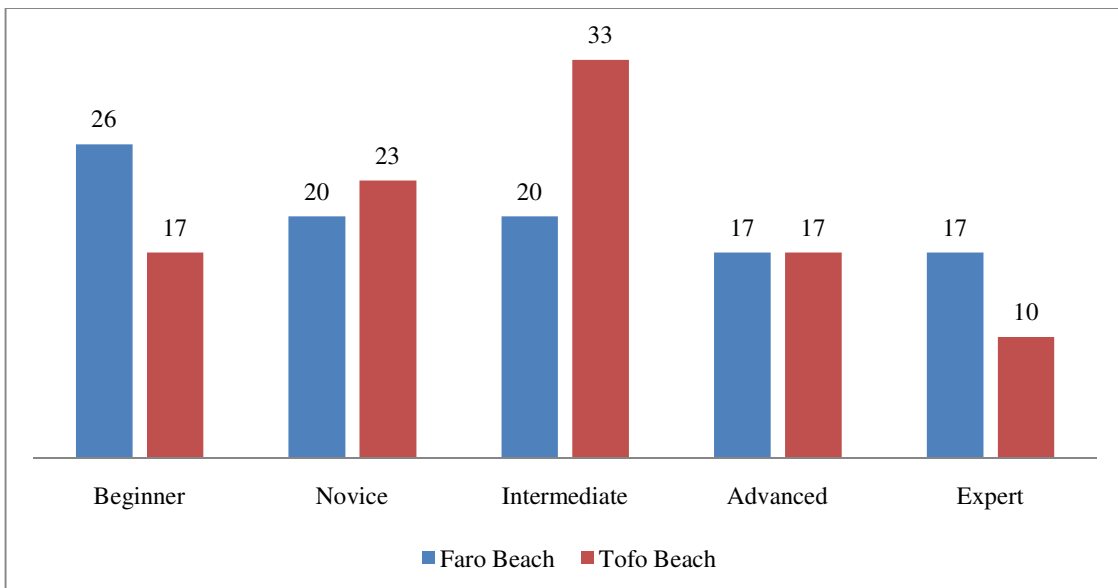


Figure 6. 5: Skill level of respondents in the main activity participated. Numbers represent the percentage of respondents in each category at each beach

Additionally, tourists were asked about trip characteristics and level of satisfaction. Results of the survey (Figure 6.6) showed that most tourists did not participate in organized trips (57% at Faro Beach and 87% at Tofo Beach) and most considered the visit satisfactory (77% at Faro Beach and 87% at Tofo Beach) and most considered the visit satisfactory (77% at Faro Beach and 78% at Tofo Beach) (Figure 6.7).

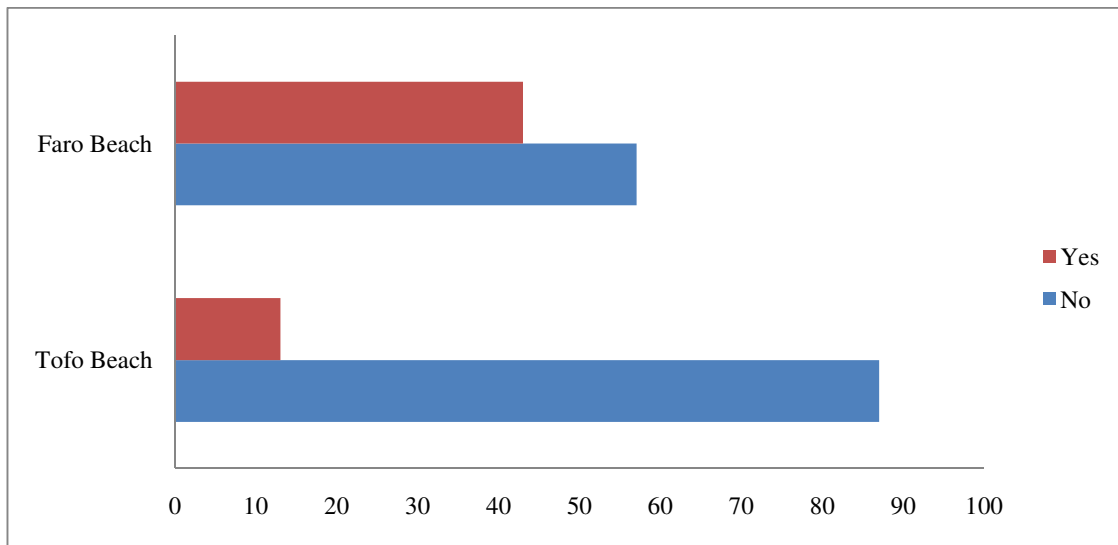


Figure 6. 6: Organizational trip of beach users. Numbers refer to the percentage of people in each category and surveyed area

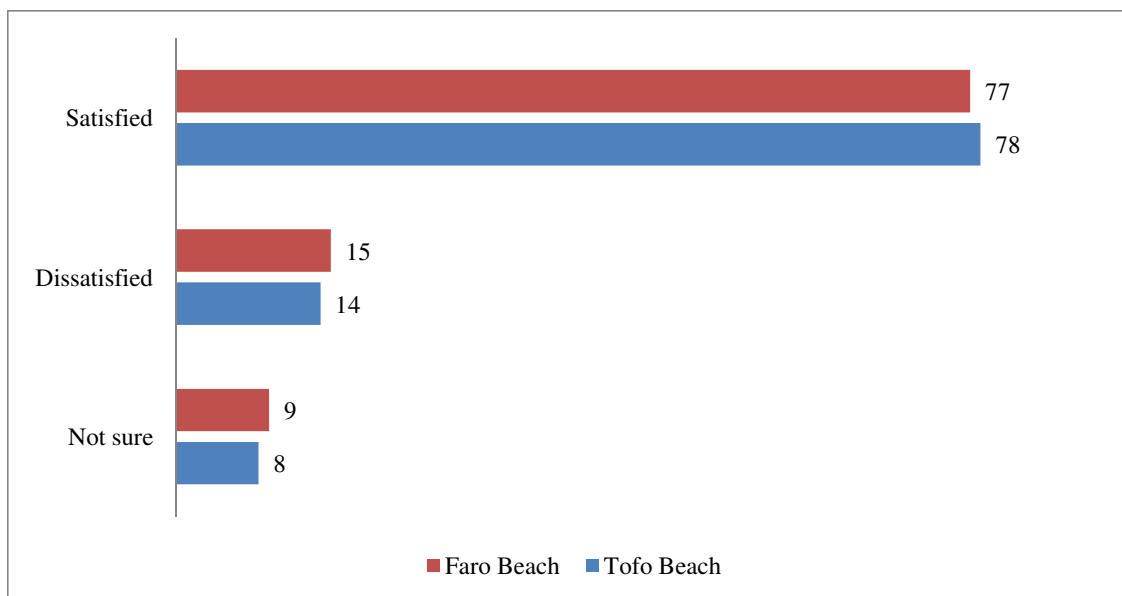


Figure 6. 7: Level of satisfaction of beach users during the survey. Numbers represent the percentage of people in each category

6.2.2 Level of satisfaction and importance of conditions and experiences

Although most respondents were satisfied with the overall visit to the study sites, it does not indicate that they were satisfied with all aspects of their experience and conditions of each beach. As reported by Manning (1999) and Needham *et al.*, (2008) high levels of overall satisfaction are common in recreation but do not demonstrate the reality and are thus quite useless for management purposes.

Hendee (1974) suggested the use of multiple satisfactions as a mean to assess various human satisfactions, i.e. an individual's satisfaction with an activity or experience is complex in the sense that satisfaction is based on multiple factors that differ from person to person rather than a single overall or global evaluation of satisfaction (Needham *et al.*, 2008). To assess the specific level of satisfaction with existing facilities and conditions, interviewees were asked to rate the level of importance and satisfaction of some existing and hypothetical conditions via a 5-point scale where 1 represented the most negative value (not at all important; very dissatisfied) and 5 meant the most positive value (very important; very satisfied). To ease interpretation, points 1 and 2 were combined as negative values and points 4 and 5 as positive with results presents in figures 6.8 and 6.9.

Figure 6.8 shows respondents' evaluation of importance and conditions of Faro Beach. As shown, the bulk of respondents considered most characteristics and conditions important for their enjoyment and satisfactions, although picnic tables and beach benches were rated as not important. This can be explained by the fact that most beach users were at the beach mainly for swimming and beach walking.

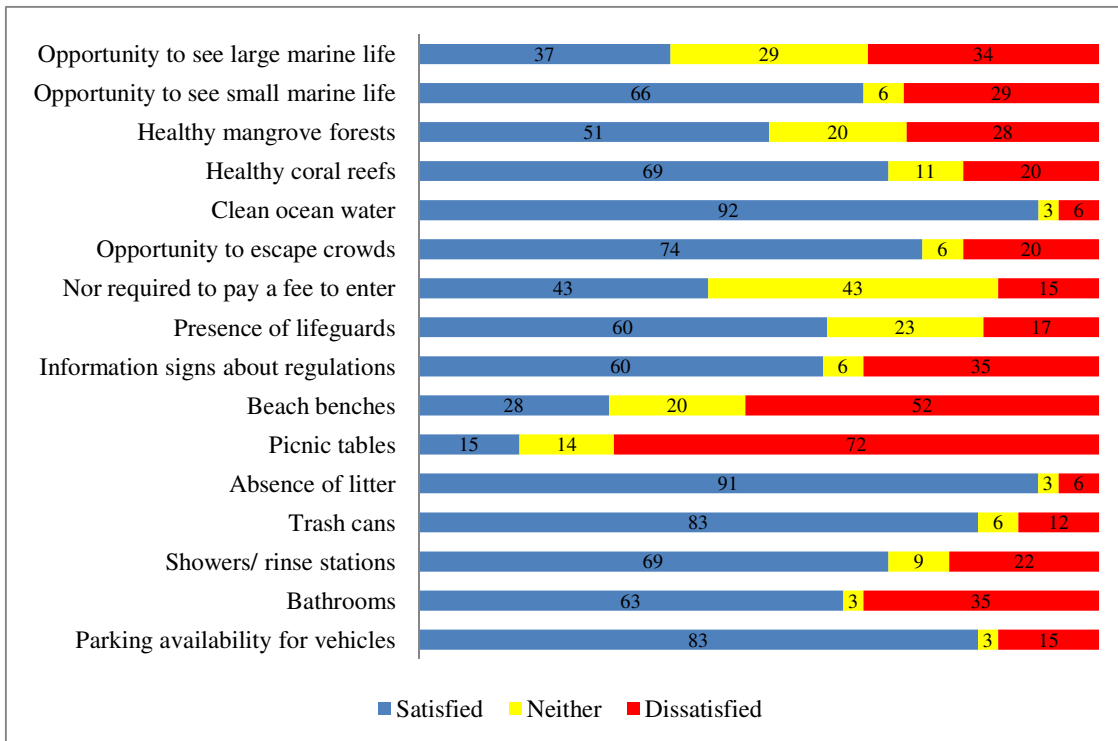


Figure 6. 8: Relative importance of beach conditions and facilities at Faro Beach. Numbers are related to the percentage of respondents in each category

Related to satisfaction (Figure 6.9), the majority of respondents were satisfied by the facilities and conditions offered at Faro Beach, although parking facilities (49%), picnic tables (63%), beach benches (49%) and the opportunity to escape crowds (63%) did not meet users' requirements.

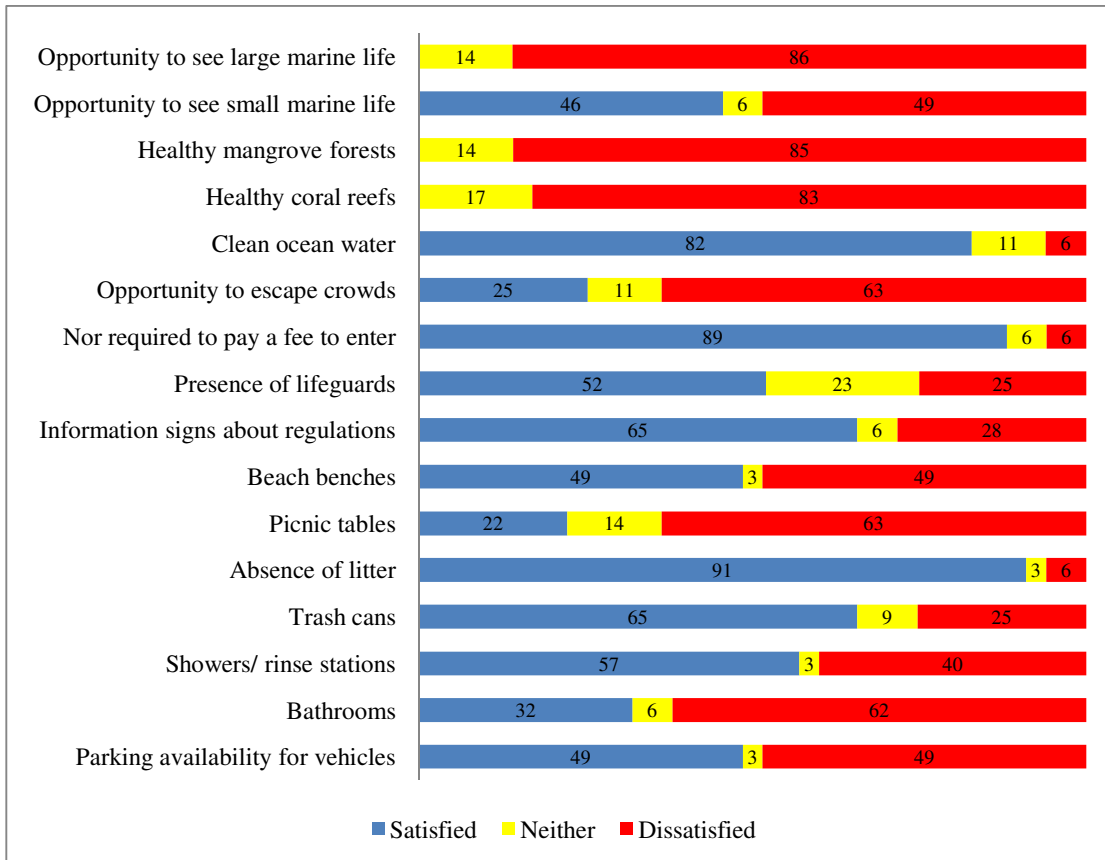


Figure 6. 9: Relative level of satisfaction with beach conditions and facilities at Faro Beach. Numbers are related to the percentage of respondents in each category

At Tofo Beach, the majority of respondents also rated important (Figure 6.10) most characteristics of the beach and again beach benches (62%) and picnic tables (55%) were not considered important. Asked to answer about their satisfaction with beach conditions and facilities at the visiting day, the majority of respondents considered them not satisfactory, especially considering infrastructure and physical condition in the beach. As a result, items such as water cleanliness (85%), absence of litter (75%) and no requirement to pay fees to enter (88%) were considered the most satisfactory characteristics, while the presence of lifeguards (88%), beach benches (80%), picnic tables (80%), showers (80%), bathrooms (80%) and parking facilities (80%) were considered not satisfactory (Figure 6.11). Other

characteristics such as the opportunity to see marine life, healthy mangrove forests and healthy coral reefs were expressed as mid-term elements.

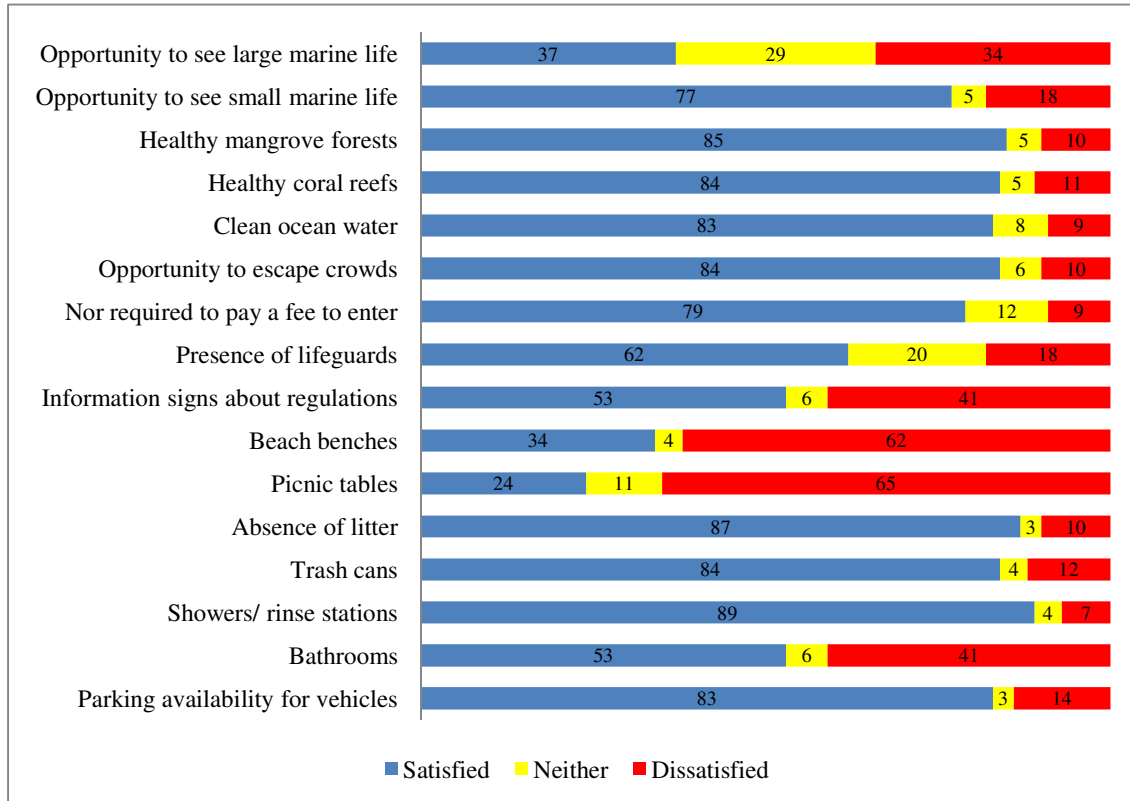


Figure 6. 10: Relative importance of beach conditions and facilities at Tofo Beach. Numbers represent the percentage of respondents' rates for each category

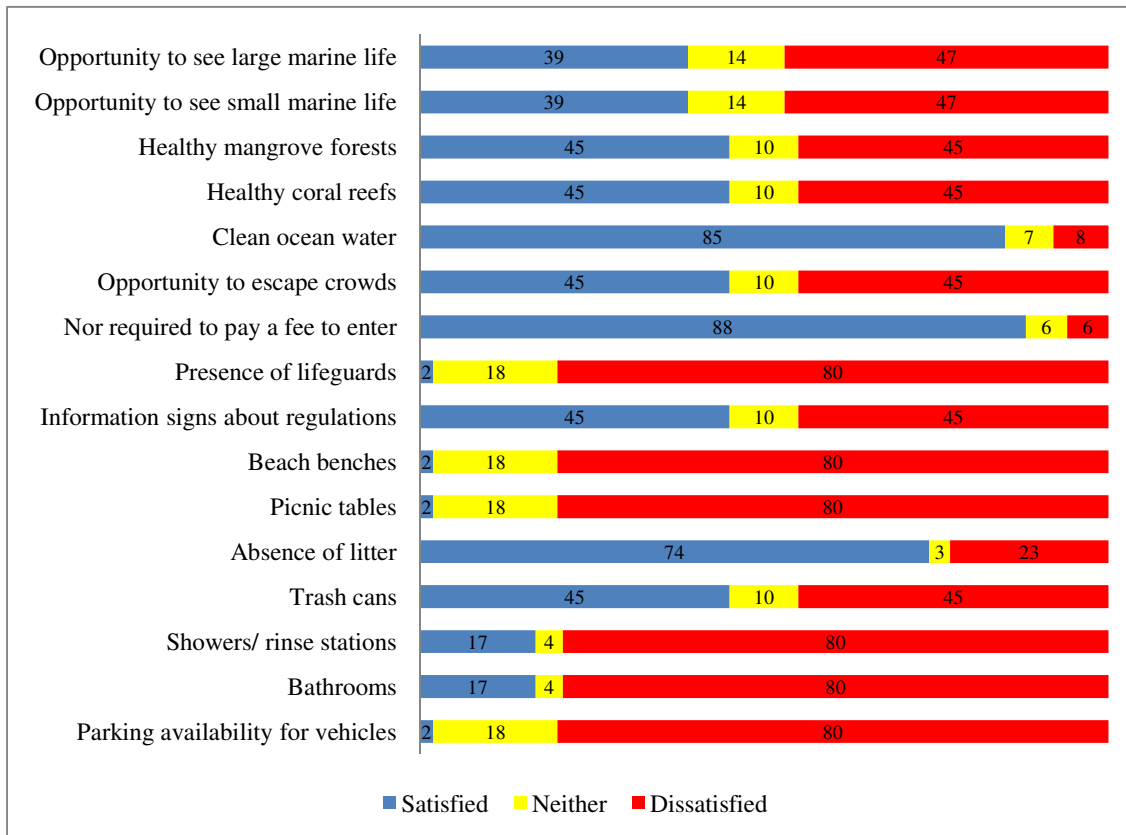


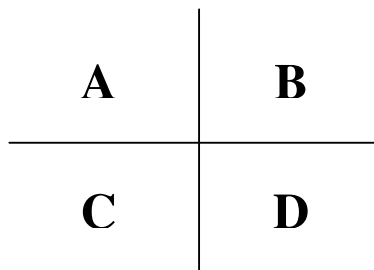
Figure 6. 11: Relative level of satisfaction with beach conditions and facilities at Tofo Beach. Numbers represent the percentage of respondents’ rates for each category

Although these results are quite expressive of the current perception of beach users and the main problems, in a managerial context, they do not provide a means of action. To assess the real extent of the problem and to assess major lines of action, the importance-performance (IP) matrix was employed, based on the fundament that “*respondents can be satisfied with a particular characteristic of the setting or experience, but feel that it is not important that the characteristic is actually provided and therefore it is important to understand relationships between both importance and satisfaction*” (Needham *et al.*, 2008:27).

This matrix, extensively applied as a performance assessment tool, was recognized as a valid and powerful technique for identifying service quality areas that require remedial strategic actions (Chu and Choi, 2000) and has become a popular managerial tool that has been broadly

used to identify the strengths and weaknesses of brands, products, services and retail establishments in various industries (e.g. Chapman, 1993; Cheron *et al.*, 1989; Hemmasi *et al.*, 1994).

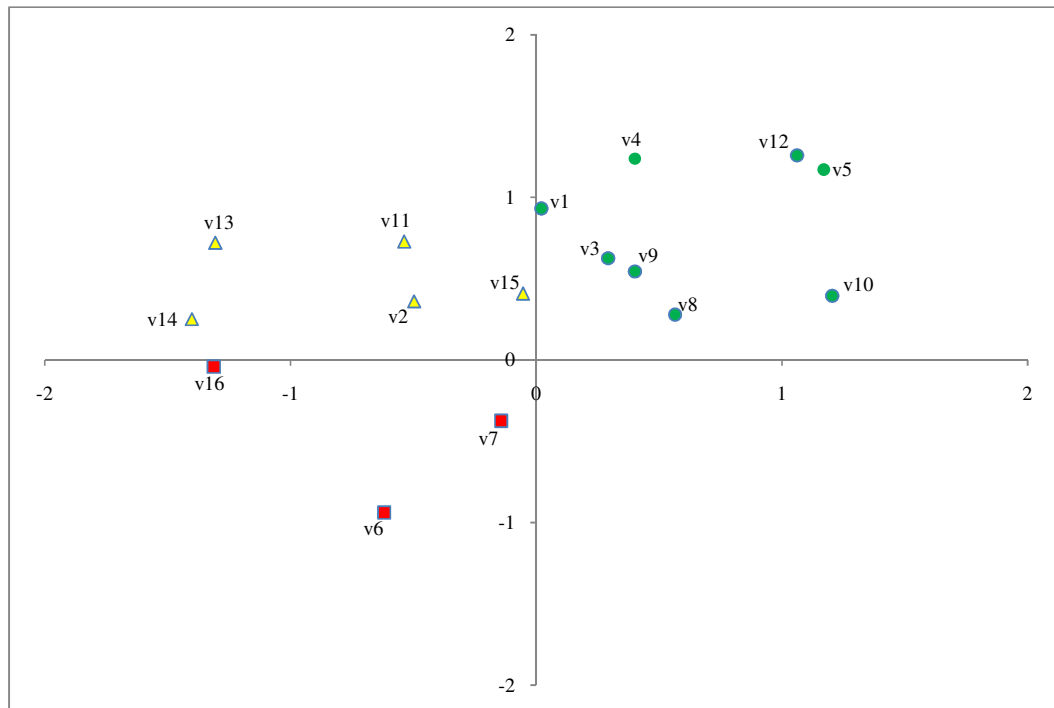
To apply this matrix, respondent values in a 5-point Likert scale (from 1 to 5) were converted into another set of 5-points scale ranging from -2 to +2 with the neutral point (3 in the original survey) converted to 0 (zero), the same approach applied by Manning (1999) and Needham *et al.*, (2008). After conversion, respective mean values were plotted with the importance in the y-axis and satisfaction in the x-axis, with results presented in four quadrants as presented below.



In this model:

- quadrant A represents high importance and low satisfaction and has been called “*concentrate here*”;
- quadrant B represents the best situation with high importance and satisfaction, called “*keep up the good work*”;
- quadrant C represents low importance and satisfaction, called “*low priority*”;
- quadrant D represents “*possible overkill*” with low importance and high satisfaction (Hollenhorst *et al.*, 1992; Siegenthaler, 1994; Slack, 1994; Chu and Choi, 2000; Needham *et al.*, 2008).

Figure 6.12 shows that respondents at Faro Beach rated important and were satisfied with most of the characteristics suggesting a “*keep up the good work*” line of action, related to car parking facilities (importance=0.93; satisfaction=0.02), trash cans (1.24;0.40), showers and rinse station (0.63;0.29), lifeguards (0.54;0.40), information about regulations (0.28;0.56), clean ocean water (1.26;1.06), absence of litter (1.17;1.17) and no requirement to pay entrance fees (0.39;1.20).



Key: Δ – “concentrate here”; \circ – “keep up the good work”; \square – “low priority”
v1 – parking facilities; v2 – bathrooms; v3 – showers/rinse stations; v4 – trash cans; v5 – absence of litter; v6 – picnic tables; v7 – beach benches; v8 – information about regulations; v9 – presence of lifeguards; v10 – no requirements to pay entrance fees; v11 – opportunity to escape crowds; v12 – clean ocean water; v13 – healthy coral reefs; v14 – healthy mangrove forests; v15 – small marine life; v16 – large marine life

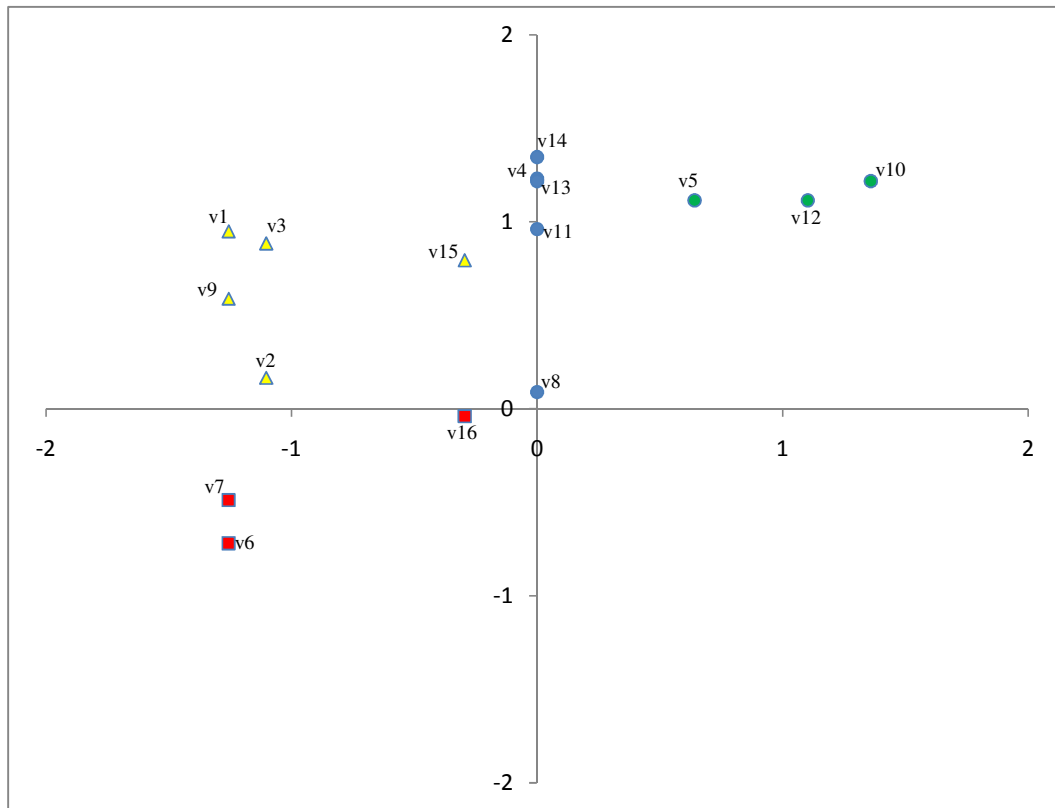
Figure 6. 12: Importance-performance matrix at Faro Beach (see Appendix 5)

However, they send a “*concentrate here*” message to managers, especially when related to bathrooms (0.36;-0.50) and the opportunity to escape crowds (0.73;-0.54) that were rated important, but respondents were not satisfied by the existing conditions in the beach. The fact that the opportunity to escape crowds was rated important but beach users did not feel

satisfied, can be the first indicator of peoples' capacity to accept other users. Picnic tables (-0.94;-0.62), beach benches (-0.37;-0.14) and the opportunity to see large marine life (-0.04;-1.31) were considered by the respondents as low priority issues, the last contrasting with the opportunity to see small marine life (0.41;-0.05) that was rated a 'concentrating' issue. Although parking availability was considered satisfactory, special attention should be addressed to it, as the satisfaction rate was very low and can at any instance drop to a concentrating point.

At Tofo Beach (Figure 6.13), the situation is rather different with a pragmatic "*concentrate here*" message with intermediate parameters that could hardly be incorporated in any of the importance-performance matrix (healthy coral reefs, trash cans, healthy mangrove forests, the opportunity of escaping crowds and information signs about regulations).

Absence of litter (1.12; 0,64), clean ocean water (1.12;1.10) and no requirement to pay entrance fees (1.22;1.36) were rated as "*keep up the good work*" parameters, whilst parking facilities for vehicles (0.95;1.26), bathrooms (0.17;-1.10), showers or rinse stations (0.88;-1.10), presence of lifeguards (0.59;-1.26) and the opportunity to see small marine life were considered aspects for further intervention. Similarly to Faro Beach, picnic tables (-0.72;-1.26) and beach benches (-0.49;-1.26) were considered "*low priority*" characteristics or conditions in association to the opportunity to see large marine life. No parameter was considered "*possible overkill*" at this beach.



Key: Δ – “concentrate here”; \circ – “keep up the good work”; \square – “low priority”
v1 – parking facilities; v2 – bathrooms; v3 – showers/rinse stations; v4 – trash cans; v5 – absence of litter; v6 – picnic tables; v7 – beach benches; v8 – information about regulations; v9 – presence of lifeguards; v10 – no requirements to pay entrance fees; v11 – opportunity to escape crowds; v12 – clean ocean water; v13 – healthy coral reefs; v14 – healthy mangrove forests; v15 – small marine life; v16 – large marine life

Figure 6.13: Importance-performance matrix at Tofo Beach (see appendix 5)

In both study areas, no significant difference was found between importance and satisfaction of beach users (paired t-test, $t = 2.617$, 15 df, $\alpha = 0.05$, Faro Beach; paired t-test, $t = 5.327$, 15 df, $\alpha = 0.05$).

6.2.3 Social carrying capacity indicators

As suggested in chapters 3.3 and chapter 5.2, the social carrying capacity can be assessed by means of the perceived sense of crowding and reported encounters. To assess these parameters, respondents were asked about perceived encounters with other beach users given 15 different levels (0, 5, 10, 20, 35, 50, 75, 100, 200, 350, 500, 750, 1000, 1500 and 2000+).

people). This approach is in accordance with previous research by Manning (1999) and Needham *et al.*, (2008) who suggested that recreationists perceived a setting to be crowded, when they likely encountered more than their norm for what they believe should be acceptable conditions or impacts in the destination.

Table 6.3 shows the number of respondents for each condition (See Appendix 2A and 2B for details) and the average number of people indicated by those who were able to specify one of the suggested options.

Table 6. 3: Maximum number of people encountered by respondents at survey sites

		Maximum number of tourists at any time			Mean
		Specify	Does not matter	Cannot specify	
Faro Beach	Local people	42	43	43	640
	Tourists	125	13	8	740
Tofo Beach	Local people	62	31	46	339
	Tourists	55	14	9	494

A large amount of respondents could not specify the maximum number of people they would accept near them or it did not matter (except for local people at Faro Beach). From respondents who could specify a number, tourists at Faro Beach had the highest capacity to accommodate other people near them (mean value of 740), while local people at Tofo Beach had the lowest capacity with an average value of 339 people.

Results provided by Manning (1999), Manning *et al.*, (2002), Manning (2007) and Needham *et al.*, (2008) suggest that only application of the close-ended format to assess the maximum number of people may be unrealistic and may not accurately ascertain this values, especially in places with high use levels. Thus, these authors (Manning (1999); Manning *et al.*, (2002); Manning (2007) and Needham *et al.*, (2008)) suggested a co-joint application of this method in association with the image capture technology (ICT) where respondents are asked to rate in

a set of images, one that is much similar to reality, described by Manning *et al.*, (2002) as the people-at-one-time (PAOT) approach (see point 3.2, this dissertation).

For this project, this same approach was used and beach users were asked to rate the photographs (Figure 6.14) that was similar to what they saw on the beach, with encounters and capacities being estimated by first dividing the sites' total area by the corresponding unit standard in the photograph and then multiplying by respondents evaluation at the site (see appendix 4) in accordance with Needham *et al.*, (2008).

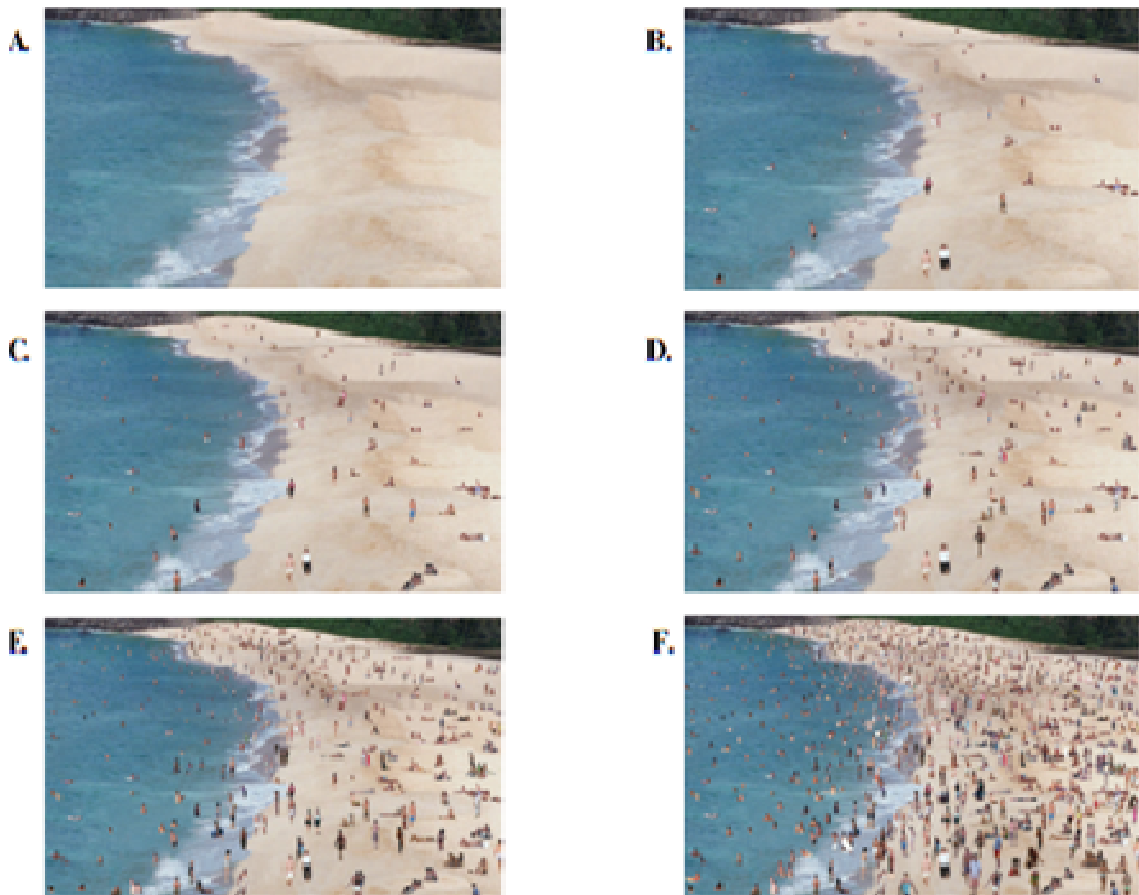


Figure 6. 14: Photographs used during the survey for measuring encounters and use level norms (retrieved and adapted from Needham *et al.*, 2008)

Following information provided in Appendix 2 and applying the PAOT format, the most rated photograph at both sites was photograph E with 84% (at Faro Beach) and 88% (at Tofo Beach), meaning that at Faro Beach respondents had encountered 282 other users at Faro Beach and 312 at Tofo Beach. Because photographs used do not cover the entire area of the beach and assuming that beach users cannot see the entire beach, these values were extrapolated to the entire environment and the actual number of other people encountered at Faro Beach was 307 and at Tofo Beach was 359 other users.

Results of application of these two methods was statistically significant at Faro Beach ($t=2.603$, $p < 0.05$) but not statistically different at Tofo Beach ($t=13.379$, $p > 0.05$), suggesting that the open-ended format can be applied to assess the maximum number of tourists at Faro Beach, but might not be accurate at Tofo Beach, similar results were achieved by Needham *et al.*, (2008) for beaches in Hawaii.

However, '*knowing reported encounters may not reveal maximum acceptable use levels*' (Needham *et al.*, 2008:32). Beach users, were thereafter, asked to rate the acceptable density of people represented at each photograph if it was to occur at the beach they were using. To ease interpretation, responses were coded in a 9-point scale ranging from -4 (very unacceptable) to 4 (very acceptable) and average values were plotted as social norm curves (Manning *et al.*, 2002) to assess at which conditions use levels reach unacceptable levels (see chapter 3.2).

The following set of Figures show results of the application of the above method. In Figure 6.15, the impact acceptability curve (social norm value) shows that on average, local people at Faro Beach rated acceptable photographs containing 50, 100, 200 and 300 people per

457x182 metres. The maximum acceptable use level was 282 people per 457x182 metres that when extrapolated to the entire beach would mean a maximum of 305 other users at the beach with high levels of crystallization (0.27; range = 0 to 2) or consensus¹³.

This suggests that an empty beach is not well viewed and people are happy to find a certain amount of people at the same recreation site. Still, accepting a certain amount of other users at the beach does not mean that they would accept any number and more than 305 users at the same time would not be seen as a pristine condition.

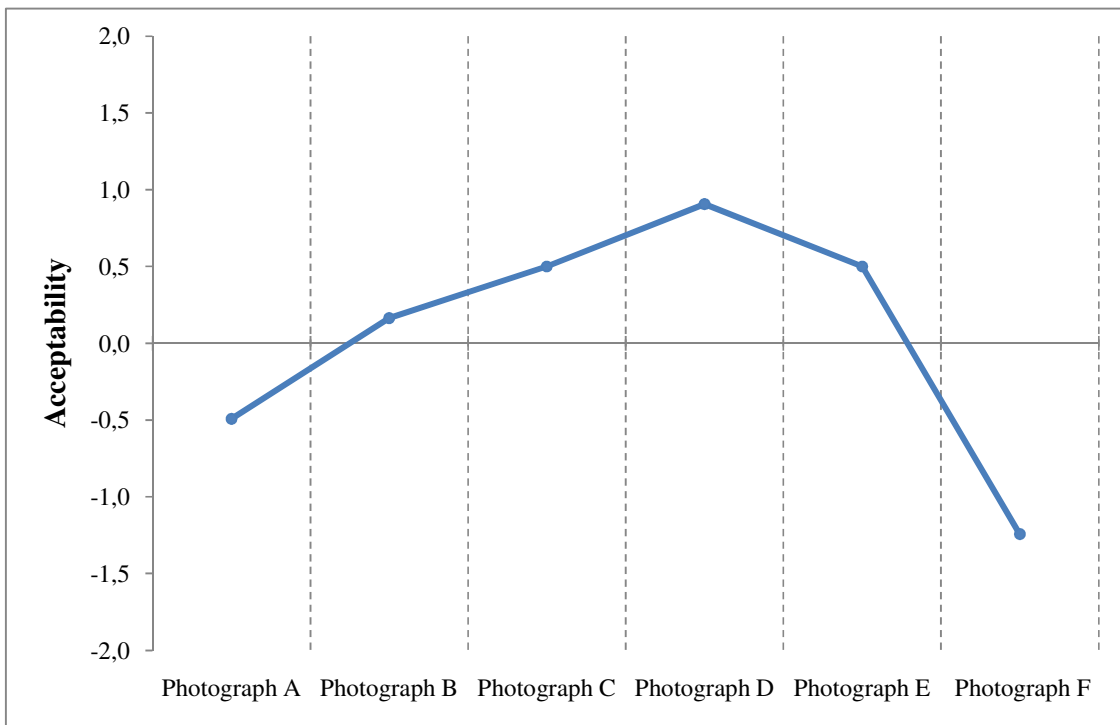


Figure 6. 15: Local communities' impact acceptability curve for encounters with other people at Faro Beach

¹³ As stated in chapter 3, crystallization is “a measure of consensus or agreement among respondents for the indicator conditions” (Needham *et al.*, 2008:6), presented as the average of the standard deviations for all points comprising the curve (Shelby and Heberlein, 1989; Shelby *et al.*, 1996). Crystallization is high when the average standard deviation is small and considering the scale used in this project (-2; 2) it corresponds to values near zero.

When related to tourists at Faro Beach (Figure 6.16), the impact acceptability curve (social norm value) shows that on average respondents rated acceptable photographs containing 100, 200 and 300 people per 457x182 metres, with a maximum acceptable use level of 282 people per 457x182 metres, that when extrapolated to the entire beach would mean a maximum of 608 other users at the beach with high level of crystallization (0,36; range = 0 to 2). For this group of respondents, an empty beach is not acceptable and even very few amounts of people is not considered good, showing that tourists at Faro Beach were open to interact with other users.

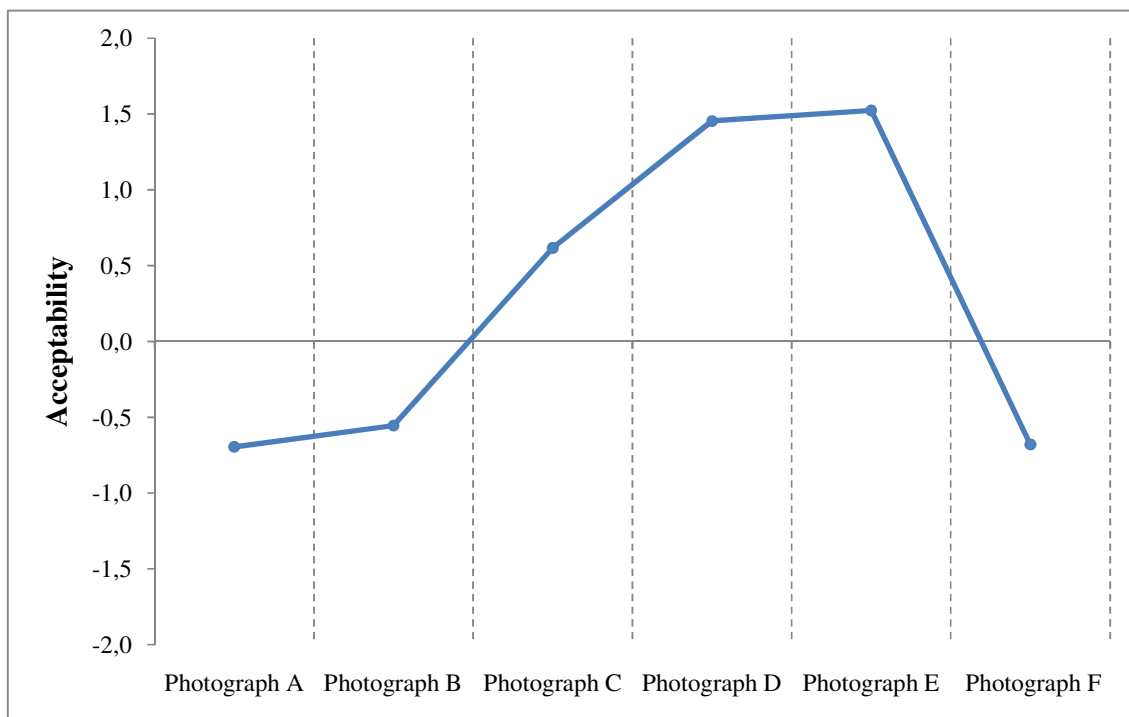


Figure 6. 16: Tourists' impact acceptability curve for encounters with other people at Faro Beach

In the case of communities living nearest to Tofo Beach (Figure 6.17), the impact acceptability curve (social norm value) shows that on average respondents rated acceptable photographs C, D and E containing 100, 200 and 300 people per 457x182 metres, with a maximum acceptable use level of 312 people per 457x182 metres that when extrapolated to

the entire beach would mean a maximum of 358 other users at the beach with high levels of crystallization (0,23; range = 0 to 2). Again, very low and very high numbers of people are not acceptable, with minimum conditions appearing to be about 90 people and maximum conditions appearing to be 358 tourists.

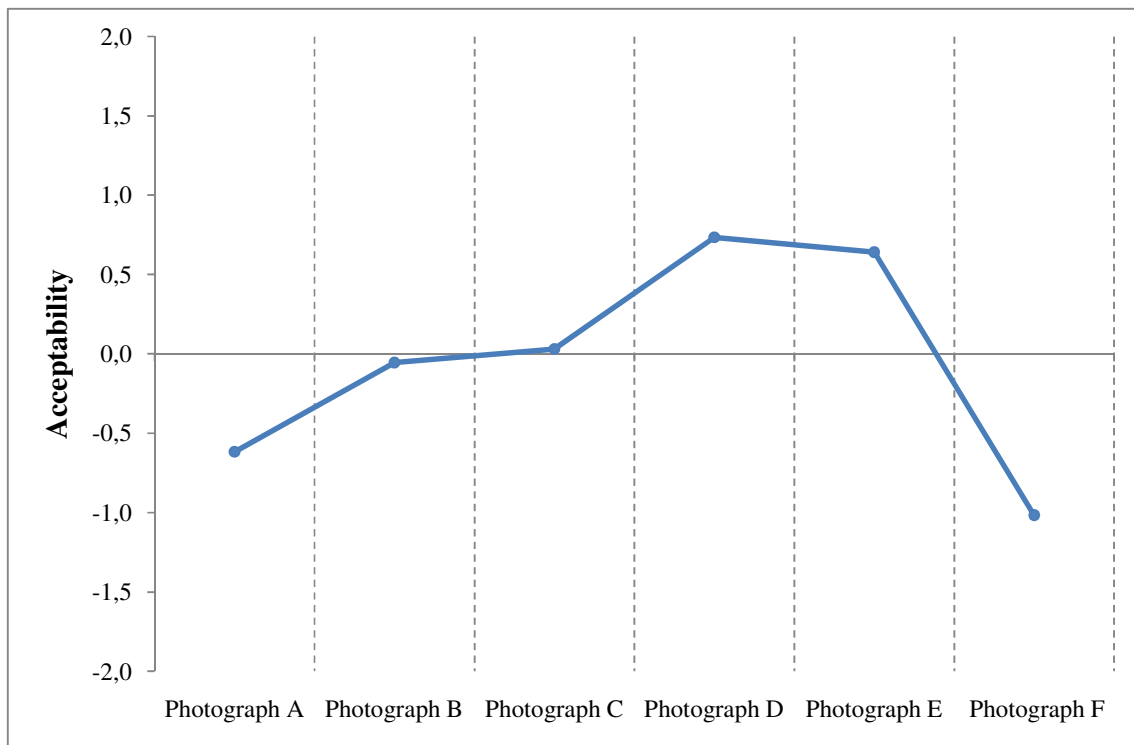


Figure 6. 17: Local communities' impact acceptability curve for encounters with other people at Tofo Beach

Tourists at Tofo Beach did not differ much from local communities at the same area. Their impact acceptability curve (Figure 6.18) shows that on average respondents also rated acceptable photographs C, D and E containing 100, 200 and 300 people per 457x182 metres, with a maximum acceptable use level of 312 people per 457x182 metres that when extrapolated to the entire beach would mean a maximum of 358 other users at the beach with high levels of crystallization (0,12; range = 0 to 2). very low and very high numbers of people

are not tolerated, with minimum conditions appearing to be about 90 people and maximum conditions appearing to be 714 tourists.

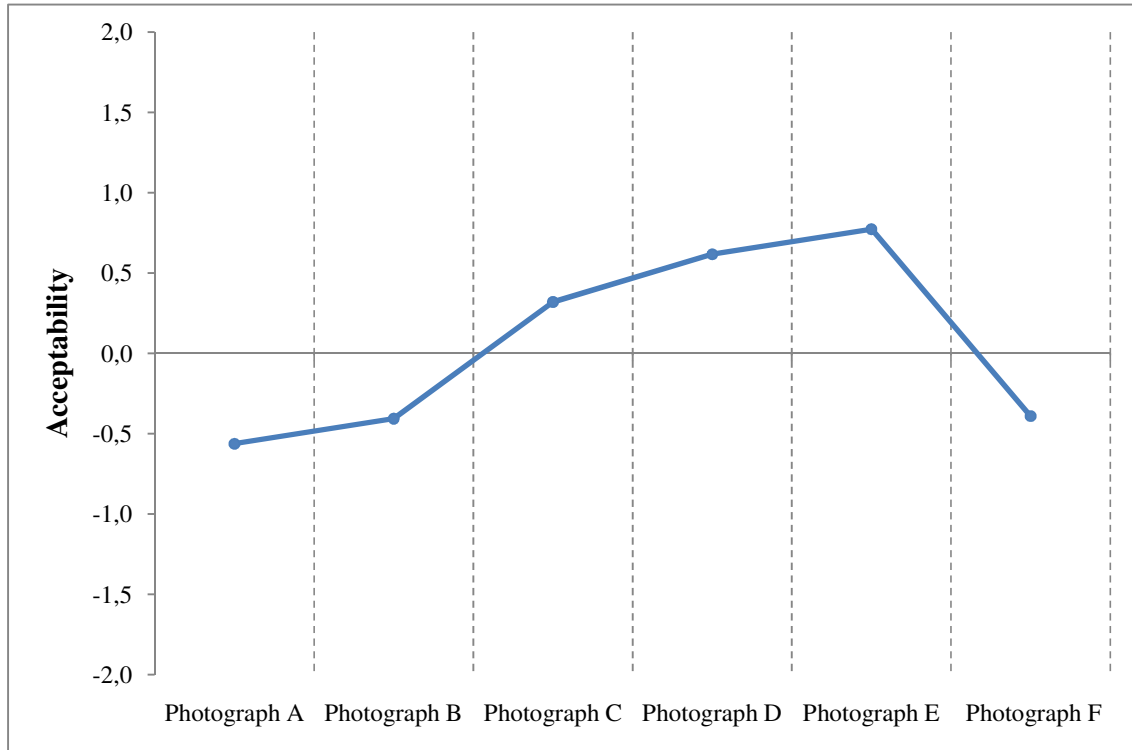


Figure 6. 18: Tourists' impact acceptability curve for encounters with other people at Tofo Beach

Knowing the optimum number of people that beach users would accept, there was a need to assess the level of conflict with other user groups and activities (sunbathers or swimmers, snorkelers or SCUBA divers, surfers, windsurfers, boaters and anglers) based on 4-point scale. First, respondents were asked how often they had observed three parameters for each user groups (being '*rude or discourteous*', being '*too close*' and '*not looking where they were going*') with responses ranging from '*never*', '*once or twice*', '*sometimes*' and '*many times*'. To get consistency with past research (Needham *et al.*, 2008), answers were coded '*observed*' (1 or 2 times, sometimes and many times') and '*not observed*' (never).

Figure 6.19 shows observations of other users/ activities by local people while visiting Faro Beach. Here, beach users coexisted peacefully; people were polite and had specific places for their activities, avoiding thereafter friction among groups. Of particular interest in this group is the proximity of people that in most of the charts were given a mid-range rate (50%;50%) suggesting that a sense of crowding might exist at this beach.

For the case of tourists at the same beach (Figure 6.20), the situation is rather different, as the sense of crowding was not felt in the majority of group behaviour, apart from the number of sunbathers or swimmers being too close that was rated in mid-terms (50%;50%), snorkelers being too close (55%;45%), boaters being too close (51%;49%) and windsurfers in the same situation (58%; 42%). This suggests that a potential source of conflict might exist at Tofo Beach which if not managed can be a limiting factor to beach users' experience and enjoyment.

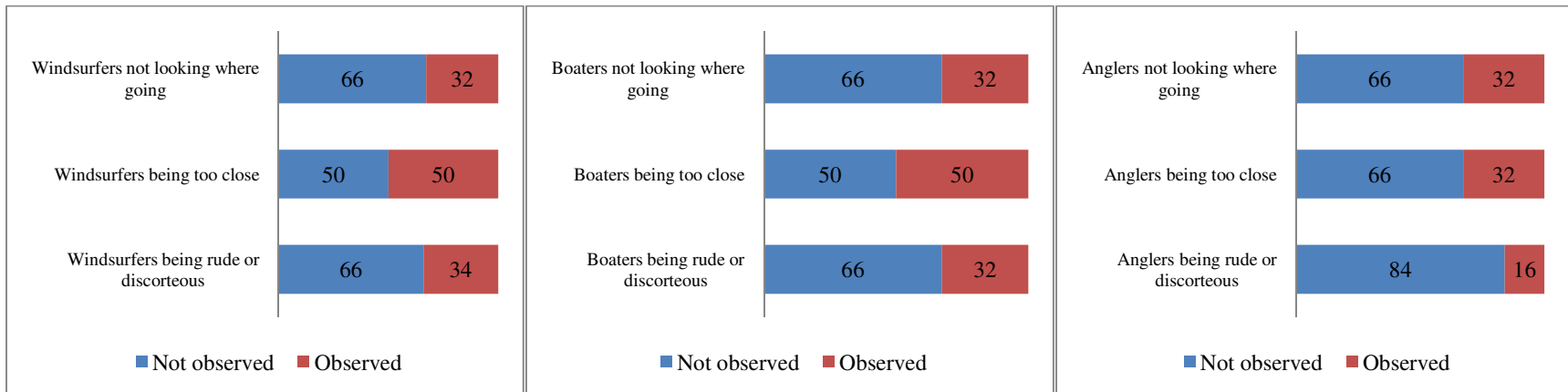
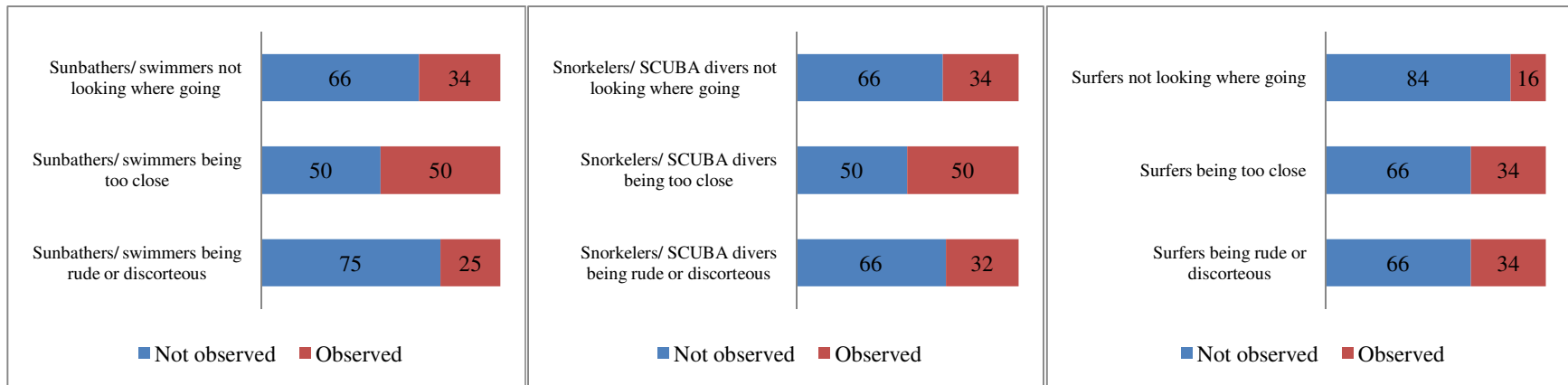


Figure 6.19: Percentage of observed activity group by local community at Faro Beach. Numbers refer to the percentage of respondents' rates towards each parameter

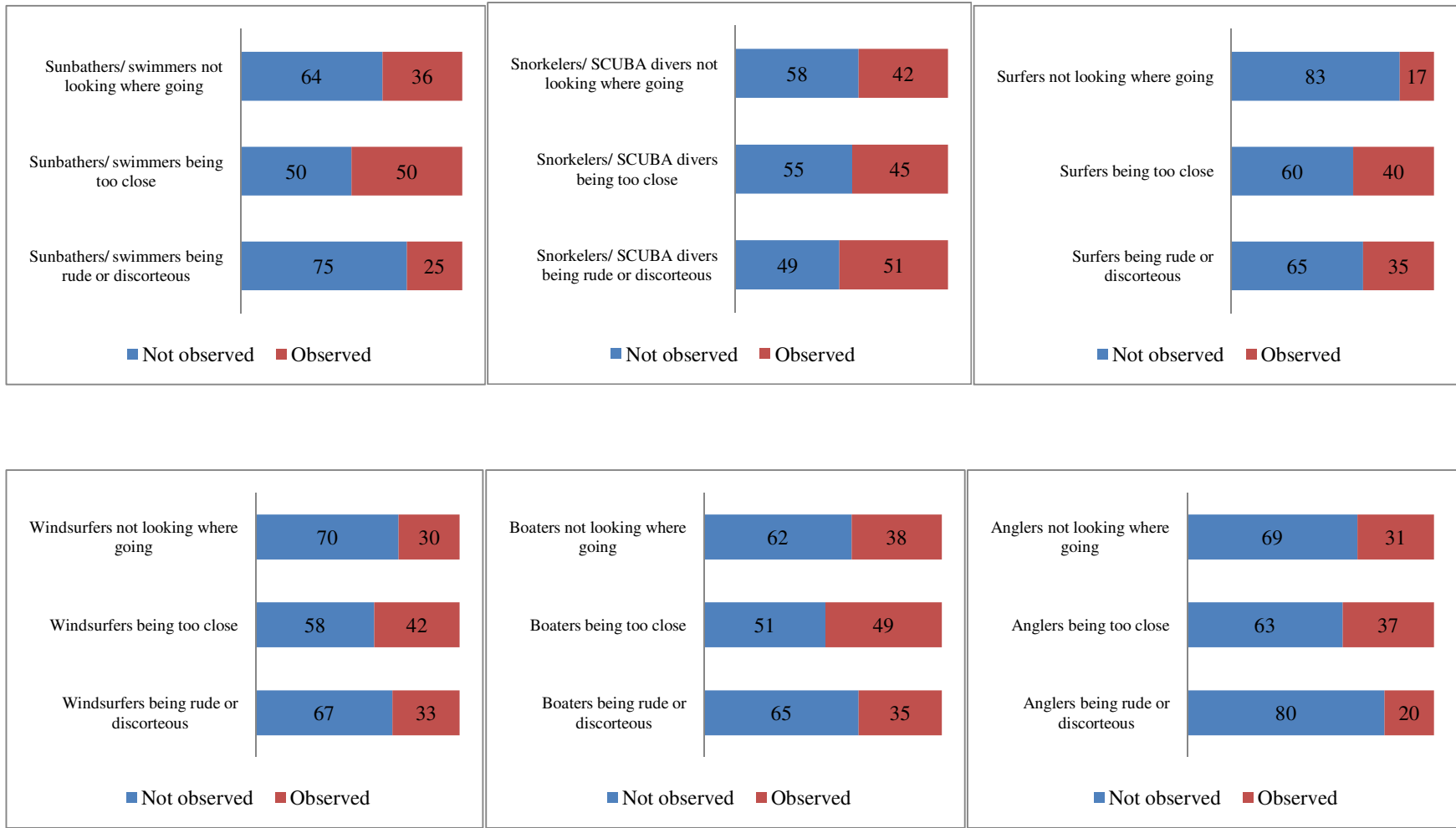


Figure 6.20: Percentage of observed activity group by tourists at Faro Beach. Numbers refer to the percentage of respondents' rates towards each parameter

At Tofo Beach, local communities reported having most of the activities at least once, as all activities happen in the beach. Sunbathers or swimmers '*not looking where they were going*' (n=139; 56%) and '*being too close*' (n=139; 59%); snorkelers or SCUBA divers '*not looking where they were going*' (n=139; 59%), '*being too close*' (n=139; 67%) and '*being rude and discourteous*' (n=139; 56%); surfers '*being too close*' (n=139; 52%), and '*being rude and discourteous*' (n=139; 52%); windsurfers '*not looking where they were going*' (n=139; 52%), '*being too close*' (n=139; 59%), '*being rude or discourteous*' (n=139; 52%); boaters '*not looking where they were going*' (n=139; 56%) and '*being too close*' (n=139; 59%); anglers '*not looking where they were going*' (n=139; 52%) and '*being close*' (n=139; 56%) were the most common answers.

Tourists, however, have a different perception regarding other activities. For this group, the most common scenario were snorkelers or SCUBA divers being rude or discourteous (n=78; 51%) while the rest were not in great extent (values more or less 45% and 55%). This can be explained by the fact that tourists go to the beach seasonally or in specific periods of time and can be used as a great indicator of the tolerance to other people or activities in the beach. Because local people have the beach for entire time of the year, they face, understand or view other activities or beach users in another manner and can give more significant results related to the beach they 'own'.

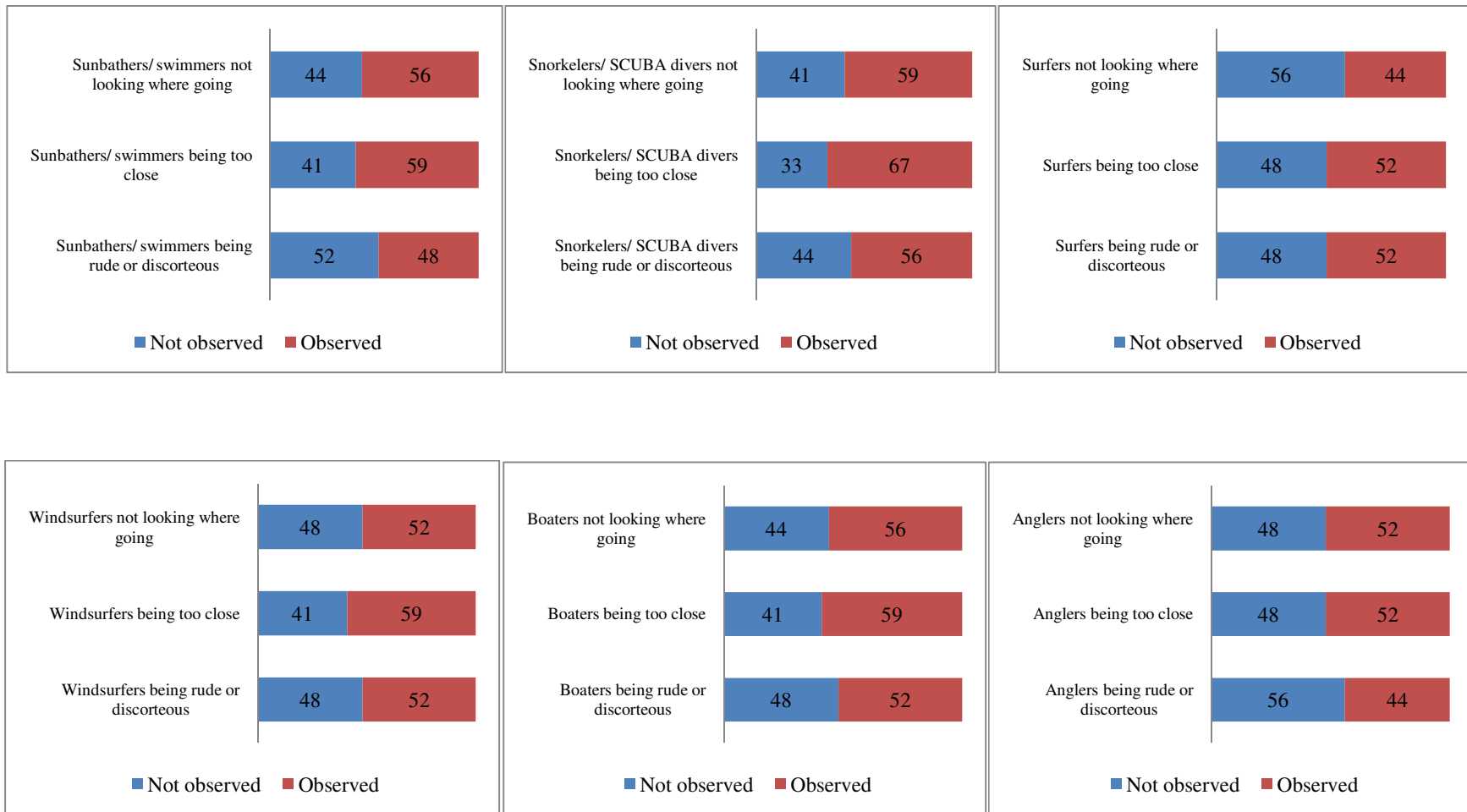


Figure 6.21: Percentage of observed activity group by local community at Tofo Beach. Numbers refer to the percentage of respondents' rates towards each parameter

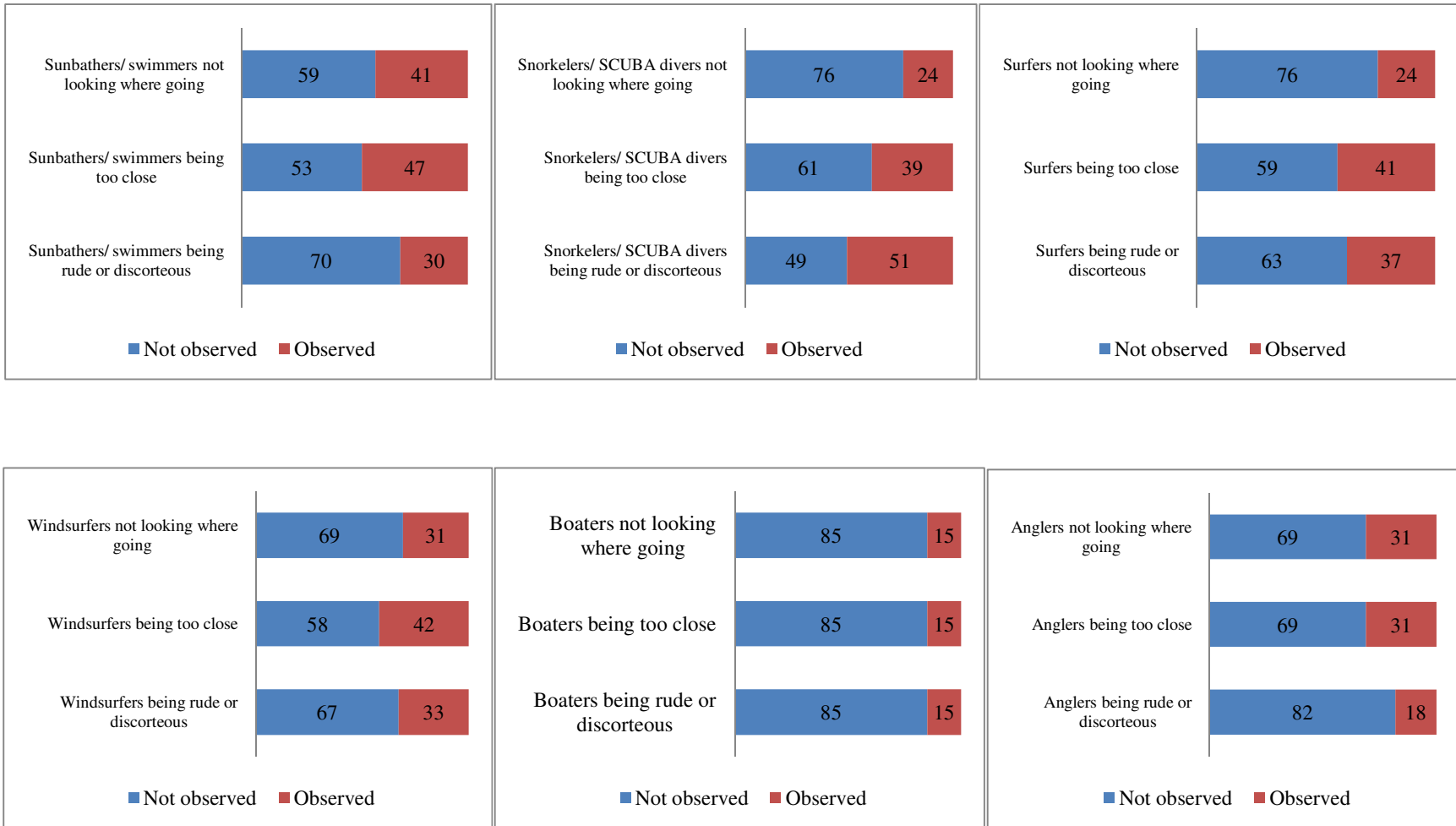


Figure 6.22: Percentage of observed activity group by local community at Faro Beach. Numbers refer to the percentage of respondents' rates towards each parameter

After knowing the number of different activities seen at the beach, beach users were asked to rate extent of conflict of each of the previous scenario, with variables ranging from ‘*not a problem*’ to ‘*extreme problem*’. Respondents’ answers were coded in 4 series, being the first ‘*no problem*’ (average values below 1); ‘*slight problem*’ (for values between 1 and 2); ‘*moderate problem*’ (average values between 2 and 3) and ‘*extreme problem*’ (average values equal to 3).

Table 6. 4: Observed activity group behaviour at surveyed sites*

Parameter	Faro Beach		Tofo Beach	
	Locals	Tourists	Locals	Tourists
Sunbathers/ swimmers being rude or discourteous	1,54	1,95	1,59	2,06
Sunbathers/ swimmers being too close	1,49	1,65	1,46	1,56
Sunbathers/ swimmers not looking where going	1,59	1,49	1,48	1,60
Snorkelers/ SCUBA divers being rude or discourteous	1,76	1,65	1,52	1,83
Snorkelers/ SCUBA divers being too close	1,52	1,64	1,37	1,78
Snorkelers/ SCUBA divers not looking where going	1,76	1,82	1,55	1,79
Surfers being rude or discourteous	1,93	1,69	1,59	1,78
Surfers being too close	1,91	1,61	1,45	1,68
Surfers not looking where going	1,67	1,11	1,48	1,59
Windsurfers being rude or discourteous	1,67	1,65	1,45	1,67
Windsurfers being too close	1,59	1,50	1,41	1,54
Windsurfers not looking where going	1,50	1,48	1,37	1,53
Boaters being rude or discourteous	1,76	1,76	1,52	1,69
Boaters being too close	1,83	1,77	1,52	1,83
Boaters not looking where going	1,77	1,67	1,48	1,91
Anglers being rude or discourteous	2,08	1,85	1,66	1,78
Anglers being too close	1,83	1,65	1,63	1,60
Anglers not looking where going	1,59	1,84	1,63	1,94

* Values are averaged to easy data management and interpretation (scale range: 0 to 3)

Table 6.4 shows that beach users at the study sites rated all parameters as a ‘*slight problem*’ with average values ranging from 1,11 (average value from tourists related to ‘*surfers not looking where they were going*’ at Faro Beach) to 1,95 (average value from tourists related to ‘*sunbathers or swimmers being rude or discourteous*’ at Faro Beach). However, ‘*sunbathers or swimmers being rude or discourteous*’ at Tofo Beach was rated by tourists as a moderate

problem (average of 2,06) together with ‘*anglers being rude or discourteous*’ at Faro Beach (details on the general distribution can be seen of Appendix 4, uncollapsed results).

Because this project is directed to management of visitors and their activities, there was a need to assess the support or opposition to potential management strategies and beach users were asked to give their perception of the actual situation what should be done in the future, related to environmental education, beach zoning and car parking facilities.



Figure 6.23: Level of support to management strategies by visitor type and area: a) local people at Faro Beach; b) tourists and Faro Beach; c) local people at Tofo Beach; d) Tourists at Tofo Beach

Figure 6.23 shows that on average, respondents give support to the managerial strategies proposed, an exception of beach zoning at Tofo beach was considered by tourists as a non-appropriate measure (only 35% support); more parking areas at Faro Beach was also considered inappropriate by tourists (only 34% of respondents support). Considering that Faro Beach is on a very sensitive environment (see chapter 4), the rejection of an increase of parking facilities might be an indicator of the level of protectionism tourists have with their destination. Contrarily, Tofo Beach is not zoned and does not have parking facilities. Respondents at this beach, although supporting to some extent implementation of these characteristics (again with the exception of beach zoning for tourists), show a cautious behaviour as the difference between people opposing and supporting is minimal.

In general, beach users were eager to learn more about the beach and ecosystems and were ready to engage in environmental-friendly activities at these destinations, as most of them supported environmental education at the beaches.

CHAPTER 7: GENERAL DISCUSSION AND CONCLUSIONS

Management of the relationship between tourism and the environment, especially in coastal areas, is a great challenge for both tourism planners and coastal managers. With increasing tourism trends, this challenge each time gets bigger calling for new approaches to ensure the long-term sustainability of coastal resources.

Tourism is a growing activity and projections refer to an exponential growth rate, especially towards natural or semi-natural destinations with astonishing beauty like the coast. With increasing tourism activities, the probability of increasing the rate of environmental hazards in the destinations is also increasing. When properly applied, carrying capacity (with its all components) is a powerful tool to mainstream economic benefits and the negative impacts resulting from tourism activities.

As previously stated (chapter 2), for long time the concept of carrying has been completely misunderstood and early attempts to its application have resulted in failures and extensive contestation of the framework. As a result most studies aimed at achieving the magic number that could indicate the saturation level of the ecosystem without the consideration of the system of values to be applied and the maximum limit of acceptable change in relation to the ideal situation (Pereira da Silva, 2002; after Turner *et al.* 1997 and Saveriades, 2000).

Such situation increasingly reduced the importance or relevance of carrying capacity and it turned in a procedure that “*seemed a way of blaming the victim, without doing the hard work of getting more money to do a proper job of maintenance*” (Burch Jr., 1984:489 cited by Pereira da Silva, 2002:61). With the introduction of sustainability concepts, this concepts regained new perspectives and new guidelines were developed as a mean to ensure that

tourism destination turn sustainable, reducing thereafter negative impacts from tourism activities.

As tourism activities continued their exponential growth, the concept and frameworks towards managing visitors gained new inputs and were again redesigned, although its worldwide application do not mean that it has become perfect. Several questions still arise from several papers related to this topic, with examples coming from Lindberg and McCool (1998) who state that though agreeing that the negative environmental impacts of tourism should be addressed... the carrying capacity approach is inadequate for the task in most situations.

Continuing in this context, Lindberg *et al.* (1996) suggest the need of rethinking the applicability of this concept based in three main lines:

- First, carrying capacity definitions often provide little guidance for its practical implementation;
- Second, carrying capacity is perceived as a scientific, objective concept;
- Third, carrying capacity typically focuses attention on use levels or number of visitors, yet management objectives typically relate to conditions, creating a confusion of inputs and outputs.

Apart from these two arguments, two major questions arise from the real applicability of the concept of carrying capacity: can coastal tourism be sustainable? Should it be massive? In this research an attempt to explore one of the frameworks for tourism carrying capacity estimations was applied. Although it has been widely applied not only in protected areas (where it was originally developed for) but also in for coastal tourism, this framework, by

itself, does not provide complete answers for appropriate management and needs to be applied alongside with other frameworks.

As a result of the application of the Framework for Carrying Capacity Assessment in Protected areas, an initial range of thousand visits/day (36,000 to 71,000 at Faro Beach and 28,649 to 57,298 at Tofo Beach). From the management viewpoint these number would be optimum as they would mean an increase in revenue generation at these destinations. Because of this econometric view, these huge numbers would be pleasant for local managerial, but would they still be from the environmental point of view? How would managers accept a reduction of nearly 75% of the number of tourists as a result of including restriction factors?

This project outlined the heterogeneity in the way people perceive congestion levels, as suggested in previous papers and the varying capacity limits from one site to another. This is a great challenge, especially for managers, as with different tourism flows, the carrying capacity of such areas might fluctuate. In this situation, managers must decide whether to take managerial decisions based on environmental congestion costs (physico-ecological carrying capacity) or based on the social congestion cost, which is not an easy task.

Results indicate that Faro Beach has a normal capacity to accommodate from 36,000 to 72,000 tourists every year whilst Tofo Beach has a capacity to accommodate tourists ranging from 28,649 to 57,298 on the basis of 10m^2 to 5m^2 per user, respectively. After integrating restriction factors (rainfall, absence of sunshine, strong winds and water quality, beach erosion and temporary closure, with the last only applicable to Faro Beach) this capacity reduces to 1,779-3,558 and 708-1415 visits a day (Faro and Tofo Beaches, respectively). Because beach management is not fully accomplished (only 87.5% and 75% is reached at

Faro and Tofo) the optimum permissible number of tourists should be between 1,557-3,114 visitors/year (at Faro Beach) and 531-1062 visitors/year (for Tofo Beach).

Similarly to results found in many previous papers, this project outlines that the physico-ecological carrying capacity of a destination can be affected by several factors related to the area's intrinsic characteristics. At Faro Beach, for example, beach erosion plays a significant role in reducing its capacity to accommodate tourists, as a great percentage of beach area is lost every year. This problem can be solved by other alternatives, such as beach nourishment after a prior assessment of the overall impacts this action might have and the mitigation measures. At Tofo Beach, a particular factor needs to be addressed: water quality. Although no studies have been applied regarding this issue, there is a need of assessing this parameter, as it might reduce visitor's satisfaction and therefore visitor numbers at the beach.

The level of interaction between beach users was found very high with both sets of respondents considering acceptable use levels above 50 people on-site at a time as the minimum and 714 as a maximum. While at Faro Beach local people would accept a minimum of 50 and a maximum of 305 other people and tourists would accept a minimum of 608 other users, at Tofo Beach local communities would accept a minimum of 90 and a maximum of 358 users and tourists would accept a minimum of 90 and a maximum of 714 other users at a time.

These results suggest that beach users had a great level of acceptance of other users and are open to support additional managerial options in both beaches. Furthermore, results of this project suggest that the physico-ecological carrying capacity can be a great tool to be applied when the main objective is broad ecosystem management, as it provides the optimum number

of tourists an area can support, which when overlapped can create damage to the ecological settings of the surroundings. Considering the societal point of view and aiming at maximizing visitor's experience and satisfaction, the application of physico-ecological carrying capacity might not be valuable, as to a certain extent it overlaps user's satisfaction and enjoyment.

In this case (enhancing users' experience and satisfaction), applying the socio-cultural carrying capacity can hinder better results as it provides the minimum and maximum acceptable levels of use that people have on average, based on norm curves and the crystallization or level of consensus between them. Targeting this issue, provision of beach facilities, placement or improvement of the lifeguarding system would be valuable management practices.

Although this project has assessed the level of conflict with other beach users and the level of satisfaction, the extent to which it was applied does not provide deeper insights on the reality of these beaches. Therefore, research on the application of other types of visitor management frameworks such as the Visitor Impact Management (VIM), Limits of Acceptable Change (LAC) and Visitor Experience and Resource Protection (VERP) are suggested as they complement the carrying capacity framework.

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APPENDICES

Appendix 1: Survey instruments

Appendix 2A1: Uncollapsed responses from local communities at Praia de Faro (Faro Beach), Portugal

Appendix 2A2: Uncollapsed responses from tourists at Praia de Faro (Faro Beach), Portugal

Appendix 2B1: Uncollapsed responses from local communities at Praia Do Tofo (Tofo Beach), Mozambique

Appendix 2B2: Uncollapsed responses from tourists at Praia do Tofo (Tofo Beach), Mozambique

Appendix 3A: Physico-ecological carrying capacity of Praia de Faro (Faro Beach), Portugal

Appendix 3B: Physico-ecological carrying capacity of Praia do Tofo (Tofo Beach), Mozambique

Appendix 4: Number of people represented by each photograph used in this project

Appendix 5: Importance-satisfaction data tables and matrices for Faro and Tofo Beaches

**TOURISM CARRYING CAPACITY ASSESSMENT AND
MANAGEMENT**

**AVALIAÇÃO E GESTÃO DA CAPACIDADE DE CARGA
TURÍSTICA**



European Joint Master in Water and Coastal Management, Erasmus
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TOURISTS' QUESTIONNAIRE

QUESTIONÁRIO AOS TURISTAS

As part of a research program for a masters' degree, we are conducting a survey to understand your experiences and satisfaction at this beach and opinions on how this beach should be managed. Your participation is voluntary and anonymous. Please answer **ALL** questions and return to the researcher. Have a nice day!

Como parte de um programa de pesquisa conducente ao grau de mestre, estamos desenvolvendo este inquérito de forma a perceber a sua experiência e satisfação em relação à praia, bem como a sua opinião sobre o processo de gestão deste espaço. Por favor, responda a **TODAS** as questões e devolva o questionário ao inquiridor. Continuação de um bom dia!

1. Prior to today, have you ever been to this beach before? (check **ONE** option)

No

Yes. If yes, how many previous times have been to this beach? (*write* response) _____
time(s)

2. Please check all the activities in which you are participating at this beach, today (check **ALL THAT APPLY**)

A. Sunbathing	<input type="checkbox"/>	B. Swimming	<input type="checkbox"/>	C. Fishing	<input type="checkbox"/>
E. Scuba diving	<input type="checkbox"/>	F. Beach walking	<input type="checkbox"/>	G. Surfing	<input type="checkbox"/>
H. Windsurfing	<input type="checkbox"/>	I. Boating	<input type="checkbox"/>	J. Other	<input type="checkbox"/>

If you stated 'other', please specify _____

3. From the activities in question 2 above, what is the **ONE** main activity in which you are participating at this beach today? (write **ONE** letter that matches your response)

Letter for main activity _____

4. How would you describe your skill level in this main activity? (check **ONE**)

Beginner Novice Intermediate Advanced Expert

5. Are you participating in this main activity today as part of an organized or guided tour? (check **ONE**)

No Yes

6. Overall, how satisfied are you with your visit to this beach, today? (circle **ONE** number)

Very dissatisfied	Dissatisfied	Neither	Satisfied	Very satisfied

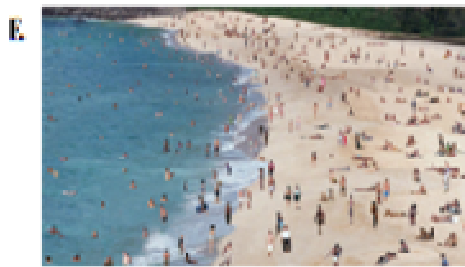
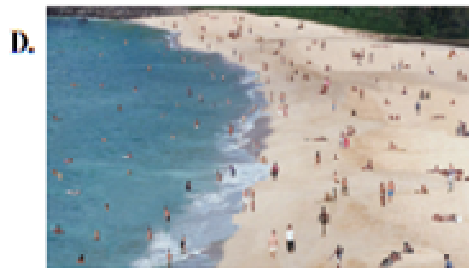
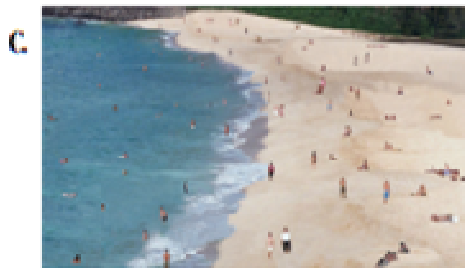
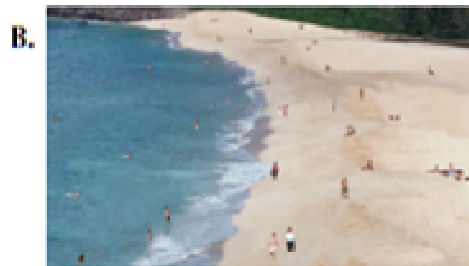
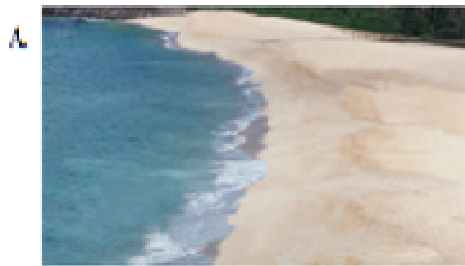
7. What is the *maximum* number of other people you would accept seeing at any one time at this beach? Is it OK to see as many as: (circle **ONE** number **OR** check one of the other two options)

0 5 10 15 20 35 50 75 100 200 350 500 750 1000
1500 2000+people

OR ___ the number of people doesn't matter to me; ___It matters to me, but I can't specify a number

8. We are interested in how many people you are willing to see at this beach. Please rate how **ACCEPTABLE** the density of people is in **EACH** photograph below **IF IT WAS TO OCCUR AT PRAIA DO TOFO** (circle **ONE** number for each photo)

Photograph	Very unacceptable	Unacceptable	Neither	Acceptable	Very Acceptable
A	1	2	3	4	5
B	1	2	3	4	5
C	1	2	3	4	5
B	1	2	3	4	5
E	1	2	3	4	5
F	1	2	3	4	5



9. Which **ONE** photograph above is like you saw most often at this beach? (check **ONE**)

Photo A Photo B Photo C Photo D Photo E Photo F

APPENDIX 1

10. How often have you seen each of the following during any of your visits to this beach? (circle **ONE** number for **EACH** item)

	Never	Once or twice	Sometimes	Many times
Sunbathers or swimmers being rude or discourteous	0	1	2	3
Sunbathers or swimmers being too close	0	1	2	3
Sunbathers or swimmers not looking where they are going	0	1	2	3
Snorkelers or scuba divers being rude or discourteous	0	1	2	3
Snorkelers or scuba divers being too close	0	1	2	3
Snorkelers or scuba divers not looking where they are going	0	1	2	3
Surfers being rude or discourteous	0	1	2	3
Surfers being too close	0	1	2	3
Surfers not looking where they are going	0	1	2	3
Windsurfers being rude or discourteous	0	1	2	3
Windsurfers being too close	0	1	2	3
Windsurfers not looking where they are going	0	1	2	3
Boaters being rude or discourteous	0	1	2	3
Boaters being too close	0	1	2	3
Boaters not looking where they are going	0	1	2	3
Anglers (people fishing) being rude or discourteous	0	1	2	3
Anglers (people fishing) being too close	0	1	2	3
Anglers (people fishing) not looking where they are going	0	1	2	3

11. To what extent do you feel that each of the following is a **PROBLEM** at this beach? (circle **ONE** number for **EACH** item)

	Not at all a problem	Slight problem	Moderate problem	Extreme problem
Sunbathers or swimmers being rude or discourteous	0	1	2	3
Sunbathers or swimmers being too close	0	1	2	3
Sunbathers or swimmers not looking where they are going	0	1	2	3
Snorkelers or scuba divers being rude or discourteous	0	1	2	3
Snorkelers or scuba divers being too close	0	1	2	3
Snorkelers or scuba divers not looking where they are going	0	1	2	3
Surfers being rude or discourteous	0	1	2	3
Surfers being too close	0	1	2	3
Surfers not looking where they are going	0	1	2	3
Windsurfers being rude or discourteous	0	1	2	3
Windsurfers being too close	0	1	2	3
Windsurfers not looking where they are going	0	1	2	3
Boaters being rude or discourteous	0	1	2	3
Boaters being too close	0	1	2	3
Boaters not looking where they are going	0	1	2	3
Anglers (people fishing) being rude or discourteous	0	1	2	3
Anglers (people fishing) being too close	0	1	2	3
Anglers (people fishing) not looking where they are going	0	1	2	3

12. Listed below are several characteristics. On the left, please rate how **IMPORTANT** it is to you that each characteristic is provided at this beach. Then, on the right, rate how **SATISFIED** you are with each characteristic at this beach. Please answer **BOTH** the importance (on left) and satisfaction (on right) question for **EACH** characteristic by circling numbers for each item.

Rate IMPORTANTANCE					Characteristics of the beach	Rate SATISFACTION				
Not important	Neither	Very important		Very dissatisfied		Neither	Very satisfied			
1	2	3	4	5	Parking availability for vehicles	1	2	3	4	5
1	2	3	4	5	Bathrooms	1	2	3	4	5
1	2	3	4	5	Showers/ rinse stations	1	2	3	4	5
1	2	3	4	5	Trash cans	1	2	3	4	5
1	2	3	4	5	Absence of litter	1	2	3	4	5
1	2	3	4	5	Picnic tables	1	2	3	4	5
1	2	3	4	5	Beach benches	1	2	3	4	5
1	2	3	4	5	Information signs about regulations	1	2	3	4	5
1	2	3	4	5	Presence of lifeguards	1	2	3	4	5
1	2	3	4	5	Nor required to pay a fee to enter	1	2	3	4	5
1	2	3	4	5	Opportunity to escape crowds	1	2	3	4	5
1	2	3	4	5	Clean ocean water	1	2	3	4	5
1	2	3	4	5	Healthy coral reefs	1	2	3	4	5
1	2	3	4	5	Healthy mangrove forests	1	2	3	4	5
1	2	3	4	5	Opportunity to see small marine life	1	2	3	4	5
1	2	3	4	5	Opportunity to see large marine life	1	2	3	4	5

13. Should there be more educational information at this beach? (check **ONE**)

No _____ Yes _____ Unsure _____

14. Should this beach be zoned so different recreation activities don't overlap in the same area? (check **ONE**)

No _____ Yes _____ Unsure _____

15. Should there be designated parking areas at this beach? (check **ONE**)

No _____ Yes _____ Unsure _____

TO BE FILLED BY THE RESEARCHER	
Gender (check ONE) Male	Female
Age range: _____	
Where do you live?	
State/ Province _____	
Country _____	

THANKS FOR YOUR COLLABORATION

LOCAL COMMUNITIES'S QUESTIONNAIRE

QUESTIONÁRIO ÀS COMUNIDADES LOCAIS

As part of a research program for a masters' degree, we are conducting a survey to understand your experiences and satisfaction at this beach and opinions on how this beach should be managed. Your participation is voluntary and anonymous. Please answer **ALL** questions and return to the researcher. Have a nice day!

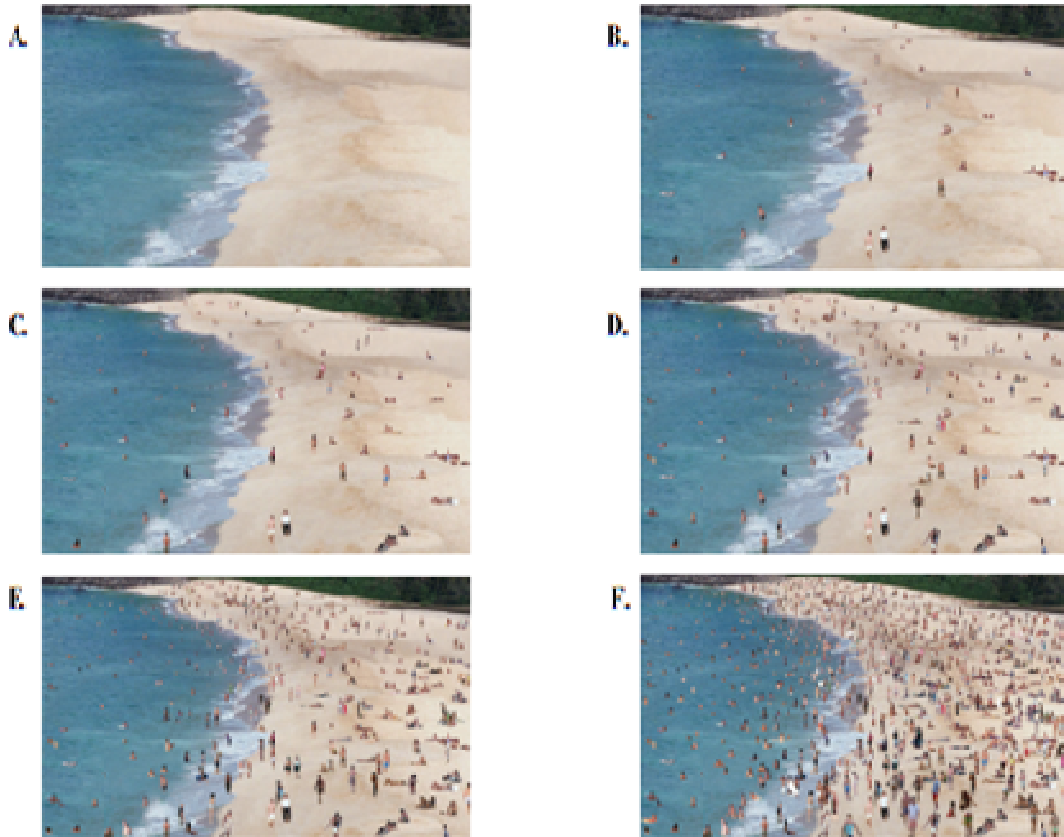
Como parte de um programa de pesquisa conducente ao grau de mestre, estamos desenvolvendo este inquérito de forma a perceber a sua experiência e satisfação em relação à praia, bem como a sua opinião sobre o processo de gestão deste espaço. Por favor, responda a **TODAS** as questões e devolva o questionário ao inquiridor. Continuação de um bom dia!

12. What is the *maximum* number of other people you would accept seeing at any one time at this beach? Is it OK to see as many as: (circle **ONE** number **OR** check one of the other two options)
 0 5 10 15 20 35 50 75 100 200 350 500 750 1000
 1500 2000+people

OR ___ the number of people doesn't matter to me; ___ It matters to me, but I can't specify a number

13. We are interested in how many people you are willing to see at this beach. Please rate how **ACCEPTABLE** the density of people is in **EACH** photograph below **IF IT WAS TO OCCUR AT PRAIA DO TOFO** (circle **ONE** number for each photo)

Photograph	Very unacceptable	Unacceptable	Neither	Acceptable	Very Acceptable
A	1	2	3	4	5
B	1	2	3	4	5
C	1	2	3	4	5
B	1	2	3	4	5
E	1	2	3	4	5
F	1	2	3	4	5



14. Which ONE photograph above is like you saw most often at this beach? (check ONE)

Photo A Photo B Photo C Photo D Photo E Photo F

15. How often have you seen each of the following during any of your visits to this beach? (circle ONE number for EACH item)

	Never	Once or twice	Sometimes	Many times
Sunbathers or swimmers being rude or discourteous	0	1	2	3
Sunbathers or swimmers being too close	0	1	2	3
Sunbathers or swimmers not looking where they are going	0	1	2	3
Snorkelers or scuba divers being rude or discourteous	0	1	2	3
Snorkelers or scuba divers being too close	0	1	2	3
Snorkelers or scuba divers not looking where they are going	0	1	2	3
Surfers being rude or discourteous	0	1	2	3
Surfers being too close	0	1	2	3
Surfers not looking where they are going	0	1	2	3
Windsurfers being rude or discourteous	0	1	2	3
Windsurfers being too close	0	1	2	3
Windsurfers not looking where they are going	0	1	2	3
Boaters being rude or discourteous	0	1	2	3
Boaters being too close	0	1	2	3
Boaters not looking where they are going	0	1	2	3
Anglers (people fishing) being rude or discourteous	0	1	2	3
Anglers (people fishing) being too close	0	1	2	3
Anglers (people fishing) not looking where they are going	0	1	2	3

16. To what extent do you feel that each of the following is a **PROBLEM** at this beach? (circle **ONE** number for **EACH** item)

	Not at all a problem	Slight problem	Moderate problem	Extreme problem
Sunbathers or swimmers being rude or discourteous	0	1	2	3
Sunbathers or swimmers being too close	0	1	2	3
Sunbathers or swimmers not looking where they are going	0	1	2	3
Snorkelers or scuba divers being rude or discourteous	0	1	2	3
Snorkelers or scuba divers being too close	0	1	2	3
Snorkelers or scuba divers not looking where they are going	0	1	2	3
Surfers being rude or discourteous	0	1	2	3
Surfers being too close	0	1	2	3
Surfers not looking where they are going	0	1	2	3
Windsurfers being rude or discourteous	0	1	2	3
Windsurfers being too close	0	1	2	3
Windsurfers not looking where they are going	0	1	2	3
Boaters being rude or discourteous	0	1	2	3
Boaters being too close	0	1	2	3
Boaters not looking where they are going	0	1	2	3
Anglers (people fishing) being rude or discourteous	0	1	2	3
Anglers (people fishing) being too close	0	1	2	3
Anglers (people fishing) not looking where they are going	0	1	2	3

17. Should there be more educational information at this beach? (check **ONE**)
 No _____ Yes _____ Unsure _____

18. Should this beach be zoned so different recreation activities don't overlap in the same area? (check **ONE**)
 No _____ Yes _____ Unsure _____

19. Should there be designated parking areas at this beach? (check **ONE**)
 No _____ Yes _____ Unsure _____

TO BE FILLED BY THE RESEARCHER
Gender (check ONE) Male _____ Female _____
Age range: _____
Where you live? State/ Province _____
Country _____

THANKS FOR YOUR COLLABORATION

APPENDIX 2A1: UNCOLLAPSED RESPONSES FROM LOCAL COMMUNITIES AT PRAIA DE FARO (FARO BEACH), PORTUGAL

n= 128

Question 1: What is the *maximum* number of other people you would accept seeing at any one time at this beach? Is it OK to see as many as: (circle **ONE** number **OR** check one of the other two options)

Average (42) = 640 people

34% (43) - the number does not matter

34% (43) – cannot specify

Question 2: We are interested in knowing how many people you are willing to see at this beach. Please rate how **ACCEPTABLE** the density of people is in **EACH** photograph below **IF IT WAS TO OCCUR AT PRAIA DE FARO** (circle **ONE** number for each photo)

Photo	1	2	3	4	5
A	41%	9%	16%	25%	9%
B	9%	34%		50%	9%
C		16.4%	16.4%	66.4%	
D		9%	9%	66%	16%
E		25%	25%	25%	25%
F	50%	41%			9%

Question 4: Which **ONE** photograph above is like you saw most often at Tofo Beach? (check **ONE**)

Photo E – 84% (107), Photo F – 16% (21)

Question 4: How often have you seen each of the following during any of your visits to Praia de Faro? (circle **ONE** number for **EACH** item)

Variable	Sub-variable	Never	1 or 2 times	Sometimes	Many times
A	A1	75%	25%		
	A2	50%	25%	25%	
	A3	66%		25%	9%
B	B1	66%	16%		16%
	B2	50%	16%	25%	9%
	B3	66%		34%	
C	C1	66%	34%		
	C2	66%	16%	16%	
	C3	84%		16%	
D	D1	66%	34%		
	D2	50%	16%	34%	
	D3	66%		16%	16%
E	E1	66%	16%		16%
	E2	50%	16%	34%	
	E3	66%	16%	16%	

F	F1	84%	16%		
	F2	66%	16%	16%	
	F3	66%	16%	16%	

Question 5: To what extent do you feel that each of the following is a **PROBLEM** at Praia de Faro? (circle **ONE** number for **EACH** item)

Variable	Sub-variable	Not problem	Slight problem	Moderate problem	Extreme problem
A	A1	16%	25%	16%	41%
	A2	16%	16%	66%	
	A3	16%	34%	25%	25%
B	B1	16%	25%	25%	34%
	B2	25%	9%	59%	9%
	B3	16%	25%	25%	34%
C	C1	9%	25%	34%	34%
	C2	9%	25%	59%	16%
	C3	25%	16%	25%	34%
D	D1	25%	16%	25%	34%
	D2	16%	16%	59%	9%
	D3	25%	25%	25%	25%
E	E1	16%	25%	25%	34%
	E2	9%	16%	59%	16%
	E3	25%	9%	34%	34%
F	F1	9%	16%	34%	41%
	F2	9%	16%	59%	16%
	F3	16%	16%	34%	25%

Question 6: Should there be more educational information at this beach? (check **ONE**)
100% (128) yes

Question 7: Should this beach be zoned so different recreation activities don't overlap in the same area? (check **ONE**)
25% (32) no; 75% (96) yes

Question 8: Should there be designated parking areas at this beach? (check **ONE**)
9% (11) no; 84% (107) yes; 9% (11) not sure

Question 9: Gender
41% (53) Male; 59% (75) Female

Question 10: Age
9% (11) less than 20; 9% (11) between 21 and 24; 16% (21) between 25 and 29; 9% (11) between 30 and 34; 16% (21) between 40 and 44; 41% (53) with 50 or more

**APPENDIX 2A2: UNCOLLAPSED RESPONSES FROM
TOURISTS AT PRAIA DE FARO (FARO BEACH),
PORTUGAL
n=147**

Question 1: Prior to today, have you ever been to this beach before? (check one option)
57% = No
43% = Yes; average visitation = 5 (3.3); mode = 2

Question 2: Please check all activities in which you are participating at Praia do Faro today (check all that apply to you)

A	29%	B	20%	C	11%
D	9%	E	23%	F	6%
G	6%	H	3%	I	11%

Question 3: From the activities in question 2 above, what is the one main activity in which you are participating today? (write one letter – A to I – that matches your response)

A	26%	B	23%	C	3%
D	3%	E	20%	F	9%
G	6%	H	3%	I	9%

Question 4: How would you describe your skill level in the main activity you are participating? (check one)

BEGINNER	26%
NOVICE	20%
INTERMEDIATE	20%
ADVANCED	17%
EXPERT	17%

Question 5: Are you participating in the main activity today as part of an organized or guided tour? (check one)
57% = No; 43% = Yes

Question 6: Overall, how satisfied are you with this visit to Praia de Faro? (circle one number)

V.D	6%
D	9%
N	9%
S	54%
V.S	23%

Question 7: What is the maximum number of other people you would accept seeing at any one time at this beach? Is it ok to see as many as: (circle one number or check one of the other two sections)

Average (85%) = 740 people

9% = the number does not matter

6% = cannot specify

Question 8: Please rate how acceptable the density of people is in each photograph below if it was to occur at Praia de Faro (circle one number for each photo)

Photograph	1	2	3	4	5
A	37%	23%	14%	14%	11%
B	34%	26%	9%	17%	14%
C	11%	20%	3%	34%	31%
D	3%	3%		54%	40%
E	3%	6%		40%	51%
F	34%	29%	9%	20%	9%

Question 9: How often have you seen each of the following during any of your visits to Praia de Faro? (circle one number for each item)

Variable	Sub-variable	Never	1 or 2 times	Sometimes	Many times
A	A1	75%	15%	5%	5%
	A2	50%	25%	10%	15%
	A3	64%	2%	20%	14%
B	B1	59%	20%	5%	16%
	B2	55%	18%	22%	5%
	B3	58%	6%	32%	4%
C	C1	65%	15%	5%	15%
	C2	60%	16%	10%	14%
	C3	83%	2%	14%	1%
D	D1	67%	20%	8%	5%
	D2	58%	22%	13%	7%
	D3	70%	15%	8%	7%
E	E1	65%	12%	10%	13%
	E2	51%	5%	30%	14%
	E3	62%	10%	13%	15%
F	F1	80%	4%	10%	6%
	F2	63%	10%	8%	19%
	F3	69%	10%	8%	13%

Question 10: To what extent do you feel that each of the following is a problem at Praia de Faro? (circle one number for each item)

Variable	Sub-variable	Not problem	Slight problem	Moderate problem	Extreme problem
A	A1	16%	24%	9%	51%
	A2	16%	19%	50%	15%
	A3	18%	32%	32%	18%
B	B1	16%	27%	34%	23%
	B2	27%	23%	10%	40%
	B3	15%	20%	33%	32%
C	C1	12%	26%	43%	19%
	C2	14%	24%	49%	13%
	C3	22%	14%	34%	30%
D	D1	23%	19%	29%	29%
	D2	19%	21%	51%	9%
	D3	27%	22%	25%	25%
E	E1	13%	29%	29%	29%
	E2	11%	20%	49%	20%
	E3	22%	14%	39%	25%
F	F1	10%	22%	41%	27%
	F2	12%	25%	50%	13%
	F3	17%	20%	25%	38%

Question 11: Listed below are several characteristics. On the left, please rate how important it is to you that each characteristic is provided at this beach. On the right, rate how satisfied you are with each characteristic at this beach. Please answer both the importance (on the left) and satisfaction (on the right) for each characteristic by circling numbers for each item.

Rate IMPORTANCE						Rate SATISFACTION				
1	2	3	4	5		1	2	3	4	5
9%	6%	3%	49%	34%	v1	26%	23%	3%	20%	29%
26%	9%	3%	29%	34%	v2	32%	30%	6%	20%	12%
11%	11%	9%	40%	29%	v3	34%	6%	3%	11%	46%
6%	6%	6%	26%	57%	v4	11%	14%	9%	54%	11%
3%	3%	3%	57%	34%	v5	3%	3%	3%	57%	34%
46%	26%	14%	6%	9%	v6	34%	29%	14%	11%	11%
29%	23%	20%	14%	14%	v7	40%	9%	3%	23%	26%
26%	9%	6%	31%	29%	v8	14%	14%	6%	31%	34%
6%	11%	23%	43%	17%	v9	14%	11%	23%	23%	29%
9%	6%	43%	23%	20%	v10	3%	3%	6%	49%	40%
6%	14%	6%	51%	23%	v11	29%	34%	11%	14%	11%
3%	3%	3%	49%	43%	v12	3%	3%	11%	51%	31%
6%	14%	11%	40%	29%	v13	49%	34%	17%		
14%	14%	20%	34%	17%	v14	54%	31%	14%		
20%	9%	6%	43%	23%	v15	26%	23%	6%	23%	23%
23%	11%	29%	20%	17%	v16	46%	40%	14%		

Question 12: Should there be more environmental education at this beach? (please check one)

29% = No; 54% = Yes; 17% = Unsure

Question 13: Should this beach be zoned so that different recreation activities do not overlap in the same area? (please check one option)

43% = No; 51% = Yes; 6% = Unsure

Question 14: Should there be designated more parking areas at this beach? (please check one option)

57% = No; 34% = Yes; 9% = Unsure

GENDER

51% = Male; 49% = Female

Age

6% less than 20; 11% between 20 and 24; 23% between 25 and 29; 11% between 30 and 34; 11% between 35 and 39; 14% between 40 and 44; 14% between 45 and 49; 9% with 50 or more years old

APPENDIX 2B1: UNCOLLAPSED RESPONSES FROM LOCAL COMMUNITIES AT PRAIA DO TOFO (TOFO BEACH), MOZAMBIQUE

n = 139

Question 1: What is the *maximum* number of other people you would accept seeing at any one time at this beach? Is it OK to see as many as: (circle **ONE** number **OR** check one of the other two options)

Average (45%) = 339 people

22% (31) - the number does not matter

33% (46) – cannot specify

Question 2: We are interested in how many people you are willing to see at this beach. Please rate how **ACCEPTABLE** the density of people is in **EACH** photograph below **IF IT WAS TO OCCUR AT PRAIA DE TOFO** (circle **ONE** number for each photo)

Photograph	1	2	3	4	5
A	41%	15%	11%	26%	7%
B	19%	26%	7%	37%	11%
C	15%	22%	15%	41%	7%
D	7%	11%	11%	48%	22%
E	7%	22%	11%	22%	37%
F	48%	30%	7%	11%	11%

Question 3: Which **ONE** photograph above is like you saw most often at Tofo Beach? (check **ONE**)

Photo D – 11%; Photo E – 63%; Photo F – 26%

Question 4: How often have you seen each of the following during any of your visits to Praia de TOFO? (circle **ONE** number for **EACH** item)

Variable	Sub-variable	Never	1 or 2 times	Sometimes	Many times
A	A1	52%	22%	15%	11%
	A2	41%	22%	22%	15%
	A3	44%	19%	26%	11%
B	B1	44%	26%	11%	19%
	B2	33%	30%	26%	11%
	B3	41%	22%	26%	11%
C	C1	48%	26%	15%	11%
	C2	48%	19%	22%	11%
	C3	56%	11%	19%	15%
D	D1	48%	26%	11%	15%
	D2	41%	22%	26%	11%
	D3	48%	15%	19%	19%
E	E1	48%	19%	11%	22%
	E2	41%	22%	26%	11%
	E3	44%	26%	19%	11%

F	F1	56%	19%	11%	15%
	F2	48%	19%	19%	15%
	F3	48%	19%	19%	15%

Question 6: To what extent do you feel that each of the following is a **PROBLEM** at Tofo beach? (circle **ONE** number for **EACH** item)

Variable	Sub-variable	Not a problem	Slight problem	Moderate problem	Extreme problem
A	A1	26%	22%	19%	33%
	A2	26%	19%	41%	15%
	A3	26%	26%	22%	26%
B	B1	26%	22%	26%	26%
	B2	30%	19%	37%	15%
	B3	19%	33%	22%	26%
C	C1	19%	30%	26%	26%
	C2	22%	26%	37%	15%
	C3	26%	26%	22%	26%
D	D1	30%	22%	22%	26%
	D2	26%	22%	37%	15%
	D3	30%	26%	22%	22%
E	E1	26%	22%	26%	26%
	E2	22%	22%	37%	19%
	E3	30%	19%	26%	26%
F	F1	19%	26%	26%	30%
	F2	19%	22%	37%	22%
	F3	22%	22%	26%	30%

Question 6: Should there be more educational information at this beach? (check **ONE**)
7% No; 67% Yes; 26% Not Sure

Question 11: Should this beach be zoned so different recreation activities don't overlap in the same area? (check **ONE**)
33% No; 52% Yes; 15% Not Sure

Question 12: Should there be designated parking areas at this beach? (check **ONE**)
26% No; 52% Yes; 22% Not Sure

Gender

48% Male; 52% Female

Age

7% less than 20; 15% between 20 and 24; 22% between 25 and 29; 11% between 30 and 34; 11% between 35 and 39; 15% between 40 and 44; 7% between 45 and 49; 11% with 50 or more.

**APPENDIX 2B2: UNCOLLAPSED RESPONSES FROM
TOURISTS AT PRAIA DE TOFO (TOFO BEACH),
MOÇAMBIQUE
n=78**

Question 1: You are at Praia do Tofo. Prior to today, have you ever been to this beach before? (check one option)

23% = No

77% = Yes; average visitation = 7 (3.3); mode = 9

Question 2: Please check all activities in which you are participating at Praia do Tofo today (check all that apply to you)

A	22%	B	43%	C	10%
D	21%	E	23%	F	3%
G	2%	H	1%	I	9%

Question 3: From the activities in question 2 above, what is the one main activity in which you are participating today? (write one letter – A to I – that matches your response)

A	33%	B	23%	C	12%
D	4%	E	28%	F	1%
G	1%	H	1%	I	26%

Question 4: How would you describe your skill level in the main activity you are participating? (check one)

BEGINNER	17%
NOVICE	23%
INTERMEDIATE	33%
ADVANCED	17%
EXPERT	10%

Question 5: Are you participating in the main activity today as part of an organized or guided tour? (check one)

87% = No; 13% = Yes

Question 6: Overall, how satisfied are you with this visit to Praia de Tofo? (circle one number)

V.D	5%
D	9%
N	8%
S	64%
V.S	14%

Question 7: What is the maximum number of other people you would accept seeing at any one time at this beach? Is it ok to see as many as: (circle one number or check one of the other two sections)

Average (70%) = 494 people

18% = the number does not matter

12% = cannot specify

Question 8: Please rate how acceptable the density of people is in each photograph below if it was to occur at Praia de Tofo (circle one number for each photo)

Photograph	1	2	3	4	5
A	49%	22%	9%	12%	8%
B	22%	52%	6%	11%	9%
C	12%	20%	3%	34%	31%
D	9%	3%	4%	45%	39%
E	3%	6%	4%	36%	51%
F	38%	27%	7%	17%	11%

Question 9: How often have you seen each of the following during any of your visits to Praia de Tofo? (circle one number for each item)

Variable	Sub-variable	Never	1 or 2 times	Sometimes	Many times
A	A1	70%	18%	7%	5%
	A2	53%	26%	11%	10%
	A3	59%	7%	18%	16%
B	B1	49%	26%	9%	16%
	B2	61%	22%	14%	3%
	B3	76%	5%	17%	6%
C	C1	63%	12%	9%	16%
	C2	59%	15%	9%	17%
	C3	76%	8%	12%	4%
D	D1	67%	20%	8%	5%
	D2	58%	22%	13%	7%
	D3	69%	16%	7%	8%
E	E1	85%	8%	5%	2%
	E2	85%	8%	5%	2%
	E3	85%	8%	5%	2%
F	F1	82%	4%	6%	8%
	F2	69%	9%	10%	12%
	F3	69%	9%	10%	12%

Question 10: To what extent do you feel that each of the following is a problem at Praia de Tofo? (circle one number for each item)

Variable	Sub-variable	Not a problem	Slight problem	Moderate problem	Extreme problem
A	A1	14%	23%	5%	58%
	A2	14%	35%	32%	19%
	A3	15%	29%	38%	18%
B	B1	10%	33%	23%	34%
	B2	15%	18%	40%	27%
	B3	15%	22%	31%	32%
C	C1	11%	25%	40%	24%
	C2	12%	29%	38%	21%
	C3	25%	20%	27%	28%
D	D1	23%	19%	29%	29%
	D2	19%	21%	44%	16%
	D3	26%	23%	24%	27%
E	E1	19%	23%	27%	31%
	E2	10%	23%	43%	24%
	E3	12%	18%	38%	32%
F	F1	13%	21%	39%	27%
	F2	16%	25%	42%	17%
	F3	12%	23%	25%	40%

Question 14: Listed below are several characteristics. On the left, please rate how important it is to you that each characteristic is provided at this beach. On the right, rate how satisfied you are with each characteristic at this beach. Please answer both the importance (on the left) and satisfaction (on the right) for each characteristic by circling numbers for each item.

Rate IMPORTANCE						Rate SATISFACTION				
1	2	3	4	5		1	2	3	4	5
9%	5%	3%	49%	34%	v1	50%	30%	18%	1%	1%
25%	16%	6%	22%	31%	v2	51%	29%	4%	12%	5%
2%	5%	4%	55%	34%	v3	51%	29%	4%	12%	5%
5%	7%	4%	27%	57%	v4	23%	22%	14%	22%	23%
3%	7%	3%	51%	36%	v5	15%	8%	3%	44%	30%
44%	21%	11%	13%	11%	v6	50%	30%	18%	1%	1%
34%	28%	4%	18%	16%	v7	50%	30%	18%	1%	1%
29%	12%	6%	26%	27%	v8	23%	22%	14%	22%	23%
5%	13%	20%	41%	21%	v9	50%	30%	18%	1%	1%
3%	6%	12%	25%	54%	v10	3%	3%	6%	33%	55%
4%	6%	6%	57%	27%	v11	23%	22%	14%	22%	23%

3%	6%	8%	43%	40%	v12	3%	5%	7%	49%	36%
3%	8%	5%	34%	50%	v13	23%	22%	14%	22%	23%
3%	7%	5%	49%	36%	v14	23%	22%	14%	22%	23%
10%	8%	5%	46%	31%	v15	39%	8%	14%	22%	17%
23%	11%	29%	20%	17%	v16	39%	8%	14%	22%	17%

Question 12: Should there be more environmental education at this beach? (please check one)

17% = No; 68% = Yes; 15% = Unsure

Question 13: Should this beach be zoned so that different recreation activities do not overlap in the same area? (please check one option)

61% = No; 35% = Yes; 4% = Unsure

Question 14: Should there be designated more parking areas at this beach? (please check one option)

39% = No; 54% = Yes; 7% = Unsure

GENDER

67% = Male; 33% = Female

Age

12% less than 20; 25% between 20 and 24; 14% between 25 and 29; 12% between 30 and 34; 10% between 35 and 39; 8% between 40 and 44; 9% between 45 and 49; 10% with 50 or more years old

**Physico-ecological carrying capacity of Praia de Faro (Faro Beach),
Portugal**

A) Physical carrying capacity

$$PCC = \frac{A}{A_u} \times R_f$$

$$PCC_1 = \frac{90,000 \text{ m}^2}{5 \text{ m}^2} \times 4$$

$$PCC_1 = 72,000 \text{ visits/day}$$

$$PCC_2 = \frac{90,000 \text{ m}^2}{10 \text{ m}^2} \times 4$$

$$PCC_2 = 36,000 \text{ visits/day}$$

B) Real Carrying Capacity

$$RCC = PCC \times (cf1 \times cf2 \times cf3 \times \dots \times cfn)$$

Correction Factors

$$Cf_x = 1 - \frac{Lm_x}{Tm_x}$$

Rainfall (November, December, January,

February)

4 months = 120 days/year

Temporary Closure (January, February,

March, April, May, October, November,

December)

8 months = 243 days/ year

Excessive Wind (June, July, August and

September)

4 months = 122 days/year

No sunshine

5760 hours/year

Beach Erosion

1.7 m/ year = 3060 m²/ year

$$Cf_{rain} = 1 - \frac{Lm_{rain}}{Tm_{rain}}$$

$$Cf_{rain} = 1 - \frac{120}{365}$$

$$Cf_{rain} = 0.6712$$

$$Cf_{wind} = 1 - \frac{Lm_{wind}}{Tm_{wind}}$$

$$Cf_{wind} = 1 - \frac{122}{365}$$

$$Cf_{wind} = 0.6658$$

$$Cf_{sun} = 1 - \frac{Lm_{sun}}{Tm_{sun}}$$

$$Cf_{er} = 1 - \frac{Lm_{er}}{Tm_{er}}$$

$$Cf_{sun} = 1 - \frac{5760}{8760}$$

$$Cf_{sun} = 0.3425$$

$$Cf_{er} = 1 - \frac{3,060m^2}{90,000m^2}$$

$$Cf_{er} = 0.966$$

$$Cf_{tc} = 1 - \frac{Lm_{tc}}{Tm_{tc}}$$

$$Cf_{tc} = 1 - \frac{243}{365}$$

$$Cf_{tc} = 0.3342$$

$$RCC = PCC \times (Cf_{rain} \times Cf_{sun} \times Cf_{tc} \times Cf_{wind} \times Cf_{be})$$

$$RCC_1 = 72,000 \times (0.6712 \times 0.3425 \times 0.3342 \times 0.6658 \times 0.966)$$

$$RCC_1 \approx 3558 \text{ visits/day}$$

$$RCC_2 = 36,000 \times (0.6712 \times 0.3425 \times 0.3342 \times 0.6658 \times 0.966)$$

$$RCC_2 \approx 1779 \text{ visits/day}$$

C) Effective or Permissible Carrying Capacity

Management Capacity

Variable	Scenario 1	Scenario 2
Infrastructure	0.961	
Equipments	0.714	
Average	0.838	
Management Capacity	83.8%	

$$ECC = RCC \times Mc$$

$$ECC_1 = 3,558 \text{ visits/day} \times 0.838$$

$$ECC_2 = 1,779 \text{ visits/day} \times 0.838$$

$$ECC_1 = 2,982 \text{ visits/day}$$

$$ECC_2 = 1,491 \text{ visits/day}$$

$$PCC \geq RCC \geq ECC$$

Scenario 1

Scenario 2

$$72,000 \geq 3,558 \geq 2,982$$

$$36,000 \geq 1,779 \geq 1,491$$

**Physico-ecological carrying capacity of Praia do Tofo (Tofo Beach),
Mozambique**

A) Physical carrying capacity

$$PCC = \frac{A}{A_u} \times R_f$$

$$PCC_1 = \frac{95,496 \text{ m}^2}{5 \text{ m}^2} \times 3$$

$$PCC_1 = 57,298 \text{ visits/day}$$

$$PCC_2 = \frac{95,496 \text{ m}^2}{10 \text{ m}^2} \times 3$$

$$PCC_2 = 28,649 \text{ visits/day}$$

B) Real Carrying Capacity

$$RCC = PCC \times (cf1 \times cf2 \times cf3 \times \dots \times cfn)$$

Correction Factors

$$Cf_x = 1 - \frac{Lm_x}{Tm_x}$$

Rainfall (November, December, January, February)
3 months = 90 days/year

4 months = 120 days/year

Excessive Wind (December, January, August)

Poor Water Quality

7 days/year

No sunshine

12 hours/day = 4380 hours/year

$$Cf_{rain} = 1 - \frac{Lm_{rain}}{Tm_{rain}}$$

$$Cf_{rain} = 1 - \frac{120}{365}$$

$$Cf_{rain} = 0.67$$

$$Cf_{wind} = 1 - \frac{Lm_{wind}}{Tm_{wind}}$$

$$Cf_{wind} = 1 - \frac{90}{365}$$

$$Cf_{wind} = 0.75$$

$$Cf_{sun} = 1 - \frac{Lm_{sun}}{Tm_{sun}}$$

$$Cf_{sun} = 1 - \frac{4,380}{8,760}$$

$$Cf_{sun} = 0.5$$

$$Cf_{wq} = 1 - \frac{Lm_{wq}}{Tm_{wq}}$$

$$Cf_{wq} = 1 - \frac{7}{365}$$

$$Cf_{wq} = 0.980$$

$$RCC = PCC \times (Cf_{rain} \times Cf_{wind} \times Cf_{sun} \times Cf_{wq})$$

$$RCC_1 = 57,298 \times (0.6712 \times 0.75 \times 0.5 \times 0.980)$$

$$RCC_1 \approx 14,134 \text{ visits/day}$$

$$RCC_2 = 28,649 \times (0.6712 \times 0.75 \times 0.5 \times 0.980)$$

$$RCC_2 \approx 7,067 \text{ visits/day}$$

C) Effective or Permissible Carrying Capacity

Management Capacity

Variable	Scenario 1	Scenario 2
Infrastructure	0.884	
Equipments	0.616	
Average	0.75	
Management Capacity	75%	

$$ECC = RCC \times Mc$$

$$ECC_1 = 14,134 \text{ visits/day} \times 0.75$$

$$ECC_2 = 7,067 \text{ visits/day} \times 0.75$$

$$ECC_1 = 10,601 \text{ visits/day}$$

$$ECC_2 = 5,301 \text{ visits/day}$$

$$PCC \geq RCC \geq ECC$$

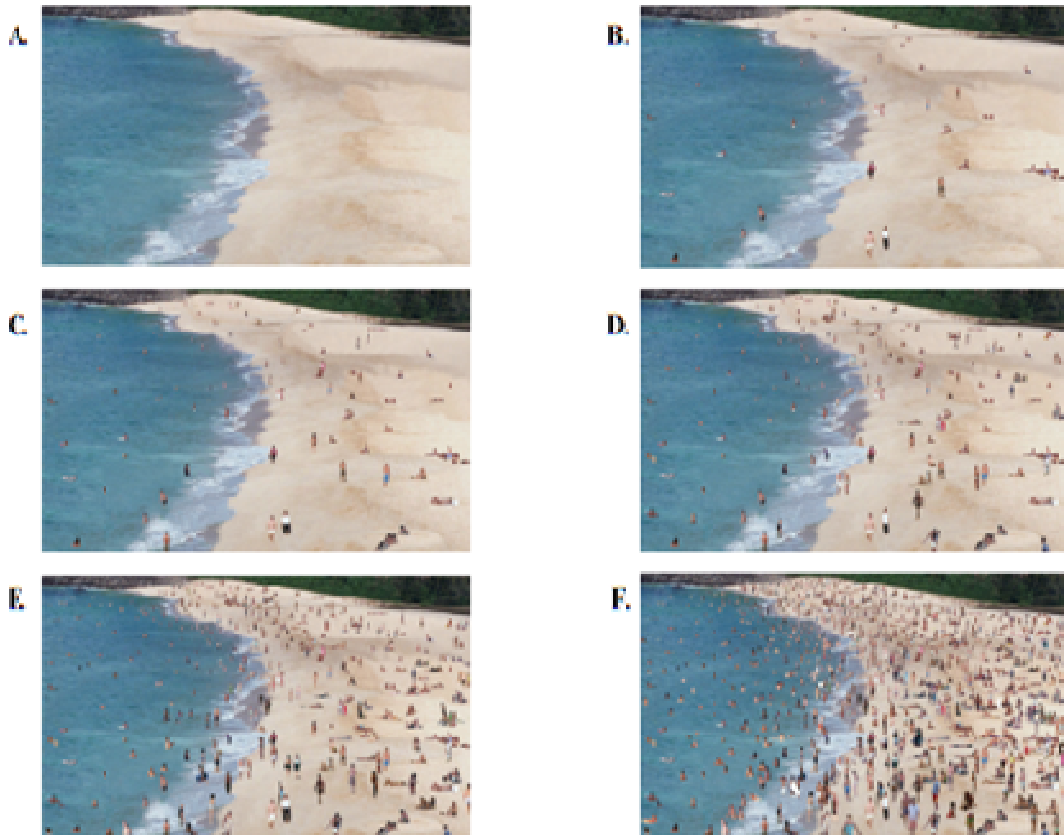
Scenario 1

Scenario 2

$$57,298 \geq 14,134 \geq 10,601$$

$$28,649 \geq 7,067 \geq 5,301$$

Number of people represented by each photograph used in this project



	Faro Beach	Tofo Beach
Total beach length (m)	1800	692
Total beach width (m)	50	138
Length of beach area (m)	40	118
Length of water area (m)	10	20
Photograph length (m)	457	457
Photograph width (m)	182	182

Photographs retrieved from Needham et al. (2008)

Faro Beach

Photograph A = 0

Photograph B

	Actual site size (length x width)		Photograph size (length x width)			Number of people in photograph		Number of people at site
Beach area	72000	÷	83174	=	0,866 *	37	=	32
Water area	18000	÷	83174	=	0,216 *	13	=	3

Photograph C

	Actual site size (length x width)		Photograph size (length x width)			Number of people in photograph		Number of people at site
Beach area	72000	÷	83174	=	0,866 *	75	=	65
Water area	18000	÷	83174	=	0,216 *	25	=	5

Photograph D

	Actual site size (length x width)		Photograph size (length x width)			Number of people in photograph		Number of people at site
Beach area	72000	÷	83174	=	0,866 *	150	=	130
Water area	18000	÷	83174	=	0,216 *	50	=	11

Photograph E

	Actual site size (length x width)		Photograph size (length x width)			Number of people in photograph		Number of people at site
Beach area	72000	÷	83174	=	0,866 *	300	=	260
Water area	18000	÷	83174	=	0,216 *	100	=	22

Photograph F

	Actual site size (length x width)		Photograph size (length x width)			Number of people in photograph		Number of people at site
Beach area	72000	÷	83174	=	0,866 *	600	=	519
Water area	18000	÷	83174	=	0,216 *	200	=	43

Tofo Beach

Photograph A = 0

Photograph B

	Actual site size (length x width)		Photograph size (length x width)			Number of people in photograph		Number of people at site
Beach area	81656	÷	83174	=	0,982 *	37	=	36
Water area	13840	÷	83174	=	0,166 *	13	=	2

Photograph C

	Actual site size (length x width)		Photograph size (length x width)			Number of people in photograph		Number of people at site
Beach area	81656	÷	83174	=	0,982 *	75	=	74
Water area	13840	÷	83174	=	0,166 *	25	=	4

Photograph D

	Actual site size (length x width)		Photograph size (length x width)			Number of people in photograph		Number of people at site
Beach area	81656	÷	83174	=	0,982 *	150	=	147
Water area	13840	÷	83174	=	0,166 *	50	=	8

Photograph E

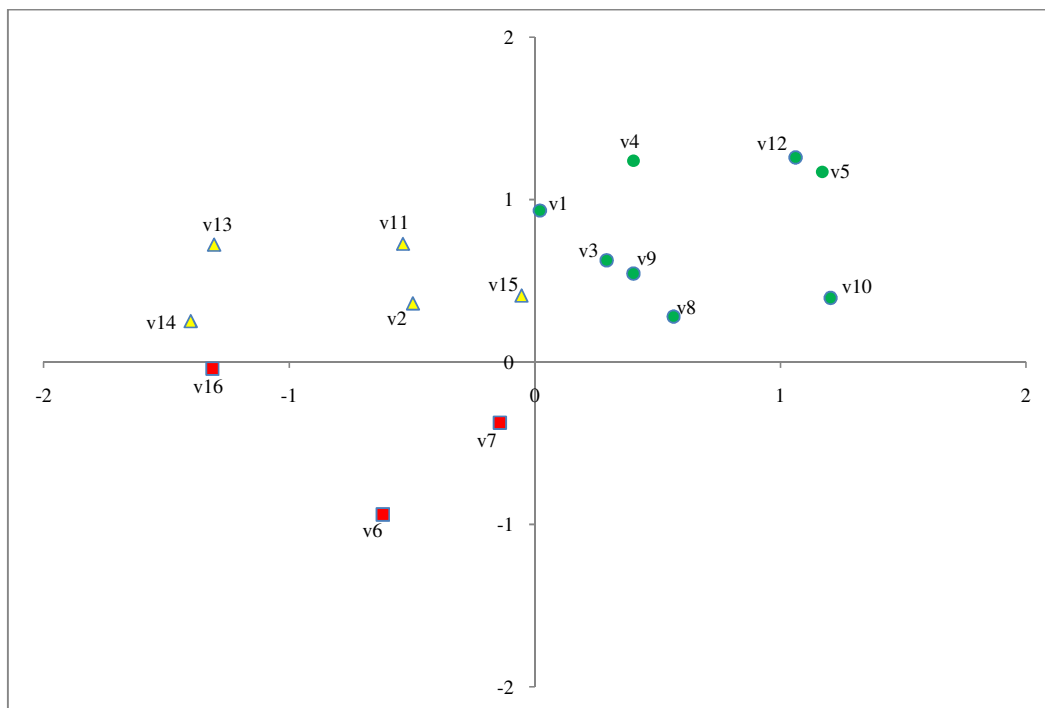
	Actual site size (length x width)		Photograph size (length x width)			Number of people in photograph		Number of people at site
Beach area	81656	÷	83174	=	0,982 *	300	=	295
Water area	13840	÷	83174	=	0,166 *	100	=	17

Photograph F

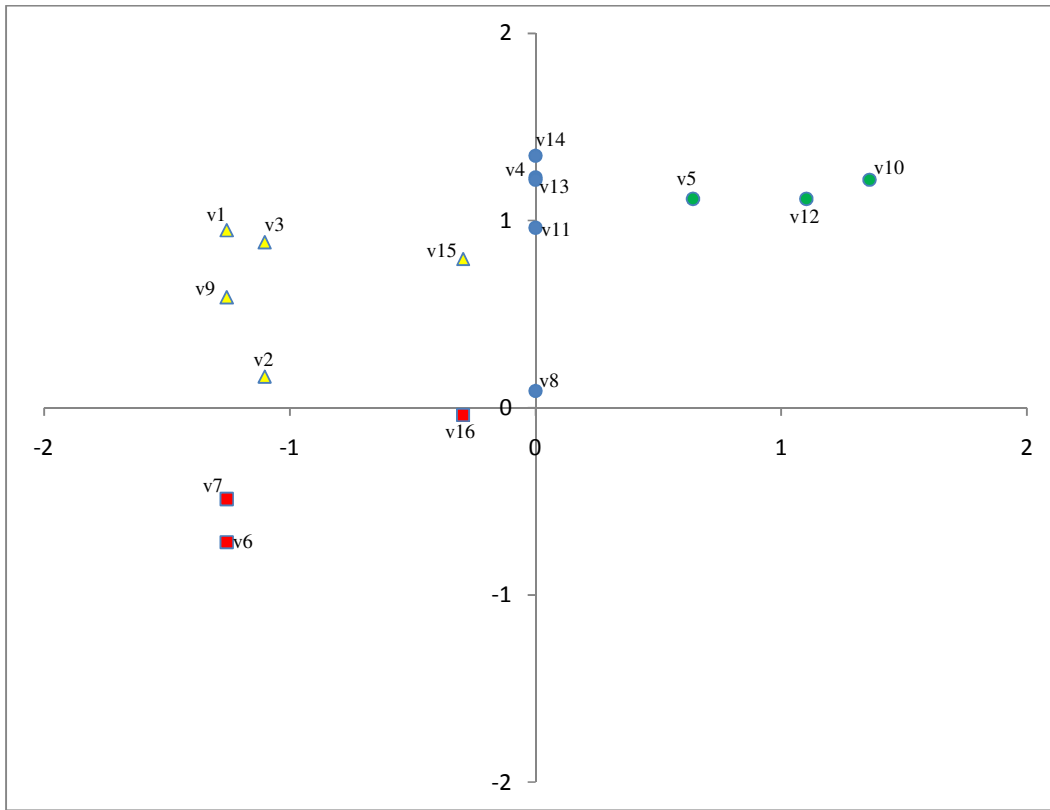
	Actual site size (length x width)		Photograph size (length x width)			Number of people in photograph		Number of people at site
Beach area	81656	÷	83174	=	0,982 *	600	=	589
Water area	13840	÷	83174	=	0,166 *	200	=	33

Importance-satisfaction data tables and matrices for Faro and Tofo Beaches

Variables		Faro Beach		Tofo Beach	
		Importance	Satisfaction	Importance	Satisfaction
v1	Parking availability for vehicles	0,93	0,02	0,95	-1,26
v2	Bathrooms	0,36	-0,50	0,17	-1,10
v3	Showers/ rinse stations	0,63	0,29	0,88	-1,10
v4	Trash cans	1,24	0,40	1,23	0,00
v5	Absence of litter	1,17	1,17	1,12	0,64
v6	Picnic tables	-0,94	-0,62	-0,72	-1,26
v7	Beach benches	-0,37	-0,14	-0,49	-1,26
v8	Information signs about regulations	0,28	0,56	0,09	0,00
v9	Presence of lifeguards	0,54	0,40	0,59	-1,26
v10	Nor required to pay a fee to enter	0,39	1,20	1,22	1,36
v11	Opportunity to escape crowds	0,73	-0,54	0,96	0,00
v12	Clean ocean water	1,26	1,06	1,12	1,10
v13	Healthy coral reefs	0,72	-1,31	1,22	0,00
v14	Healthy mangrove forests	0,25	-1,40	1,35	0,00
v15	Opportunity to see small marine life	0,41	-0,05	0,79	-0,29
v16	Opportunity to see large marine life	-0,04	-1,31	-0,04	-0,29



Importance-performance matrix at Faro Beach (Portugal)



Importance-performance matrix at Tofo Beach (Mozambique)