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A System of Integral Quality Indicators as a Tool for Beach Management

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By

Eduard Ariza Solé

Dissertation supervisors:

Rafael Sardá Borroy, CEAB-CSIC & José A. Jiménez Quintana, LIM-UPC

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Als pares

A la mare

Quan no s’estima massa no s’estima prou.

Blaise Pascal

A papá

Algunos luchan un día y son buenos;
otros luchan un año y son mejores;
unos pocos luchan toda la vida:
esos... son imprescindibles.

Bertolt Brecht

Agraïments

El reconeixement de l'ajuda i la influència rebudes durant els últims quatre anys és una part molt important de la memòria d'aquesta tesi. Acabo d'escriure amb la sensació, prou afortunada, d'haver absorbit intensament del meu entorn intel·lectual i afectiu. El contacte i l'esforç de moltes persones ens ha fet créixer, a mi i a la meva recerca. A un nivell més concret, la concessió de la beca I3P-Predoctoral per part del CSIC ha permès que pogués divertir-me a jornada completa durant aquest temps.

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Edu
Blanes, Maig 2007

Summary of the thesis

This thesis stemmed from the idea that the beach is an integrated system where different and interconnected processes occur. The analyses of these processes and of the physical and administrative framework in which they occur, was the thread of the project. In the development of the study, the processes for the beaches of La Selva Marítima, located in the south of the Costa Brava (northwestern Mediterranean) were analysed. This area is a good example of a coastal area highly affected by tourism dynamics.

The analysis of the legal and administrative framework uncovered some important shortcomings. No specific beach policy exists that accounts for the management of all basic aspects. As a consequence, the information available is partial. Strategies (national/regional) are currently being developed in the framework of the Integrated Coastal Zone Management (ICZM) strategy, including indicators of processes that, until now, have been excluded from monitoring programs. This may change the current situation of a lack of information.

A review of beach assessment measurements (Blue Flag and CEDEX, ACA and CANTABRIA Index) used or potentially used for management of the studied area, revealed important deficiencies in the management of beaches, of which the most important were use, safety and rescue services, landscape, the natural community and certain services. Furthermore, these tools do not take analyses of beach functions into account. In recent years, Environmental Management Systems for Beaches (EMSBs) have begun to be used for beach management. EMSBs allow for the application of proactive and clear management practices, although they need to be complemented with adequate monitoring tools.

This research also analysed the work, focus and problems of local managers. Varied management goals are not usual (many processes remain unmanaged) and management is sometimes exclusively service-oriented. Tools that evaluate beach quality do not cover problematic aspects for local managers, such as sediment management, coordination between responsible authorities, or emergency situations.

The information available and the characteristics of the studied area demonstrated the need to analyse two particularly important beach management processes: beach use and waste/litter production. Results demonstrate that, as a general trend, beaches are saturated. The threshold defined in the literature for urban beaches ($5m^2$) has been surpassed by some of beaches. Crowding, which has occurred consistently for more than 20 years, implies certain problems, such as the high production of waste, representing an important volume of the total produced in a beach municipality during the summer (3.24%). In Gran de Lloret, environmental quality typically diminishes as the bathing season progresses, mainly as a consequence of the incapacity of the municipal cleaning service to collect the small-size litter that accumulates in the sand. Management of beach waste could be improved substantially by segregating different kinds of waste, enhancing mechanical cleaning practices, and implementing environmental educational programmes.

Information obtained in the development of this project led to the creation of a Beach Quality Index (BQI) for the studied beaches. This index took into account important issues not represented in other management tools. In the process of allocating weights for the purpose of aggregating partial indexes, user and expert opinions were taken into account.

The BQI, which also took account of function analysis, was designed to be used with EMSBs, and can be included at different EMSB stages. The most important index factors are initial environmental diagnosis, the definition of environmentally significant aspects, operational control, and the assessment of steady improvement. Results obtained for beaches for the BQI, its subindices and partial indices, indicated arrange of situations. Aggregated values were high for the BQI (0.63-0.85), and also for the subindices (RF (0.53-0.73), NF (0.80-0.92) and PF (0.50-1)). High scores were typically obtained for partial indices such as water quality, environmental quality, services and facilities, activities, comfort, absence of water and sand pollution, and physical quality. Scores for beach use, surrounding quality, safety, and natural conditions were low. Future management of studied beaches should focus on the weakest aspects, such as controls over use, transformation of beach environs, and preservation of natural beach communities. Other priorities should be the allocation of resources that guarantee user safety, protection of human facilities, and beach cleaning.

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ICZM	Integrated Coastal Zone Management
PDSC	Plan de Desarrollo Sostenible de la Costa
BQI	Beach Quality Index
PGOP	Plan General de Ordenación de la Playa
PIDU	Plan Indicativo de Usos del Dominio Público
PEGIZC	Pla Estratègic per la Gestió Integrada de les Zones Costaneres
DPMT	Dominio Público Marítimo Terrestre
CAMCAT	Pla Especial d'Emergències per Contaminació Accidental de les Aigües Marines de Catalunya
INUNCAT	Pla de Protecció Civil per al risc d'inundacions a Catalunya
EMSB	Environmental Management System for beaches
ACA	Agència Catalana de l'Aigua
CEDEX	Centro de Estudios y Experimentación de Obras Públicas
BRS	Beach Rating System
BARE	Bathing Area Registration and Evaluation technique
EMAS	Eco-Management and Audit Scheme
GDP	Gross Development Product
BAR	Barcelonès
MAR	Maresme
SEL	La Selva
BEM	Baix Empordà
AEM	Alt Empordà
SM	Sediment Management
SD-CE	Storm damage-Chronic Erosion
S	Services
ES	Emergency Situation
OV	Overcrowding
SWAQ	Sand, Water and Service Quality
CL	Cleaning of beaches
LS	Lack of Sand
NEP	Natural Ecosystem Protection
LP	Litter and Pollution
AC	Activities
GM	General Maintenance
MC	Managerial Conflicts
AQ	Access Quality
EI	Economic Investment
UBA	Urban beach Area
BA	Beach Area
P	Population
HL	Hotel Lodging
TR	Tax Revenues
SW	Solid Waste

PEIN	Pla d'Espais d'Interès Natural
O & M	Organic and miscellaneous waste
Pl/W/BC	Plastic, wrapping and beverage containers
P	Paper
Gl	Glass
BSC	Big size litter on sand
ST	Sand withdrawn by trotter
SSLT	Small size litter withdrawn by trotter
TBS	Total Beach Surface
UBS	Useful Beach Surface
MSA	Minimum Sand Availability
MNU	Maximum Number of Users
Mean SA	Mean Sand Availability
RFI	Recreational Function Index
NFI	Natural Function Index
PFI	Protection Function Index
Alpha	Water microbiological quality partial index
TC	Total Coliforms
FC	Faecal Coliforms
FS	Faecal *Streptococcus*
IC	Beach crowding partial index
IEQ	Environmental Quality partial index
ISerF	Services and Facilities partial index
IAct	Activities partial index
IAcPark	Acess and parking partial index
IComf	Comfort partial index
IS	Quality of surrounding area partial index
IBS	Beach Safety partial index
IN	Natural Condition partial index
IWSP	Water-Sand Pollution partial index
IPQ	Physical Quality partial index
IPP	Protection partial index

NOTE

Point is used for decimal separator and comma for thousands separator.

Chapter I
Introduction

1.1. INTRODUCTION

Coastal areas are valuable spaces of extreme variability, diversity and multifunctionality that offer a wide range of landscapes, uses and activities. The complexity of the interactions that occur in the littoral zone is caused by various factors. Dynamic changes are intrinsic to such areas due to their special biophysical components, but anthropogenic pressure is increasingly squeezing coastal areas. At the end of the last century, 60% of the world's population lived on a 100 km wide strip along coasts (Von Bodungen & Turner 2001), and this percentage is expected to increase during the next few decades. Some of the effects of human activity are excessive construction work, exploitation of natural resources, discharges and sand mining. Erosion is also affecting the sediment dynamics of many areas of Europe (Eurosion 2004). In the Western Mediterranean, a very large part of the anthropogenic pressure in coastal areas is caused by tourism, which is the most important driver of coastal-related changes in this area (Departament d'Indústria, Comerç i Turisme 2002).

Beaches are functional links between the land and the sea. They are the main factor for attracting humans to coastal areas, and play a very important role in increasing tourist potential in the Western-Mediterranean. The attraction of coastal areas may be increased by physical qualities such as local geology and geomorphology, biological qualities such as flora and fauna, and socio-economic qualities such as recreational facilities, access, safety and landscape. Planning the integrated management of these factors is very important for the many coastal areas of the world that are subjected to highly complex interactions and impacts.

In line with the complexity of coastal ecosystems, a more integrated and holistic management focus called integrated coastal zone management (ICZM) has been created. It includes coordinated analysis and planning undertaken in several disciplines, with the concept of sustainability as the most important objective. ICZM processes require a proactive management of human and natural resources. Goals must be established according to the functions assigned to coastal areas (De Groot 2002) and planning must be adapted, in time, to defined goals. Management transparency and the active participation of all stakeholders (Barragán 2003-a) are necessary in order to cope with the uncertainty involved in managing complex systems. The process of coastal management has been transformed from an absolutely technical discipline to a scientific discipline of a social nature. The importance of social capital for achieving effective environmental management has also been recognized (Pretty 2003). Monitoring coastal processes is a decisive step for achieving ICZM. As new management tools are introduced and programs are defined, new indicators must be created so that the global functioning of coastal systems can be monitored and the state of the system known. In a recent paper, designed to monitor the implementation of ICZM, two different kinds of indicators were defined: those related to progress in the implementation of ICZM and those monitoring the state of the coast (Pickaver *et al*. 2004).

Beach quality was considered one of the factors contributing to ICZM. Several beach quality indicators are in use in different areas of the world (Cagilaba & Rennie 2005). However, the beach quality indicators used in some areas do not allow changes to be detected in many important aspects of beaches (Sardá *et al*. 2005-a), and they were not designed to contribute to the implementation of ICZM.

In Spain, coastal development was based on the Shores Act 22/88. Although this law became very important for assuring public access to the coast and protecting natural sensitive values, it did not lead to the implementation of ICZM in Spain (Barragán 2003-b). The recommendation on ICZM (COM(2000) 545) made by the European Parliament in the year 2000 was the main factor that led to the development of an integrated management strategy in the Spanish coastal area. The consequences of this strategy are some regional initiatives and the development of The *Plan Director para el Desarrollo Sostenible de la Costa* (PDSC) for the whole Spanish coast. Furthermore, besides establishing requirements for Spanish coastal development, the Shores Act 22/88 also specifically defined beach management regulation. Though its content was very useful for improving beach quality, some aspects such as responsibility definition, funding and consideration of some beach processes still need to be improved. The development of complementary beach management protocols is now very necessary.

1.2. MOTIVATION

For societal reasons, beaches have become increasingly important during the last few decades in many parts of the world. A variety of tools have been introduced during this time for controlling the quality of beaches. In some cases, their characteristics, compatibility and complementarities have not been studied. Although no studies that analyse local beach management are available, their output could be very useful to improve current beach management practices. Today, we also have poor information on significant environmental aspects and processes, such as beach waste production and composition, variations in litter gathering, beach use, ecological beach processes and the influence of tourism on beach communities (Geskhiere 2005, Llewellyn & Shackley 1996). New tools for beach management should be created that include all this information and account for the concept of beach ecosystems.

Beaches in many coastal areas are subjected to intense human activity. This has given rise to the need for quality criteria to classify and evaluate beaches. The Blue Flag award and other beach management tools have been used in many areas as a guarantee of quality by local managers. However, in general, they have failed to include specific monitoring tools that provide a precise analysis of the environmental aspects and local characteristics of the beach.

1.3. OBJECTIVES OF THE THESIS

General Objectives

- Development of a system of indicators to measure the integral quality of beaches quantitatively in support of beach managers/decision makers.
- Creation of guidelines for beach management in the study area (the Costa Brava).

Partial Objectives

- Identification of the main problems on beaches of the Costa Brava (considered as typical of the Spanish Mediterranean coast).
- Creation of partial indices to characterize different aspects of beaches.
- Definition of the aggregation process of the information obtained and the basic conditions for this aggregation.
- Determination of beach management guidelines for the different types of beaches found in the study area.

1.4. STRUCTURE OF THE THESIS

The present thesis has been developed so that the two main objectives defined in the previous section could be achieved: the development of the Beach Quality Index and the creation of beach management guidelines.

The first chapter of the thesis presents the general framework of coastal areas: activities developed on them, the role of beaches, principles of integrated coastal zone management (ICZM), monitoring of these processes, indicators of beach quality, legal and administrative tools for the development of ICZM and, with more details, motivation and objectives of the thesis.

In the second chapter, general concepts on beach management are presented: the general background in Spain, the current situation and goals, the legal and administrative framework and the shortcomings of the present management framework.

The third chapter analyses the present state of beach management by focusing on two different objectives: analysis of the most important beach assessment standards and rating systems of the area of study, and local beach management problems and priorities of the northern Catalan coast.

The area of study is considered in the fourth chapter, which is divided into three sections: a general description of the study site, an analysis of waste and litter production, and a study of beach use dynamics on some beaches of the area.

The fifth chapter deals with the development and application of the Beach Quality Index applied to urban and urbanised beaches of the area. The selected beaches were Malgrat Nord, S'Abanell, Treumal-Sta. Cristina, Gran de Lloret, Canyelles and Tossa de Mar-Mar Menuda. Partial indices, as well as the methodology and the aggregation method, are explained in detail. The results and conclusions obtained from the four previous chapters were used to create the index.

The sixth chapter is a general discussion of the results obtained in the thesis. It includes all conclusions of the five previous chapters and the integration of the Beach Quality Index (BQI) into Environmental Management Systems for beaches.

Chapter seven presents the main conclusions of this thesis and chapter eight lists the references cited throughout the text.

Chapter II
Beach Management

2.1. GENERAL BACKGROUND IN SPAIN

Human use of beaches in Spain increased sharply during the second half of the 20th century. The initial development of beach management processes in Spain began in the 1960s, as beaches were previously considered natural resources of little economic interest. The application of planning measures to beaches was a novelty of the Shores Act of 1969 (Yepes 2002), which established the *Plan de Ordenación General de la Playa* (PGOP) for the permanent planning of beach services and facilities. Following this law, the first guidelines, *Playas, modelos tipos y sugerencias para su ordenación*, which gave concrete standards for managing urban beaches, were published (MOP 1970). The Shores Act of 1969 was also a decisive step towards a clearer definition of the responsibilities of the different beach administrators, and towards establishing rights of access and use on all land bordering the shore.

In 1976, the Ministry of Public Works and Urban Planning carried out a study of the development of the coastal areas in the provinces of Barcelona and Girona. The result was the *Plan Indicativo de Usos del Dominio Público* (PIDU), which analysed parking characteristics, licenses and authorizations, uses, sediment dynamics, and, qualitatively, beach use and urbanization density. This study (Ministerio de Obras Públicas y Urbanismo 1976) was a major step forward for the beach management processes that were undertaken subsequently. Two years later, the Spanish Constitution of 1978 included beaches in the public domain (Art. 132.2) and established that they should be regulated according to more specific laws. This regulation came into place in 1988 with the new Shores Act of 1988 and its Regulation 1471/89, which developed it further. This law significantly changed beach management practices, abolishing the PGOP. The new law assigned responsibility of land use planning, urbanism, and other issues to the Autonomous Government, also establishing the competencies and responsibilities of the different governmental bodies and agencies. With this change, the focus of beach management also changed. The possibility of permanent and more or less long-term regulated management of beaches was replaced by seasonal management (when bathing season arrives, every year managers apply the same measures of management). Since then, the only framework used for annual planning has been that of the beach use plans, drawn up annually by local councils and approved by the Autonomous Government.

The approval of the new Shores Act also revoked some legal texts that ruled different aspects of beach management (*Ley General de Obras Públicas de 1877*, *Ley de Paseos Marítimos de 1918 y 1957*, *Decreto Ley de Puertos de 1880*, *Ley de Centros y Zonas de Interés Turístico Nacional de 1963*, *Ley de Costas de 1969*, *Ley de Puertos Deportivos de 1969*, and *Ley de Protección de las Costas Españolas de 1980)*. These legal texts had some deficiencies that were overcome by the new law. An important improvement of the 1988 Shores Act was the coverage of responsibilities and the management and conservation of the natural heritage by developing article 45 of the Spanish Constitution. The Shores Act also covered the criteria expressed in the Recommendation of the Council of Europe 29/1973 and other documents and studies of littoral areas.

2.2. THE CURRENT SITUATION AND GOALS

During the second half of the 20th century, coastal crowding made the processes occurring on beaches even more complex. Natural, socio-economic and managerial processes combined on beaches and generated new particular dynamics. Beach multifunctionality was being progressively accepted among coastal scientists. The approach that merely accounted for sediment management and recreation was replaced as a result of the recognition of other particular characteristics of beaches and knowledge of their main coast-based processes (Simm *et al*. 1995, Micallef 1996, Williams & Davis 1999; these authors also claim the need to establish effective legislation and adequate management practices as well as to establish complete economic balance of beaches). Micallef & Williams (2002) consider that the quality of beaches should guarantee a higher financial return, higher conservation value and higher multiplicative effect on the socio-economic structure of beach municipality. The beach management on the French Riviera was considered a useful example of balancing the economic activity of the region (Anthony 1997). No complete economic studies of Spanish beaches have yet been carried out and revenues from beaches have not been calculated. The multiplicative effect is largely unknown in many Mediterranean coastal areas. Beach managers are not used to considering complete economic consequences of beaches and beach management.

Following the EU Recommendation on ICZM (413/2002/EC), new actions are being carried out by the national and regional administration in Spain, in order to develop a strategy to implement ICZM principles. The development of this strategy should have a very significant influence on beach management processes in the immediate future. The *Plan Director para el Desarrollo Sostenible de la Costa* (PDSC), a tool for implementing the National ICZM strategy, is now currently being drawn up. Within this plan, several indicators have been created to account for beach processes: sediment dynamics, dune systems, natural characteristics, state of the landscape, beach usage, access and parking, uses, services, activities and measures of protection (Plan Director para el Desarrollo Sostenible de la Costa 2005).

In the regional context, the Catalan government has also carried out two important initiatives related to the ICZM mandate. First, it introduced its own strategy, the *Pla Estratègic per la Gestió Integrada de les Zones Costaneres a Catalunya* (PEGIZC) (Departament de Medi Ambient i Habitatge 2004), launched prior to the national initiative, which deals with water quality, land use planning, sustainability, pollution, sediment dynamics and biodiversity and seeks to enhance cooperation and responsibility between experts and actors. Second, the current trend of increased construction on the Catalan coast forced the development of the *Pla Director Urbanístic del Sistema Costaner* (PDUSC), which is specifically aimed at protecting areas that have not yet been urbanized (Departament de Política Territorial y Obres Públiques 2005). This plan will be very important for protecting the hinterland of non-urban beaches that have not yet been transformed.

Though new approaches to beach management have been introduced, responsible managers have not yet adopted an integral approach to beaches. Beach management is still carried out in Spain by various private and public organisms, frequently without an organized regular flow of information and a clear common policy to achieve mid-term goals. The segregation of competencies between different governmental bodies will cause difficulties when an effective integrated management is to be implemented. At national level, the Ministry of the Environment is in charge of the Marine and Terrestrial Public Domain (DPMT) and therefore responsible for lighting, buoying, civil works and beach nourishment operations. It is also responsible for granting the authorizations and licenses for the occupation of coastal areas. The Ministry of Development is in charge of the work related to roads. The Ministry of Agriculture, Fisheries and Food is in charge of the management and protection of the natural resources of the public domain and is therefore responsible for controlling fisheries.

At the regional administrative level, in Catalonia the *Departament de Política Territorial i Obres Públiques* is responsible for regulating beach use and approving municipal urban plans. It is also responsible for maintaining protected areas. The *Departament de Medi Ambient* is responsible for applying environmental impact assessments to new public and private projects, drawing up sewage treatment plans, and monitoring the quality of bathing water, sewage discharge and water treatment plants and the aesthetic quality of water and sand. The *Departament d'Agricultura, Ramaderia i Pesca* is responsible for planning and managing natural protected areas and natural resources. The *Departament d'Economia i Finances* is responsible for Tourism. In Catalonia, a supramunicipal administrative structure, the *Consells Comarcals*, can also intervene in the development of strategic plans. The local administration, represented by the *Diputacions*, *Consells Comarcals* and local councils, is responsible for several aspects. The *Diputacions* are responsible for monitoring environmental parameters and they share the intervention in beach management with the other supramunicipal structures by organizing and managing common services. Local councils are responsible for land use planning, economic activity authorizations, cleanliness, the provision of services/facilities on beaches and the daily management of beaches.

2.3. THE LEGAL AND ADMINISTRATIVE FRAMEWORK

2.3.1. The Shores Act 22/88

The Shores Act (22/88) is the most important legal text influencing the beach environment in Spain. It introduced fundamental innovations in the management of coastal areas. It provided legal cover for the public ownership of natural areas and acknowledged natural processes that go further than the intertidal area. The concept of the public domain is clearly reinforced by the law, which takes into account natural processes and coastal habitats. It also establishes restrictions on the protection area and guarantees the conservation of the public area.

The Shores Act establishes that Autonomic Governments may create further legislation to protect the public domain more restrictively. The areas on which each regional government can develop legislation are defined in the law that regulates autonomic activity. For example, based on its Statute of Autonomy, the Catalan Government has the authority to develop legislation on land use planning, littoral issues, urbanism and sewage discharges.

One of the main aims of the Shores Act was to regulate the DPMT. It contains rules for the occupation of the DPMT when activities cannot be located elsewhere. It defines the DPMT, establishes its limits, regulates uses, defines responsibilities and establishes penalties (Montoya Font 1995). It establishes the DPMT zone for the purpose of environmental protection, not simply considering the strategic or recreational value of beaches. Finally, it also covers the protection of landscapes.

2.3.2. Legal responsibilities defined in the Shores Act 22/88

According to the Shores Act 22/88, the beach management responsibilities of the national, autonomous and municipal governments are:

<u>Responsibilities of the national government</u>

- The national government is responsible for establishing the limits of the DPMT and the administrative work required in each case to maintain or achieve established public areas. It is responsible for managing the DPMT and granting licenses and authorizations for the occupation of it.
- It is also in responsible for conserving the DPMT and the access areas.
- It is responsible for navigation, pollution control, and human safety and rescue services. Navigation and pollution control are carried out in conjunction with other competent authorities according to the coordination principles established in the corresponding plans and programs.

<u>Responsibilities of the autonomous government</u>

- It is responsible for carrying out action related to littoral land use planning and urbanism, discharges into the sea and other aspects attributed according to its statute.
- It is responsible for giving permission for occupation of the protection area.
- It is responsible for dealing with infringements in the protection area.
- It is responsible for distributing beach use; subsequently, the national Ministry must give permission for occupation of the DPMT.

- It regulates urbanism documents of the local councils in the protection area, which must report all activities carried out in these areas.
- It is responsible for works, promenades, parapet walks, etc. In the case of some of the promenades that have already been constructed, the cost has been shared (50%) by the national and autonomous governments.

Responsibilities of the local government

- It reports when the limits of the DPMT should be established, and also when there are requests for changing the usual management conditions of areas of the DPMT. It also reports on authorizations, licenses, occupation and exploitation of the DPMT.
- It exploits seasonal services that can be established on beaches by direct or indirect management as established in the legislation on local responsibilities.
- It maintains beaches and public bathing areas in a suitable state of cleanliness, hygiene and health. It is responsible for complying with the legal requirements established by the national government on safety and rescue services.

2.3.3. Land use planning and urbanism legislation

In Spain, land use planning and urbanism responsibilities have been transferred to the autonomous governments. In Catalonia, they are developed by the *Llei de Política Territorial de 1983*, the *Llei 1/1995 Pla Territorial de Catalunya*, the *Llei 2/2002 d'Urbanisme* and the *Decret 166/2002*. Other legal texts that affect land use planning are related to the protection and management of natural areas (*Llei 12/1985 d'Espais Naturals*, *Llei 6/1998 Forestal de Catalunya*, *Llei 3/88 de Protecció dels animals* and the *Decret 328/1992* del *Pla d'Espais d'Interès Natural*). On the littoral fringe, certain protective planning measures have been developed in some natural areas. In the north of Catalonia, in the Costa Brava region, before the development of urban areas, other legal texts regulated urbanism and landscape activities. The 1960s and 1970s was a period of major urban development. Now though, due to current requirements, the possibility of further land use planning on those areas is limited.

2.3.4. Other legislation affecting beach management

There is a highly complicated body of regulation concerning beach management issues in Spain. In Table 2.3.1., the most important ones affecting beach management in the Catalan region have been summarized. Due to the fact that some aspects of beach management are poorly regulated, legal texts that affect other autonomous communities have also been included. They may be used as reference criteria to establish standards that are not clearly defined.

These legal texts regulate aspects such as water quality, sanitation, beach use plans, and safety and rescue services:

a) Water quality is regulated in international and national legal texts. The new Directive 2000/60/CEE establishes ecological parameters for assuring the quality of water masses (European Parliament & the European Council 2001). Directive 91/271/EEC establishes the requirements of sewage treatment. Directive 76/160/EEC and the *Real Decreto 734/88* regulate bathing water quality parameters, reviewed recently by the approval of the new Directive 2006/7/EC (European Parliament & the European Council 2006). Member states must adapt to its requirements before January 2008. The main changes are the reduction of the analysed parameters and the frequency of sampling.

b) The regulation of beach services and facilities is covered by several legal texts. Requirements include conditions of stands and the occupation of beach space. The *Ley 7/1985 Reguladora de las Bases de Régimen Local* establishes that local councils are in charge of cleanliness and the provision of necessary services in the public areas of their municipalities. The *Ley 14 /1986 General de la Sanidad* requires local councils to maintain public places in a good state of hygiene.

c) Another group of legal requirements accounts for safety and rescue services. Most legal texts focus on establishing sectors for bathers with restriction and prohibition of nautical activities, also considering the characteristics for buoying. In Catalonia, there is no specific law that establishes minimum measures of safety and protection for beaches. However, the requirements defined in the *Decreto 98/2003* developed for the beaches of the Autonomic Community of the Canary Islands may be used as a guide.

d) There are also other laws affecting beach management. In Catalonia, the *Decret 109/1995* regulates recreational fishing, The *Llei 13/2002* defines requirements for tourist municipalities and the *Llei 30/1992* establishes principles for collaboration and cooperation between authorities. The *Llei 20/1991*, developed by its *Decret 135/1995*, regulates accessibility and the elimination of architectural barriers and the approval of the Accessibility Code. The *Llei 4/1997 de Protecció Civil a Catalunya* establishes mechanisms to diminish the effects of emergencies in municipalities. The *Llei 4/2003* establishes conditions for public safety of municipalities and the *Llei 25/1998* establishes the responsibilities of the Catalan Water Agency (a body dependent on the autonomous government), which include quality control of beaches and water in general.

Legal text		Topic
Water Quality		
EU	Directive 76/160/EEC	Establishes parameter values and methods for controlling bathing water quality.
NA	“Real Decreto 734/88. Normas de calidad de las aguas de baño”	Establishes parameters, values and sampling methods for controlling bathing water quality.
EU	Directive 2000/60/EEC	Establishes criteria for assuring ecological quality of water masses.
EU	Directive 2006/7/EC	Reviews parameters and methods established in Directive 76/160/EEC.
EU	Directive 91/271/EEC	Defines criteria for urban and industrial sewage discharges.
Services and facilities		
NA	“Orden del Ministerio del Interior 31 de marzo 1976 sobre establecimientos públicos en las playas y zonas”	Requirements to be accomplished by food and beverage stands located on beaches and in public areas.
NA	“Orden de la Dirección General de Puertos y Costas de 21 de julio de 1986. Normas para el establecimiento delimitación y explotación de los servicios de temporada”	Establishes conditions for occupation of beaches by recreational facilities.
NA	“Ley 7/1985 Reguladora de las Bases de Régimen Local”	Establishes services that local councils must provide in public areas.
AUT	“Orden 4 de marzo 1994. Conselleria de Obras Públicas y Ordenación del Territorio de las Islas Baleares”	Complements criteria defined by the Directorate-General of Ports and Coasts for beach space distribution on the Balearic Islands.
AUT	“Decreto 72/1994 sobre Planes de Ordenación del litoral de las Baleares”	Defines the conditions of services and facilities and their location on the Balearic Islands.
NA	“Ley 14/1986 General de la Sanidad”	Establishes the obligation of the local councils to maintain health control of the environment.
AUT	“Llei 8/87 de 15 d’abril municipal i de règim local a Catalunya”	Establishes mechanisms of citizen participation, relationships between authorities and local organization.

Table 2.3.1. Legal texts regulating aspects of beach management (Yepes 2002, Diputació de Barcelona 2003-a, Diputació de Barcelona 2003-b, Diputació de Barcelona 2005-a). Legislation: EU= European, NA=National, AUT= Autonomic.

Legal text		Topic
Security		
NA	"Orden 31 de julio de 1972. Normas para la seguridad humana en lugares de baño"	Regulations for human safety in bathing areas. It prohibits the presence of motorboats and water skiing in these areas.
NA	"Orden 2 de Julio 1964"	Defines areas for bathers on beaches, as well as the use of sport and leisure boats.
NA	"Real Decreto 259/2002"	Updates safety measures on the use of jet skis.
NA	"Resolución Director General de Puertos y Costas 4/11/1991"	Establishes the technical characteristics of buoying (modified by the Resolution of State Ports of 12 May 1998).
NA	"Real Decreto 1685/83"	Adopts the buoying system of the International Association of Lighthouse Authorities (IALA) for the Spanish Coasts.
NA	"Normas Técnicas sobre obras e instalaciones de ayuda a la navegación de 1986 de la Dirección de Puertos y Costas"	Defines conditions of buoying.
NA	"Real Decreto 1043/2003"	Conditions of navigation of nautical self-propelled artefacts.
AUT	"Decreto 98/2003 (proyecto piloto)"	Regulates minimum measures of security and protection that beaches must meet in the Canary Islands.

Table 2.3.1. (Continued). Legal texts regulating aspects of beach management (Yepes 2002, Diputació de Barcelona 2003-a, Diputació de Barcelona 2003-b, Diputació de Barcelona 2005-a). Legislation: EU= European, NA=National, AUT= Autonomic.

	Legal text	Topic
Other issues		
AUT	"Decret 109/1995"	Regulates recreational fishing in Catalonia.
AUT	"Llei 13/2002 de Turisme de Catalunya"	Regulates conditions that must be met by tourist municipalities. They have the obligation to protect public health and hygiene in the whole municipality.
AUT	"Llei 30/1992"	Establishes the bases for collaboration and cooperation between authorities and regulates specific questions for executing actions.
AUT	"Decret 135/1995"	Regulates accessibility and suppression of architectural barriers and the approval of the Accessibility Code.
AUT	"Llei 4/1997 Protecció Civil a Catalunya"	Defines measures for mitigating the effect of emergencies occurring in municipalities.
AUT	"Llei 4/2003"	Establishes requirements for local authorities in order to assure safety in all areas of municipalities.
AUT	"Llei 25/1998 de responsabilitats de l'Agència Catalana de l'Aigua"	Establishes that it is responsible for controlling water quality.
NA	"Ley 27/1992 de Puertos del Estado y de la Marina Mercante" (changed by "Ley 62/1997 de Puertos del Estado y de la Marina Mercante)"	Regulates questions such as jet skis and safety and maritime rescue service.
NA	"Real Decreto 1835/1983"	Establishes maritime signalling for Spanish coasts.
AUT	"Llei 3/98 d'Intervenció Integral de l'Administració Ambiental"	Regulates activities with an environmental impact carried out by companies.
AUT	"Decret 114/1998 activitats sotmeses a Declaració d'Impacte Ambiental"	Regulates activities that are subject to Environmental Impact Assessment before they are carried out.
AUT	"Llei 16/1991 de les policies locals"	Regulates the execution of the Civil Protection Plans.

Table 2.3.1. (Continued). Legal texts regulating aspects of beach management (Yepes 2002, Diputació de Barcelona 2003-a, Diputació de Barcelona 2003-b, Diputació de Barcelona 2005-a). Legislation: EU= European, NA=National, AUT= Autonomic.

2.4. SHORTCOMINGS DETECTED IN THE LEGAL AND ADMINISTRATIVE FRAMEWORK OF BEACH MANAGEMENT

As has been reported in other countries (see the case of Australia, for example, James (2000-a)), in Spain effective beach management can occur under the current coastal management framework, but better guidance is needed in order to improve the process. When the current management system and the most important legal texts are analysed (Table 2.4.1.), the most evident shortcomings are found in planning, consideration of beach characteristics, beach use control and monitoring, erosion control and the administrative process.

Beach management lacks proactive management tools that allow coordination between the different authorities that are responsible for it. There is no periodic communication between coastal managers. Responsibilities are highly dispersed and more explicit information is needed. Although the Shores Act 22/88, *Llei 30/1992* and *Llei 8/87* (in Catalonia) consider principles of cooperation between authorities, they are not applied in beach management. The role of local managers is not clearly established in all beach management aspects, though its necessity has already been demonstrated (Breton *et al*. 2000, Larson 2002).

Emergency Plans for municipalities that include special circumstances occurring on beaches have been carried out. In Catalonia, the Autonomous Administration has developed Regional Plans to fight water pollution (*Pla Especial d'Emergències per Contaminació Accidental de les Aigües Marines de Catalunya*- CAMCAT) and flooding (*Pla de Protecció Civil per al Risc d'Inundacions a Catalunya*- INUNCAT), but more specific plans including other beach emergencies should be developed.

Planning	Beach characterization	Beach usage control and monitoring	Other issues
No proactive coordinated management tools.	No beach classification beyond those situated in natural protected areas.	Beach management focuses on assuring beach usage without restriction.	No active mechanism has been established to define precisely when erosion occurs.
No establishment of responsibilities and periodic communication.	No consideration of the beach community on natural beaches or semi-natural beaches.	No tool has been applied for establishing maximum carrying capacity and reducing beach usage when necessary.	The administrative process is time-consuming and does not allow immediate action when problems appear.
No emergency plan specific to beaches.	No consideration of the different interests of different beach users.		
No incorporation of the principle of steady improvement.			
No creation of medium-term management programs.			

Table 2.4.1. Shortcomings detected within the legal and administrative beach management framework.

The principle of steady improvement is not assumed as a basic element of beach management due to the fact that management is considered to be static from season to season. Also, the current framework does not account for the creation of medium-term management programs. As Yepes says (2005), for management to improve, a tool similar to the PGOP present in the Shores Act of 1969, which was excluded from the Shores Act 22/88, is needed.

Concerning the intrinsic natural environment, natural beach communities on natural and semi-natural beaches have not been widely studied and considered. Only beaches with evident natural values (those situated in protected areas or with fragile communities such as dune systems or seagrasses) are specially considered within the framework of management, and only in such cases are protection measures applied.

Very few user surveys have been carried out on beaches, although some studies have reflected differences in beach user profiles (Chapman 2006). The current administrative and legislative framework does not consider user opinion as an input for management, although some studies made on the Spanish coasts show interesting results and may be useful (Morgan *et al*. 1996, Villares 1999, Buceta 2000). Due to the lack of information on the natural and social processes that occur on them, beaches have not been characterized and classified according to their most important features.

One of the most important advances of the Shores Act 22/88 was the guarantee that people had public access to beaches without restriction. However, further mass tourism has caused beaches in some localities to become overcrowded. Few frequentation studies of Mediterranean beaches have been carried out (Alemany 1984) and no clear guidelines have been defined for the management of beach use.

Besides the above information, other issues are not considered within the present framework for beach management. In the current situation of general erosive dynamics in many coastal areas (Eurosion 2004), a sediment management policy is needed that allows planned proactive management in conflictive areas. In the case of storm damage, for instance, a very time-consuming administrative process has been established that does not allow immediate action when problems occur.

The shortcomings explained above make it very difficult to establish permanent planning measures for beach management. Permanent planning also requires the assignation of functions to beaches according to particular characteristics. The functions currently attributed to beaches are the protection of promenades and human facilities from wave energy, the recreational experience of users, and the natural function as a landscape and container of natural heritage. However, if functions are to be properly assigned to beaches, more information on some important beach processes is needed (*i.e*. the waste and litter production process, the consequences of mechanical cleaning,..). In addition, more specific criteria must be defined and applied to other aspects: buoying, safety and rescue services, facilities, access for the disabled…). Also, activities carried out by companies operating in beach areas, as established in The *Llei 3/98 d'Intervenció Integral de l'Administració Ambiental*, need to be assessed and controlled in order to assure the minimum environmental impacts.

All detected shortcomings described in this chapter have also been analysed in detail in Chapter 3 (3.3). The study of the local beach management needs of 38 municipalities of the northern Catalan coast is in accordance with this analysis.

Chapter III
An Assessment of Beach Management Practices on the Catalan Coast

3.1. INTRODUCTION

In the previous chapter, theoretical aspects of beach management have been studied. Main shortcomings of the normative framework were defined and discussed. The present chapter covers the practical framework by analysing management tools and local needs.

Beach management practices observed elsewhere normally do not take into consideration the information of the different processes occurring on beaches. In spite of this, beach practices have been improved during last decades as a consequence of the high demand for beach quality by tourism and also as a need for preserving beach natural and physical values from the most serious human impacts. A new beach management culture has emerged in littoral areas, and several beach assessment measurements have been created and applied to beaches of different locations (Williams & Morgan 1995, Cagilaba & Rennie 2005). The characteristics of measurements have strongly influenced beach management practices of local and regional managers. The most paradigmatic example may be the Blue Flag Award, introduced in 1987 (Nelson *et al*. 2000) and extended today to 34 countries.

Some studies of characteristics of beach assessment measurements have been developed for different coastal areas. In the Mediterranean zone, tourism exerts an intense pressure on beaches, with many direct and indirect consequences. Although measurements exist, the capacity of those assessment measurements both to detect such complex dynamics and to satisfy manager need for monitoring has not been completely tested. It is important that assessment measurements are applied to beaches of the area, so that sensitivity to local characteristics such as morphological aspects, beach use or services provided could be determined. The application of Environmental Management Systems to beaches (EMSBs), recently developed in Spain, is somehow changing beach management framework. It makes this critical analysis even more suitable. Compatibility among assessment measurements must be known in order to best adapt to coastal Mediterranean processes.

In order to evaluate local aspects and beach management, opinion of local managers about priorities, developed practices, and the structure of their organizations was thought to be useful. In Spain, beach management responsibility is distributed among local, regional and central administrations (Barragán 2003-b), but day-by-day management is carried out by local administration. The view of local managers is synthetic and its study may be very useful when analysing beach management in practical terms.

This chapter is presented in two different separated parts and constitutes an analysis of current beach management practices done in the studied area. In the first part, a critical analysis of the most common beach assessment measurements of the study site is made, including the framework of EMSB's. In the second part, a sector of the Catalan coast has been selected and local beach management processes analysed, through questionnaires used that analyse the main beach management characteristics of the area. Data obtained from analysis of assessment measurements and EMSB's combined with information of local management characteristics, allows extracting important conclusions of the state of beach management in the Catalan coast (it is an example of practices done in other sites of the North-Western Mediterranean zone). Effectiveness of assessment measurements as a tool for satisfying local needs can be tested, as well as influence of such tools in establishing manager's priorities.

In each of the two parts of this chapter there is a specific description of the area of study. A more extended and general description has been included in chapter 4 (4.2).

3.2. PERFORMANCE ASSESSMENT MEASUREMENTS VERSUS MANAGEMENT SYSTEMS[1]

3.2.1. Introduction

Despite the widespread view of beaches as stretches of sand on which users lay their sun beds, they are in fact unique environments occupied by a variety of organisms adapted to particular physical processes. These environments are currently under substantial pressure from human activities and patterns of global change, and its stretches of sand, the beach faces, are just a part of the beach ecosystem. The human needs met by beaches can be divided into three categories: a) protection of the landscape, promenades, and human facilities from waves impact, b) recreational opportunities for users such as swimming, sunbathing, relaxation and sports activities, and c) provision of natural scenery and ecological reservoirs. A long list of ecological services are provided by these three assigned functions (better maintenance of human infrastructures by sea grass, absorbance of wave energy, provision of natural resources, enhanced income generated by ecotourism, etc.). However, in many coastal zones under substantial human pressure, beach ecosystems are only considered in terms of the recreational opportunities they provide and other ecological services are undervalued and/or not considered in decision-making processes. Ecological and protective functions are highly neglected and extensive degradation occurs. To stop this common trend in many coastal areas, a movement has appeared in recent decades demanding much greater awareness of beach ecosystems. These spaces must be considered multi-dimensionally and multi-functionally so that the varied components and their interactions can be analysed in order to achieve appropriate management (James 2000-b).

Coastal areas in the Mediterranean Sea are becoming progressively dominated by human activity and the ecology of the area is being degraded (Sardá & Fluvià 1999, Sardá 2001, UNEP 2002, Suárez del Vivero & Rodríguez-Mateos 2005). Both tourism (traditional and residential) and construction (creating a continuum of dense built-up areas) are challenging the future of coastal ecosystems and acting as a driving force for management initiatives. Beaches are a major attraction in Mediterranean coastal areas being one of the main focuses of attention for coastal and tourism management, where they represent the main asset to be managed. Around 10% of the GDP (Gross Domestic Product) of Spain is directly or indirectly linked to beaches, which are one of its most marketed products. In Benidorm, economic analysis revealed annual earnings of over 12,000 €/m^2 (Yepes 2003). This massive use of beaches has forced management of these valuable ecosystems to focus on the service offered to users, and consequently, human activity and behaviour have prevailed over other biological and physical processes that are normally seen as complementary. The pressure that tourism and construction, together with its associated revenues exert on coastal areas has led to strict and specific demands that affect beaches. The arrival of tourists who demand certain environmental conditions has led to the establishment of beach quality criteria. The main goal of these criteria is to evaluate the current state of each beach and to allow comparisons to be made between them so that users are able to consider beach quality in their choice of destinations. Various performance standards and rating systems have been developed to meet this need.

[1] Edited version of the manuscript *Beyond Performance Assessment Measurements in the Management of Beaches: Application to Spanish Mediterranean Beaches* by E Ariza, R Sardá, JA Jiménez, J Mora and C Ávila. *Coastal Management* (in press).

Performance standards were introduced to establish a set of minimal requirements that guarantee a certain level of quality on a particular beach. The best-established performance standard, the international Blue Flag, is an exclusive eco-label organized by the Foundation for Environmental Education and was introduced in 1987 (Nelson *et al*. 2000). It is currently awarded to around 3,100 beaches and marinas in 34 countries across Europe, South Africa, New Zealand, Canada and the Caribbean. This international standard works alongside other national schemes such as the distinctive yellow and blue UK Seaside Flag award, introduced in 1992 by the Tidy Britain Group (now called ENCAMS) and the Good Beach Guide, which is published annually by the Marine Conservation Society in the United Kingdom.

All of these performance standards are based on a very descriptive method. The award is given if the applicable criteria specified by each performance standard are accomplished. In addition, several performance-rating systems have been developed to allow certain aspects of beach quality to be measured quantitatively. These are weighted aggregations of different performance indicators according to several quality criteria. The final aggregated measure allows effective spatial and temporal comparison of beaches. In Spain, water agencies in the different autonomous communities have developed several indexes to monitor and control compliance with the EC Bathing Water Directive (CEC 1976). In Catalonia, the *Agència Catalana de l'Aigua* (the public organization with responsibilities in water issues in the autonomic community) developed the ACA index. At a National level, several coastal agencies have developed other integrated indexes. The *Centro de Estudios y Experimentación de Obras Públicas* (CEDEX), the autonomous organization that provides technical service to the State Government in questions such as coastal public works, has created the CEDEX index. The University of Cantabria (Spain) has developed the Cantabria index. Both are intended for use in the Spanish coastal area. Other Performance Rating Systems have also been developed elsewhere as the User-Based Rating System, BRS (Morgan 1999-a) or the novel Bathing Area Registration and Evaluation technique, BARE (Micallef & Williams 2004).

In the present paper, we analyse the use of quality criteria in several performance standards and performance rating systems developed for the management of beaches in the Spanish coastal zone. The analysis was organized into three parts. The first involved a theoretical comparison of the chosen performance standards and performance rating systems to see what each one measures. The second part involved an application of the criteria to six beaches with different characteristics. The third part involved an assessment of the development of Environmental Management Systems applied to Beach environments (EMSBs). Beaches were selected for use in this study on the basis of characteristics representative of most beaches in the Costa Brava, a typical area of the North-Western Mediterranean seashore. The main aim was to see how these standards were employed in a particular beach and to identify those points that are either partially covered or not covered at all. The analysis also allowed the criteria used to be classified in terms of their ability to consider the different aspects of beach functions as well as their suitability for use with different types of beaches. Finally, we discuss the potential for improvements offered by the use of the much more comprehensive EMSB system for the management of beach ecosystems.

3.2.2. Methods

Performance standards and performance rating systems

An assessment of the most important quality criteria used today in the management of beach ecosystems worldwide was carried out prior to the analysis of their current use in the Spanish coastal region. The assessment was based on the existing literature (Buceta

2002, Jiménez & Van Koningsveld 2002, Villares 1999, Yepes 2005) and the analysis of several reports from organizations managing those ecosystems (ACA 2002, Ajuntament de Barcelona 2005, Universidad de Cantabria 2002, FEE 2004). The fourteen criteria that were finally selected were general blocks that attempt a synthesis of all the information required for correct eco-effective management of those ecosystems.

One environmental performance standard (the Blue Flag award) and three performance-rating systems (the ACA index, the CEDEX index, and the Cantabria index) were selected to compare the use of the selected quality criteria by those methods. Except that of the ACA, all of them are voluntary and are available for use in the Spanish coastal zone. Table 3.2.1. contains general information about these performance standards and rating systems.

STD-RS	SCOPE	PUBLICITY	SOCIAL KNOWLEDGE	REQUIRED INFORMATION	BEHIND REGULATORY	STANDARD TYPE	WEB PAGE
Blue Flag	GLOBAL	Mass media	high	Quantitative and Qualitative	none	Performance standard	www.blueflag.org
ACA *	CATALONIA	Mass media	high	Quantitative and Qualitative	yes	Rating system	http://mediambient.gencat.net/aca/ca/inici.jsp
CEDEX	SPAIN	None	none	Quantitative and Qualitative	none	Rating system	------
CANTABRIA	CANTABRIA	local	low	Quantitative and Qualitative	none	Rating system	------

Table 3.2.1. Characteristics of analysed performance standards/rating systems. *In different autonomous communities similar indexes are used. STD-RS= Standard-Rating System.

The Blue Flag award is given if it is requested by the organization in charge of the management of the beach when all necessary requirements are met. The rates obtained with the other three rating systems depend on how those beaches performed during the season when evaluated against their own criteria. The ACA index is legally regulated in relation to water quality and is periodically measured to meet the EC Directive on Bathing Waters, and it has equivalent indexes in other autonomous communities because in Spain environmental responsibilities are largely dependent on regional governments.

The main goal of the different performance standards and rating systems varies from one to another. The Blue Flag award was developed for use as an environmental based beach quality tool and is also well accepted as a public marketing tool. Some studies, however, have demonstrated that it is not one of the most important factors influencing beach user choices (Tudor & Williams 2006).

The principal role of the ACA method was to give explicit information on compliance with the water quality requirements established by the Bathing Water Directive applied to Spain through the *Real Decreto 734/88*. The ACA index is composed by three different measures: water microbiological quality, water aesthetic quality and sand aesthetic quality. The five qualification categories for the three ACA parameters measured (poor, deficient, moderate, good and very good) also allow a simple numeric index to be constructed (combining the three parameters, 0 for bad to 4 for very good, to give a final index from 0 for bad to 12 for very good).

The other two rating systems were developed to help managers rate the different beaches and ultimately quantify its quality. Both are aggregated indexes made up of different performance indicators. The CEDEX index was created in 1996. Opinion polls were undertaken for different Spanish beaches, a review of the literature was undertaken and fieldwork was also performed, altogether to identify the factors considered most important by beach users and their individual weights (see Annex I for its metrics and factorial explanation).

The Cantabria beach quality index is another example of an aggregated index. The index uses different evaluation factors depending on the characteristics of the assessed beach: natural beaches, semi-natural beaches, urban beaches and industrial beaches. This index uses two kinds of indicators, basic indicators and secondary indicators. Basic indicators are the most considered (bacteriological water quality, organoleptic water quality and chemical sediment quality). Secondary factors differ for natural and non-natural beaches (see Annex I for its metrics and factorial explanation).

The Fourteen quality criteria selected were: natural systems, geomorphology, water, sand, comfort, aesthetics, access, services, activities, usage, fulfilment of legal requirements, management coordination, steady improvement and emergency planning (Table 3.2.2.).

	BLUE FLAG	CEDEX INDEX	ACA INDEX	CANTABRIA INDEX
NATURAL FUNCTION				
NATURAL SYSTEM QUALITY				
Dune protection	Y	N	N	Y
Vulnerable areas	Y	N	N	Y
Ecosystem surrounding beaches	Y	N	N	Y
Beach dry ecosystem	N	N	N	Y
Beach wet ecosystem	N	N	N	Y
Beach submerged ecosystem	N	N	N	Y
Beach rocky ecosystem	N	N	N	Y
Beach functional ecological integration	N	N	N	N
PROTECTIVE FUNCTION				
GEOMORPHOLOGIC QUALITY				
Beach width	N	Y	N	N
Beach erosion	N	Y	N	N
Slope	N	Y	N	N
Grain size	N	Y	N	N
Beach form	N	Y	N	N
MANAGERIAL FUNCTION				
LEGAL COMPLIMENT QUALITY				
Accomplishment of national, autonomic and local legal requirements	Y	N	N	N
MANAGEMENT COORDINATION				
Beach management planning, detailing responsibilities, funding and schedule	N	N	N	N
STEADY IMPROVEMENT				
Continuous assessment of goals and establishment of new objectives in accordance to beach reality	N	N	N	N
EMERGENCY PLAN QUALITY				
Possible warning mechanisms	Y	N	N	N
Contingency plans for beach emergencies	Y	N	N	N

Table 3.2.2. Main Features of natural, protective and managerial function of studied standard/rating systems. (Y=Yes, N=No).

	BLUE FLAG	CEDEX INDEX	ACA INDEX	CANTABRIA INDEX
RECREATIONAL FUNCTION				
WATER QUALITY				
Directive 76/160/EC	Y	Y	Y	Y
Water organoleptic factors	Y	Y	Y	N
Visual appreciation of water aspects	Y	Y	Y	N
Presence of annoying biological components	N	N	Y	N
SAND QUALITY				
Microbiological, chemical and OM analysis (organic matter)	N	Y	N	N
Withdrawing of decaying material	Y	Y	N	N
Visual appreciation of sand aspects	N	Y	Y	N
BEACH COMFORT QUALITY				
Weather aspects	N	N	Y	N
Oceanographic conditions	N	Y	Y	N
Difficulties at the water-sand transition zone/ obstacles	N	Y	N	N
Sand and beach structural characteristics	N	Y	N	N
Dangerous cliffs	N	N	N	N
AESTHETIC QUALITY				
Landscape condition	N	N	N	Y
Odour and/noises	N	N	N	N
ACCESS QUALITY				
Safe access	Y	Y	N	Y
Access for handicapped people	Y	Y	N	N
Parking area criteria	N	N	N	Y
Maintenance and cleaning	Y	N	Y	N

Table 3.2.2. (Continued). Main features of recreational function of standard/rating systems.

	BLUE FLAG	CEDEX INDEX	ACA INDEX	CANTABRIA INDEX
SERVICE QUALITY				
Information requirements to people	**Y**	**Y**	**N**	**Y**
Measures for maintaining quality in place (showers, cleaning, bins..)	**Y**	**Y**	**N**	**Y**
Measures to enhance safety	**Y**	**Y**	**N**	**Y**
Sanitary facilities (WC)	**Y**	**Y**	**N**	**Y**
Equipment (recreational)	**N**	**Y**	**N**	**N**
ACTIVITY QUALITY				
Presence of domestic animals	**Y**	**Y**	**N**	**N**
Annoying sports	**N**	**Y**	**N**	**N**
Dumping	**Y**	**N**	**N**	**N**
Driving and/ or similar	**Y**	**N**	**N**	**N**
Nautical activities	**Y**	**Y**	**N**	**N**
BEACH USE QUALITY				
User count requirement	**N**	**N**	**N**	**N**

Table 3.2.2. (Continued). Main features of recreational function of studied beaches.

These criteria could be classified into four categories that reflect the three main functional aspects of the beach ecosystem (the natural function, the protective function and the recreational function) as well as the way in which all three functions and criteria are managed by humans (the managerial function). The managerial function appears when beaches are considered to be inevitably affected by human activities and therefore subjected to human usage. Analysis of ecosystem functions has been considered for different ecosystems (De Groot 1992) and also specifically for bathing areas (Micallef & Williams 2003).

The potential benefits of the analysed standards/rating systems were also compared with the use of EMS applied to the management of beach ecosystems (EMSB). This mainly included the use of ISO 14001 Norm (Lamprecht 1997) and the additional requirements for the Eco-Management and Audit Scheme (EMAS) implemented in Europe (EC Council Regulation 761/2001), but also addressed a specific Spanish management system, the Q of Quality of beaches (Sistema de Calidad Turística Española en Playas). The ISO 14001 EMS is recognized internationally as a quality standard and requires three general objectives to be met: commitment to environmental policy, commitment to the compliance with legal and other applicable regulations, and steady improvement. Its general structure can be seen in Figure 3.2.1.

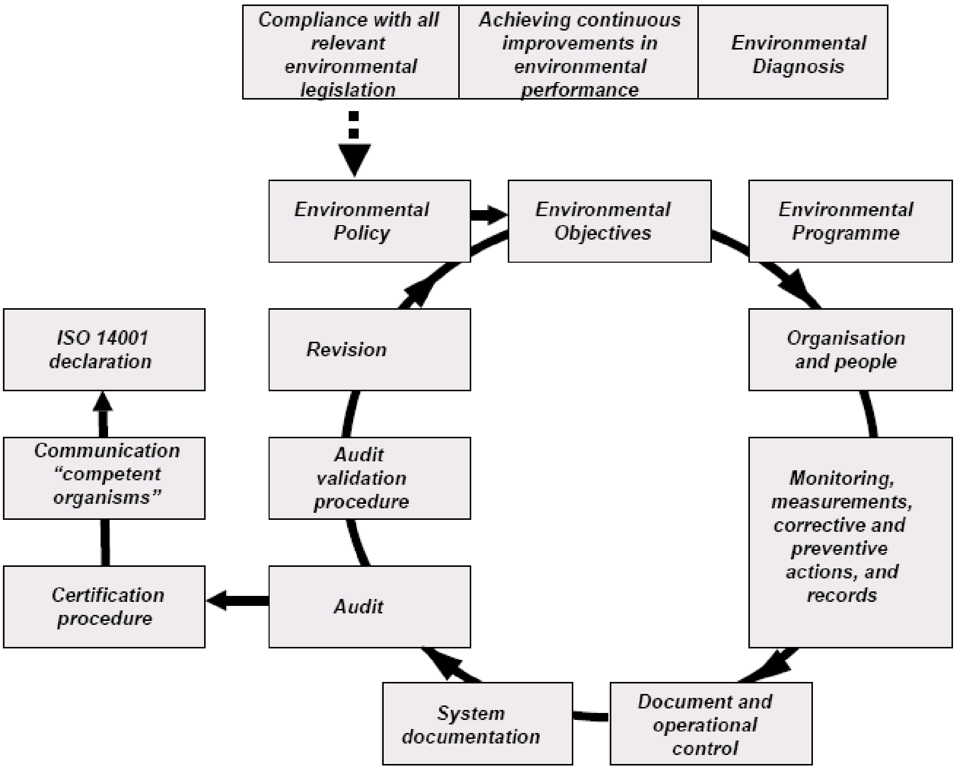

Figure 3.2.1. General structure of the ISO 14001 Environmental Management Systems applied for Beaches.

Following increasing use in the private sector in the last decade (Delmas 2002), an initiative has recently emerged in Spain to implement ISO 14001 for beaches. The requirements for certification of the environmental quality of beaches are the same as those used in the administrative and industrial sectors; however, some specific factors also need to be considered in the management of beaches (AENOR 2003).

Application to Mediterranean beaches

We used two municipalities in the southern part of the Costa Brava (North-Eastern Mediterranean coast of Spain) to determine how the chosen performance standards/rating systems are calculated and how comparable the obtained values are. The two municipalities, Lloret de Mar and Blanes, are both well-known European tourist destinations and their economies depend strongly on their beaches (Sardá & Fluvià 1999). Their coastal fringes contain beaches of varied characteristics, from highly frequented urban beaches like that in the center of Lloret de Mar, to more natural beaches such as La Boadella. Six beaches were selected for the study: St. Francesc, Treumal-Sta. Cristina, La Boadella, Fenals, Lloret Centre and Canyelles (Figure 3.2.2.). Their main physical characteristics are shown in Table 3.2.3.

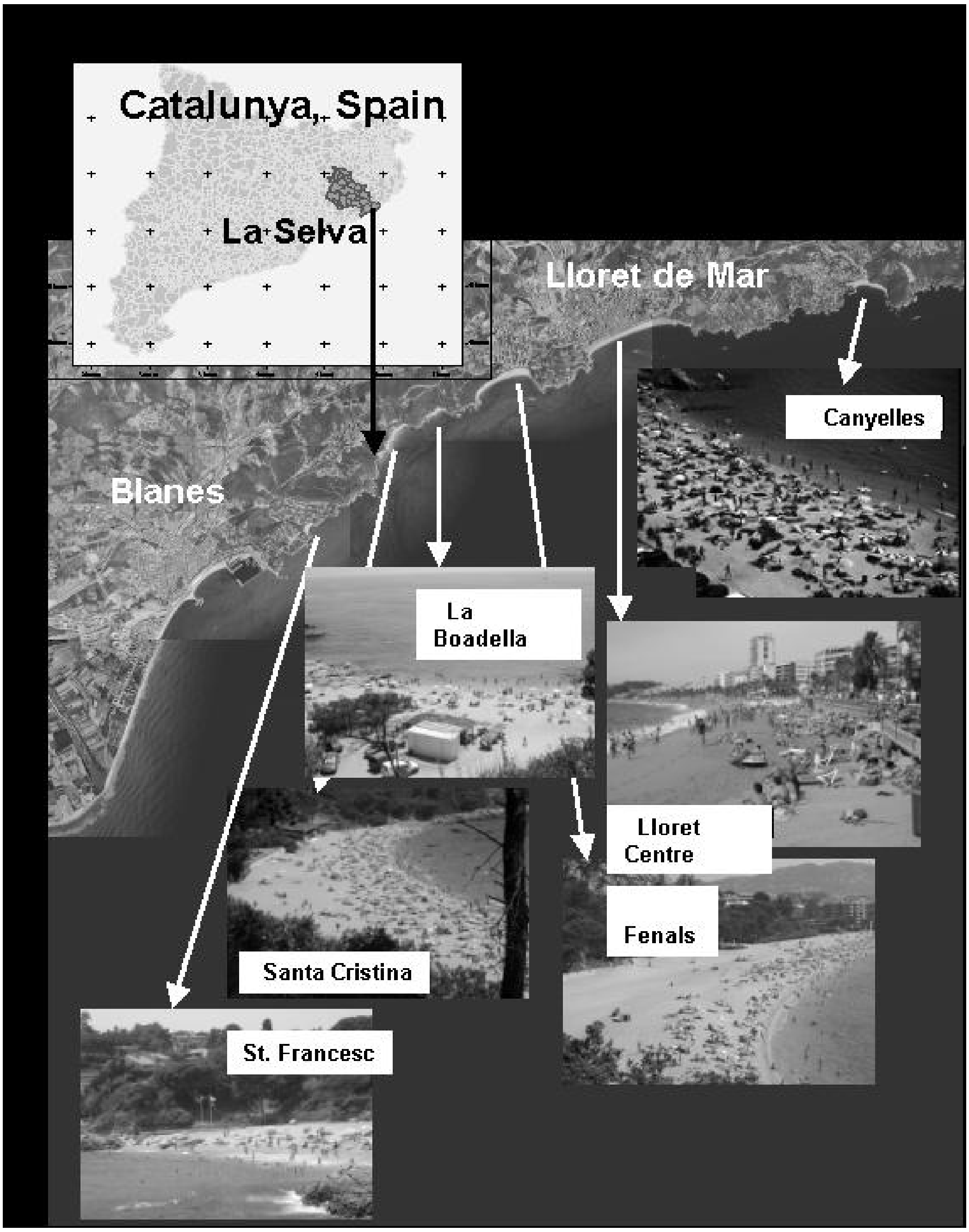

Figure 3.2.2. Photographs of beaches used for the application of assessment measurements.

Beach	Urbanization	Exposure	Lenght (m)	Parking	Services	Access	Locality	Particularities
St. Francesc	Moderate	Sheltered	220	YES	Complete	Easy	BLA	--
Tr-Sta. Cris	Moderate	Sheltered	446	YES	Moderate	Dif path	BLA-LLO	High standard hotel behind Inside natural park
La Boadella	Non-urbanized	Sheltered	310	NO	Basic	Dif path	LLO	--
Fenals	Urbanized	Exposed	775	YES	Complete	Easy	LLO	Town-Promenade behind
Lloret Centre	Urbanized	Exposed	1300	YES	Complete	Easy	LLO	Town-Promenade behind
Canyelles	Moderate	Sheltered	400	YES	Complete	Easy	LLO	Recreational marina

Table 3.2.3. Main features of studied beaches (Dif path= Difficult path, BLA=Blanes and LLO=Lloret).

The environmental performance standard and the three performance-rating systems analysed were applied to those selected beaches. For the purpose of this work, ACA Index components (water microbiological quality and water and sand visual quality) were monitored weekly during the whole bathing season. All variable CEDEX Index components and Cantabria index components, except those related with the microbiological water quality, were monitored one day at the peak of the season (first week of August).

3.2.3. Results

The selected criteria were evaluated in the four performance standards/rating systems (Table 3.2.2.). No single standard considers all fourteen criteria and several of the criteria were not included in any of the analysed standards. Out of the fourteen analysed criteria, only two, water quality and access quality, could be identified in all of the standards/rating systems. The Blue Flag award partially covers eight criteria. It also fully covers two criteria: fulfilment of legal requirements and emergency planning. The CEDEX index covers 7 criteria, of which geomorphologic quality, sand quality and service quality are covered completely. The Cantabria index covers 5 aspects; although none of them are covered completely, natural system quality and service quality are addressed quite extensively. The ACA index covers 4 of the criteria, and of these, water quality is considered completely.

The natural function of beaches is not deeply covered and some of the analysed indexes do not even consider it at all (CEDEX index and ACA index). The Blue Flag award covers the most apparent natural aspects of beaches, such as dune protection, vulnerable areas and ecosystems surrounding beaches, while the Cantabria index covers the general beach landscape condition for natural beaches. None of the addressed standards specifically determines a set of indicators to monitor the structure and dynamics of the different beach communities (dry ecosystem, wet ecosystem, submerged ecosystem or rocky ecosystem).

The protective function of beaches can be measured through its geomorphologic quality, but only the CEDEX index takes this geomorphologic quality into account. The aim in this case, however, is to satisfy user preferences rather than to evaluate coastal protection.

Most of the criteria considered were associated with the recreational function of beaches. All of the standards/rating systems consider the legal requirements on the regulation of water quality presented by directive 76/60/EC. To guarantee beach quality, some management tools (Blue Flag and Cantabria index) also address service quality but without considering other complementary quality aspects. For example, to guarantee the absence of waste on sand, they demand waste management services but do not establish quality based on the amount of waste on the beach. Beach use pattern is not considered. This fact is remarkable, because the intense dynamics of mass tourism in Spain are well known. The standards/rating systems assessed aim to guarantee beach quality in terms of monitoring services, facilities and behaviour that allow access and enjoyment while preventing the most obvious impacts on the natural system. The quality of the service provided by beach managers and assessed by the managerial function is not usually considered. Nevertheless, the performance of the standards is directly linked to the achievement of certain predefined goals, but not to the commitment to improve those goals and change them once they are achieved.

The standards/rating systems generally provided complementary information rather than express commonality. No clear pattern has resulted from the application of beach management tools to selected beaches. More important differences were found with results obtained for the Cantabria Index. They occurred due to importance of water microbiological and organoleptic factors. A comparison of the evaluated management tools revealed that the Blue Flag award penalized urbanised and natural beaches of the Costa Brava due to their characteristics, accessibility and reduced services (Table 3.2.4.).

BEACH	TYPE OF BEACH	BLUE FLAG 2003	ACA INDEX GLOBAL SCORE (maximum 12)	CEDEX INDEX GLOBAL SCORE (maximum 3)	CANTABRIA INDEX GLOBAL SCORE (maximum 100)
St. Francesc (SF)	URBANISED	YES	10	2.07	32.8
Treumal-Sta. Cristina (STA. C)	URBANISED	NO	10	2.31	71
La Boadella (BO)	NATURAL	NO	12	2.14	24
Fenals (FE)	URBAN	YES	10	2.07	65.5
Lloret Centre (LLO)	URBAN	YES	10	2.01	65.5
Canyelles (CAN)	URBANISED	NO	12	1.80	64

ACA INDEX	RANGE	SF	STA. C	BOA	FE	LLO	CAN
Water microbiological quality	0-4	3	4	4	4	4	4
Water visual quality	0-4	4	4	4	3	3	4
Sand visual quality	0-4	3	4	4	3	3	4
CEDEX INDEX		**SF**	**STA. C**	**BOA**	**FE**	**LLO**	**CAN**
Water Quality (ICAG)	0-3	2.65	2.82	2.82	2.82	2.85	2,82
Sand Quality (ICAR)	0-3	-	-	-	-	-	-
Water Physical Quality (ICFA)	0-3	-	-	-	-	-	-
Geomorphologic Quality (ICG)	0-3	1.21	1.47	1.53	1.27	1.14	0.87
Aesthetic Quality (ICE)	0-3	2	2.4	2.2	2	2.4	2.2
Service Quality (ICS)	0-3	2.01	1.54	1.30	2.21	2.54	1.52
Activity Quality (ICAC)	0-3	2.75	2.25	2	1.5	0	0

CANTABRIA INDEX	RANGE FOR NO NATURAL BEACHES	RANGE FOR NATURAL BEACHES	SF	STA. C	BO	FE	LLO	CAN
Water Quality	0-1	0-1	0.8	1	0.8	0.8	0.8	0.8
Organoleptic factors	0-1	0-1	0.5	1	0.5	1	1	1
Sediment Quality	0-1 (industrial beaches)	--	--	--	--	--	--	--
Hygiene	0-30	--	30	28	-	28	28	28
Guarding	0-30	--	30	30	-	30	30	30
Signalling	0-20	--	5	5	-	5	5	5
Information		--	4	4	-	4	4	4
Environment characteristics	0-20 (urban beaches)	100 (natural beaches)	13	4	60	15	15	13

Table 3.2.4. Standard/rating systems application to studied beaches. The CEDEX Index was calculated using 5 of the 7 considered factors, due to the lack of reliable data of Sand Quality and Water Physical Quality (Buceta 2000). The Sediment Quality factor from the Cantabria Index was not considered as no industrial beaches were assessed.

The CEDEX index detected aspects related to the comfort of analysed beaches (those natural characteristics of beaches that affect experience of users, but does not consider local characteristics such as grain size, form, steep slope, step on the shore and irregularities in the submerged zone. As a consequence, geomorphologic quality score was moderate in all beaches (Table 3.2.4.). Some homogeneity was found in the assessment of water quality (except the Cantabria index). Scores were good in all beaches. Given that nowadays water quality is high in most of the Spanish coast, standards/rating systems did not allow differences to be established. Aesthetic quality was also good although in Sta. Francesc and La Boadella some oil and foam was detected by the Cantabria index. The ACA index scored lower, water visual quality and sand visual quality in Fenals and Lloret. Characteristics of the environment assessed by Cantabria index were good in all beaches except in Sta. Cristina, due to access characteristics. Service quality assessment in the CEDEX Index was good in all beaches except in Sta. Cristina and la Boadella (it was moderate). Cantabria Index scored Hygiene and Vigilance high in all beaches. Signposting and Information scores were lower. In the case of the environmental characteristics of la Boadella (natural beach), the scored results were achieved by accounting for presence of singular elements, moderate human transformation of the area and views that improve landscape quality. Activities score of the CEDEX Index was good in St. Francesc and la Boadella, regular in Fenals, and bad in Lloret and Canyelles.

The use of certified EMSBs began in Spain in the year 2000. In the country, the legal establishment of public responsibilities for beach management means local authorities can obtain that certification. Three types of those environmental management standards are currently used: ISO 14001, EMAS, and the Q of Quality. Although the Q of Quality is the most recently developed management system, two of the studied beaches achieved the distinction in 2004: Lloret de Mar Center and Fenals. In 2005, out of a total of 3100 Spanish beaches, 189 (25 municipalities) were managed according to ISO 14001 and 26 (7 municipalities) according to EMAS requirements. Despite a rapid increase in recent years, the use of EMSBs is still significantly less than that of the Blue Flag award. In 2005, 478 Spanish beaches obtained the Blue Flag award (Figure 3.2.3.).

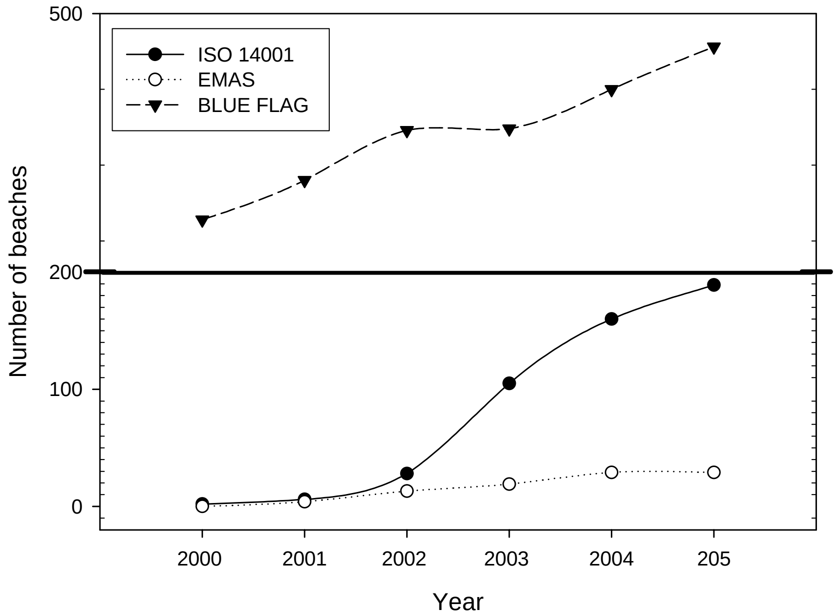

Figure 3.2.3. Evolution in the usage of Environmental Management Systems (ISO 14001 and EMAS) and Blue Flag, as beach management tools in Spain.

3.2.4. Discussion

Despite their popularity, most performance standards and performance rating systems fail to include an in-depth assessment of the three different functions (recreational, protective and natural) that need to be addressed in relation to beach ecosystems. The Blue Flag award, ACA index, CEDEX index, and Cantabria index are all assessment tools but with differing characteristics. They each have specific standards to follow and monitor. Coastal managers responsible for obtaining such awards frequently treat them as individual short-term projects to benefit conventional market-based economic activities.

Performance standards/rating systems address various goals and are mostly complementary. Some of them can be implemented in parallel for the same beach to provide useful information and help with management in different ways. However, while all of these performance standards and quality rating systems consider service quality and water quality extensively, and mirror almost exclusively the needs of human users during the bathing season, they fail to address other important criteria, especially when we consider beach faces as parts of beach ecosystems. Water quality criteria and service excellence are strongly emphasized. In contrast, some factors have not been quantified or even considered by the standards. Management coordination has been called for when measures are implemented by different administrations and/or organizations (Breton *et al*. 1996) but it appears not to have occurred in performance processes. The criteria on which beach quality is assessed should be at least partly based on user opinion (Williams & Morgan 1995, Morgan 1999-b). However, user opinion has only been considered sporadically. All of these factors seem to indicate that further developments are required in the management of beaches. Although recreation is the most extensively addressed function in beaches, there are other schemes used worldwide that may consider other aspects and functions according to other societal values (e.g. the user-based rating system, [BRS] checklist designed by Morgan (1999-a) and the BARE system (Micallef &

Williams 2004)), covering others aspects related to geomorphologic quality, natural system quality, aesthetic quality or safety quality. On the other hand, worldwide similarities and/or differences, performance standards/rating systems do not consider managerial issues such as management coordination, steady improvement or emergency plans (except the Blue Flag award).

Biological aspects other than microbiological water quality are widely neglected (Moffet *et al.*1998, Nardi *et al*. 2003). There is uncertainty about species that should be monitored in beach ecosystems (Gheskiere 2005, Sardá 2001). The lack of indicators providing information on many natural processes occurring in beaches leads to a failure to consider environmental aspects that may be affected by human activity (Llewellyn & Shackley 1996, Dietvorst & Ashworth 1995, Tremblay 1998, Sousa 1984, Hall 1994). Apart from the need to develop appropriate indicators to cover the natural function and also the protection function, the failure to consider certain aspects of beach management has led to difficulties in managing different types of beaches, due to the extreme variability present in coastal systems. Consequently, there is a lack of clarity in beach management regarding the goals that beaches should achieve.

The need to move beyond performance assessment in the management of beaches must now be considered. Once performance standards are reached and/or rating systems get good scores, management is not improved any further. To move towards effective management, it becomes necessary to establish a framework in which all the quality criteria can be expressed, adapted, and substituted when necessary. This framework should recognise the extreme variability of coastal conditions and consider beach ecosystems instead of just beach faces. In this case, a systematic approach to the integration of the recreational, protective, and natural roles of the beach ecosystem together with their managerial activities should be emphasized. Managerial activities should be enhanced by developing proactive planning and establishing responsibilities. Planning must evolve so that it can be better adapted to the true conditions associated with different beaches, and considering the objectives of beach management at various levels (Micallef & Williams 2002). If beaches are to be managed as the complex system they are, the managerial challenge is to ensure sustainable use of those resources rather than achievement of a particular standard. The use of Environmental Management Systems for beaches (EMSBs) allows different visions to be employed according to the reality of each individual beach, while nevertheless managing all of them within a similar framework.

The use of well-established, widely used certified EMSs such as the International ISO 14001 or the European EMAS, as well as the Spanish National Q of Quality for beaches is highly recommendable. Although the Q of Quality requirement includes some aspects related to recreational activity, EMSBs do not have many intrinsic concrete specificities to achieve. Their requirements include the fulfilment of legal requirements and external references such as beach quality indexes. An interesting aspect of EMSBs is the opportunity to coordinate global management offered by their flexibility. Theoretically, all criteria considered in this study can be included in those systems and become projects that take place within a general process. Thus, the process of beach management includes the carrying out of a variety of projects, review of progress, implementation of corrective measures, and continuous improvement over time. The steady improvement paradigm allows us to move beyond isolated projects and guarantee constant improvement of beach quality through the establishment of new projects once the previous ones have been completed.

EMSBs cannot replace beach indexes and awards. Projects such as the Blue Flag award or the CEDEX index should be incorporated inside the management framework offered by ISO 14001 or EMAS. EMSBs can be used as general instruments serving a wide range of purposes, and the general framework is applicable both to urban beaches in which the main goal is recreational and to highly natural beaches where environmental goals should prevail. All beaches, regardless the level of human development, represent ecosystems with the potential to be altered by human activity. This makes it highly appropriate to establish a management framework that contains the principles of management according to beach characteristics.

When using EMSBs, emphasis should be placed on establishing indicators and references that guide the objectives and criteria to pursuit. It is not only recommendable but also mandatory to include appropriate projects following significant environmental aspects in the management system so that it does not become a theoretical artefact. Of the four standards/rating systems analysed, the CEDEX index offers the best quantitative monitoring of the most aspects of beach ecosystems and can be widely used in EMSBs. The CEDEX index allows changes in beach quality to be assessed over time. It is also the only index that extensively covers geomorphologic quality, sand quality, recreational equipment (services) and some activities such as antisocial sporting practices and water sports. Performance standards, such as the Blue Flag award, may help in achieving concrete goals but they do not provide for overall monitoring of beach quality once they are awarded. However, the requirement in the Blue Flag award to enforce national, regional and local legal requirements, and to consider emergency planning measures such as warning mechanisms and emergency contingency plans is also recommendable for EMSBs. Other aspects as cleaning, access, prohibitions, parking, annoying biological components, coverage of beach natural components, landscape condition, … can be taken from other performance standards (ACA, Cantabria, BRS, …), and even beach usage can be an interesting factor to be considered (Leatherman 1997).

Beach management must include considerations other than the environmental/social issues associated with the use of those natural and/or human-dominated ecosystems. Important deficits can be observed in today used performance standards. Management and organisation usually become a weakness in this process and it is not considered at all in the performance standards and rating systems studied. EMSBs should also strengthen the sense of obligation in management. Management coordination is usually a significant problem due to the different levels of government (national, autonomic and local) involved in beach management, and limited or non-existent communication has often had negative consequences. Measurement principles must be adopted to address managerial performance indicators so that adaptive management and ecosystem management principles can be included in beach management practices (Grumbine 1994). This will make it easier for beaches to be integrated in terms of their ecological role and allow beach processes to be correctly monitored. On the other hand, problems caused by storm damage are exacerbated by the absence of general planning and the lack of clear guidelines regarding financial responsibilities. However, these problems can be addressed by establishing protocols to be put into action under these circumstances. Emergency plan criteria require prior awareness of the local characteristics of beaches. They also necessitate a detailed protocol that includes measures to be taken in emergency situations, in order to guarantee minimal environmental damage. The use of EMSBs can help to include all those deficits under a general framework.

Assessment of beach management should be done by organizations outside of the managers themselves. It is also very important that the areas to be managed are defined for each type of beach and that methods and limits are standardized as far as possible so that EMSBs can become homogeneous for the different types of beach considered. Beach classification can vary from one site to another but the categories established in this study (urban, urbanised and natural) can be adapted to other coastal zones.

Although the use of EMSBs is still in its infancy, the potential for improvement that it offers is clear. As performance standards are usually met, the use of EMSBs allows us to take a further step, not only to “do things right” but also to “do the right things” (Hamschdmit & Dyllick 2001). In this way, we can improve eco-effectiveness in the management of beaches and, depending of the reality of the situation of each single beach, we can work with the entire beach ecosystem under a general framework. Such a process should allow us to manage a highly frequented urban beach such as S’Abanell or that of Lloret Centre, and a beach inside a protected natural park area such as the Treumal-Santa Cristina complex, both with different goals, objectives, programmes and projects, but both supervised at the same time under the same scheme. EMSBs have the potential to drive current managerial activities on beaches towards eco-effectiveness; in this case in the direction of managing not only beaches per se but of managing all properties of the beach ecosystem. It is clear that we need to take into account the need for a broader experience in order to assess the strong and weak points of EMSBs. Although the possibilities should be considered with caution until sufficient information is obtained, evidence seems to suggest that EMSBs are suitable for wider management of beach ecosystems.

3.3. LOCAL NEEDS OF BEACH MANAGEMENT[2]

3.3.1. Introduction

Traditionally, recreation and coastal protection have been the main goals in beach management (Bird 1996). Consequently, research topics have been related to the social and engineering sciences (Micallef & Williams 2002). However, in recent decades, a new approach has been adopted, in which beaches are considered a multi-dimensional system where natural, socio-economic and administrative components interact. Therefore, integral system functions should be considered for properly managing beaches (James 2000-b), i.e. an ecosystem management approach should be used (James 2000-a, Pirot *et al.* 2000).

Despite this integral approach, the most common situation in developed countries is that beaches are considered to be natural environments whose main function is to provide space for leisure. Accordingly, they are managed to optimise this user-oriented function, without taking other values or characteristics into consideration. Thus, the management strategy is basically dedicated to addressing aspects that affect the service to be provided (cleanness, comfort, aesthetics) and to fulfilling beach user expectations. As a consequence, beach management is largely standardized and poorly adapted to local environmental factors. The main managerial variations depend on the number of services offered.

The other item that is usually considered is the protective function of beaches, which is mainly addressed reactively, i.e. when the beach is not fulfilling this function properly and there are adverse effects on the hinterland. The overall result is that beach management strategies are mainly designed to cover aspects of both of these topics (Simm *et al*. 1995, Williams & Davis 1999).

If beaches were considered as coastal environmental units (without any restrictions), their management would have to be integrated into a broader framework, such as Integrated Coastal Zone Management (ICZM). One of the most recent recommendations for ICZM is to follow the ecosystem management approach. This approach would have to be adapted to beach management. The proper implementation of ecosystem management should accomplish ten defined principles (Grumbine 1994), including: data collection, monitoring, adaptive management, interagency cooperation, organizational change, humans embedded in nature, and the establishment of values. To successfully adapt this approach, the support of applied researchers working on beaches is needed (Underwood 1995). In addition, the assumption of the principle of subsidiarity by local managers is required, which implies taking responsibility for planning and decision making at the lowest practical level in the governance hierarchy (Olsen 2001).

Coastal areas in major tourist destinations are subjected to additional pressure, as leisure becomes economy. Therefore, as long as the tourism industry requires beaches to support its activity, beach management will be strictly orientated to accommodating this use. In this regard, Spain is a paradigmatic case, as it is one of the world's major tourist destinations within this sector. Tourism accounted for 11.4 % of Spanish GDP in 2003. Moreover, much of the tourism industry in Spain is based on the *sun* and *sand* model (see e.g. Aguiló *et al*. 2005). Consequently, beaches are considered to be one of the country's major assets.

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[2] Edited version of the manuscript *A Critical Assessment of Beach Management on the Catalan Coast* by E Ariza, JA Jiménez and R Sardá. *Ocean & Coastal Management* (in press).

From an administrative standpoint, the main framework for regulations in the Spanish coastal zone is the 22/1988 Shores Act. This and other regional/local laws that regulate some aspects of beach management such as beach use plans, safety issues and recreational activities and services, constitute the core of existing regulatory legislation on beach systems. Although most mandatory obligations are still centralized at the national level (through the management of the coastal public domain), or at the regional administration level (by managing land use planning), the local administration—municipalities—plays an important role in beach management. Although municipalities have limited authority over management, they experience most of the benefits and problems related to the presence of beaches. As a result, daily beach management practices undertaken by the local administration can be used to identify common problems and concerns that managers must face.

Within this context, the aim of this study is to identify the main aspects of beach management that local managers have to deal with. The analysis includes a detailed survey of the local managers from 38 coastal municipalities on the Northeastern Mediterranean coast of Spain. In this survey, managers ranked usual beach problems according to their impact on management. They also evaluated current beach management processes. Although the study uses the Catalan beaches of Northeastern Spain to illustrate beach management issues, results can be extrapolated to most of the Mediterranean coast or to similar beaches where tourism is the main activity on the coast.

3.3.2. Methods

The main data used in this work consisted of answers to a questionnaire provided by personnel involved in (or responsible for) beach management processes in 38 local administrations (municipalities) along the Catalan coast. The study area extends along the northernmost 430 km of the Catalan coast (Figure 3.3.1.), where there are 210 beaches. One hundred and forty of these beaches were included in the study. The remaining beaches are small pocket beaches that are hardly used and on which practically no management processes have been implemented. Thus, all the data percentages presented in the results section were obtained with respect to a total of 140 beaches.

The questionnaire included three main blocks of subjects, covering the most common aspects of local beach management: sediment management, beach use and organizational issues. These aspects were selected by taking into account the most significant problems that local managers have to face in beaches on the Mediterranean coast (Breton *et al.* 1996, Valdemoro & Jiménez 2006, Villares 1999, Mora 2004, PAP 1997, Eurosion 2004, Sardá *et al.* 2005-a). The block related to sediment management was specifically included because this is now one of the factors that most affects beach management, due to the frequency and magnitude of erosion along European coasts (Eurosion 2004). The block on beach use was introduced because coastal tourism is the main economic sector in the study area and many of the beaches studied are intensively used. The number of users determines the services (number and type) provided and significantly affects the perception of the beach users (Breton *et al.* 1996, Villares 1999). Finally, the block concerning organizational aspects was analysed to detect the existence of a beach management system and to assess the degree of implementation of beach management processes. This block also included emergency management and financial investment issues. All the aspects dealt with in the questionnaire were selected by taking local characteristics into account. However, they are general enough to be applied or adapted to other areas. A summarized version of the questionnaire is shown in the Annex II.

The physical characteristics of the analysed beaches were obtained from a beach database set up by the Spanish Ministry of the Environment (http://www.mma.escostas/guia_playas) and from our own GIS database of the area (Sardá et al. 2005-a). A collection of colour orthophotos at a 1:5000 scale, supplied by the *Institut Cartogràfic de Catalunya* (Cartography Institute of Catalonia), was used to characterize the hinterland of all the analysed beaches. Socio-economic data for the municipalities were obtained from official statistics supplied by the autonomous government of Catalonia (www.idescat.net).

Chi-square and non-parametric correlation (Kendall's Tau coefficient) tests were applied to collected data to determine significant similarities and differences between structural, socio-economic and management variables. Statistics were performed by means of the SPSS 12.0 software package. To classify beaches into the selected types, land-use properties of the hinterland along a 500 m wide stretch were analysed by means of non-metric multidimensional scaling (MDS) and cluster analysis using the Primer 5 software package.

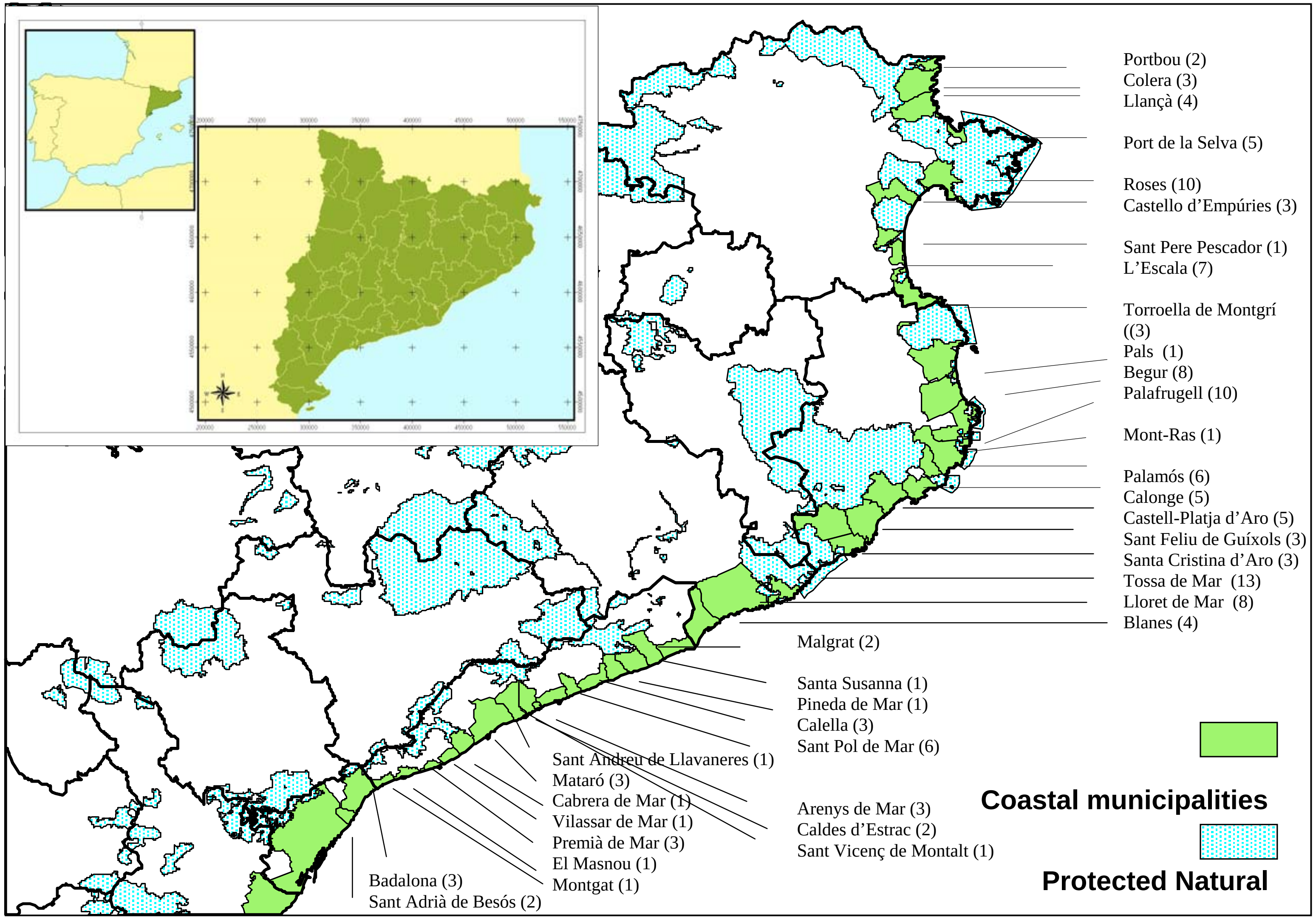


Figure 3.3.1. Map of the sector, including municipalities and beaches, where local beach management has been analysed.()= Number of beaches of the municipality.

3.3.3. Administrative, legal and regional analysis

Regional Analysis

The surveyed municipalities are included in 5 supramunicipal administrations or *comarcas* (equivalent to counties) with different coastal characteristics and uses: Barcelonès (BAR), Maresme (MAR), La Selva (SEL), Baix Empordà (BEM), and Alt Empordà (AEM). A map showing studied beaches is represented in Fig. 3.3.1. The latter three areas are located in the north and they comprise a very well known tourist destination in Europe known as the Costa Brava.

INDICATORS	UNITS	AEM	BEM	SEL	MAR	BAR
TOTAL SURFACE	Ha	250.2	303.3	103.9	124.3	26.1
LENGTH OF COAST	km	189.9	131.2	38.6	63.8	6.2
LENGTH OF BEACH AREAS	m	27,968	20,321	9,960	33,467	3,230
NUMBER OF BEACHES	number	62	71	29	44	4
RESIDENT POPULATION	number	34,444	82,912	55,298	275,814	241,433
POPULATION DENSITY	number*Ha^{-1}	137.7	273.4	532.2	2,218.9	9,250.3
INCOME "PER CAPITA"	euros	12,001	12,201	11,801	11,401	9,039
UNEMPLOYMENT RATE	% over active population	9.1	10.0	12.2	11.4	14.0
ACCOMMODATION COEFFICIENT	hotel beds per 100 inhabitants	43.6	18.3	81.8	12.4	0.1
MOTORIZATION COEFFICIENT	vehicles per 1000 inhabitants	891.9	836.9	707.0	616.1	535.3
CONSTRUCTION COEFFICIENT	built houses per 100 inhabitants during last 5 years	7.4	6.9	7.0	4.6	1.9
IMPERVIOUS SOIL	percentage over total soil	8.7	12.1	20.2	27.2	57.6
PROTECTED AREA	percentage over total soil	51.0	27.1	26.8	1.8	13.8
COASTAL ARTIFICIALIZATION	percentage over total length	40.2	57.1	58.9	96.2	100.0

Table 3.3.1. Socio-environmental report of indicators for the different "comarcas" analysed in the study area; AEM-Alt Empordà, BEM-Baix Empordà, SEL-La Selva, MAR-Maresme, and BAR-Barcelonès (except for the city of Barcelona). All data is given for the year 2001 except for the accommodation coefficient (2000) and the impervious soil and the coastal artificialization (1997). Data is pooled from different official sources and managed under the Environmental information System described in Sardá *et al.* (2005-a).

The BAR area includes two industrial and residential municipalities just north of Barcelona. The city of Barcelona was excluded from the analysis because it is a highly developed environment and the structure of its coastal area is completely different to the rest of the municipalities. Therefore, there is no point in comparing them. The MAR area is characterized by the presence of what were originally uninterrupted long sandy beaches. Nowadays, there are five recreational marinas and other coastal structures in this area, which have altered the original sediment transport pattern and induced significant erosion problems.

The Costa Brava (SEL, BEM, and AEM) has a different geomorphology. It is a highly indented coast. Most of the coastline is composed of cliffs, especially in the northernmost area. Bayed and pocket beaches are the dominant beach type. Most of these are composed of coarse- and medium-grained sand. The area’s original natural landscape comprises pine forests that reach the coastline.

In terms of beach use, the bathing season in the area extends from the end of May until the end of September. The period that is most intensively used is July and August (Sardá & Fluvià 1999).

To classify beaches in the area, main land uses on the coastal hinterland were analysed. To do this, a 500 m wide strip along the coast was analysed using a GIS database. Beaches were grouped into three general categories: urban, urbanised and natural beaches (plus few beaches that were diverse). Urban beaches are considered to be those located within the main nucleus of the municipality, with at least 60 % of urbanised hinterland (of high density). Urbanised beaches are those found in residential areas outside the main nucleus of the municipality, with a maximum of 50 % of urbanised hinterland (of low density). Natural beaches are those outside the main nucleus of the municipality located close to very low density urbanised areas (up to a maximum of 30 % of the hinterland being urbanised), or in uninhabited areas. Urban, urbanised and natural beaches accounted for 38.6, 27 and 30 % of the total respectively (Table 3.3.2., Figure 3.3.2.).

TYPE OF BEACH	NUMBER	BLUE FLAG	OVERCROWDED	EMERGENCY SITUATION	NOURISHMENT	SEDIMENT MOVEMENT	ENGINEERING
URBAN	54	15	13	21	7	9	7
URBANISED	38	9	11	2	2	3	0
NATURAL	42	3	6	2	0	6	0
DIVERSE	6	0	0	0	0	0	0
TOTAL	140	27	30	25	9	18	7

Table 3.3.2. Type of analysed beaches and number of beaches reported to experience the selected feature.

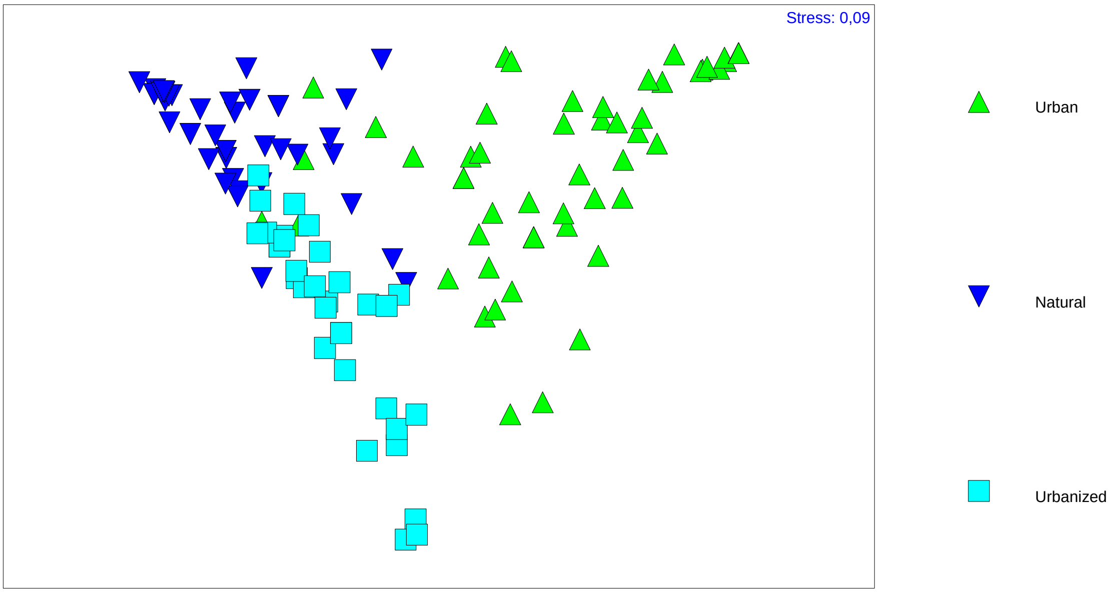


Figure 3.3.2. MDS of beaches according to main land uses adjacent to beaches.

The study area contains four environmental homogeneous management units (EHMU's) defined for the Catalan Coast by: highly natural areas (AEM), seminatural areas (SEL, BEM), semiurban areas (MAR) and high socio-economic developed areas (BAR) (Brenner *et al.* 2006). In the former two EHMU's, natural values are dominant and they significantly contribute to the total value of the coastal zone. Thus, some of the beaches are located in natural protected areas or have a protected area in the hinterland (45 beaches with a total length of about 21 km).

Out of all the analysed beaches, around 70 % are small pocket beaches (sub aerial sand surface lower than 10,000 m^2), 13 % are partially open and another 17 % are completely open with areas larger than 30,000 m^2 (large bay beaches are also included in this group). Most of the beaches were highly exposed (45.3 %) or exposed (23.8 %) to dominant eastern wave action.

Administrative and legal analysis

The main legal responsibilities for beach and coastal management in Spain are regulated by the Shores Act 22/88. The Shores Act 22/88 is designed to protect of the coastline, ensure its proper public use, regulate the rational use of its resources, and to maintain good water and shoreline quality (Montoya Font 1995). This document establishes the legal requirements for managing the Maritime Terrestrial Public Domain (DPMT), which includes beaches and, to a lesser extent, the adjacent area.

The central, regional and local (municipal) governments manage or administer the Spanish coastal area. Each level of government has very different jurisdiction and they regulate activities in different parts of the coastal area.

The Shores Act 22/88 describes the central government's responsibilities for managing the DPMT. It is responsible for the definition, management and guardianship of the DPMT and its rights (the protection area, up to 100 m inland, and its catchment area, up to 500 m inland). It also carries out, supervises and controls studies and projects; it works to protect and conserve the elements of the DPMT; and in particular, it aims to create, nourish and recover beaches. It authorizes sewage discharges in the DPMT and it defines and applies regulations regarding discharges, human safety in bathing areas, and maritime rescue. It also reports on the activities or plans of other administrations when these could potentially affect the conservation of the DPMT.

The regional administration is responsible for land use, land planning and the management of the protection area. Its responsibilities also include the protection of natural communities in coastal areas and beach quality assessment and control (water quality, sand quality and access quality). It is also in charge of passing beach use plans presented by the municipal authority, once the central government has accepted them. In some cases, it can develop projects beyond its responsibilities in a concerted manner, e.g. promenade construction (sharing costs).

Finally, the local administration has the duty to report to the central government on projects in the DPMT. Its main responsibility is to run seasonal facilities and to keep beaches clean and free from waste. It is also in charge of reinforcing requirements established by the central administration for safety and rescue issues (Montoya Font 1995). Municipalities draw up plans for beach use before the start of the high season. These plans program and locate the facilities and services to be provided on each beach. Municipal managers may decide about beach exploitation. However, some restrictions are laid down by the Shores Act, such as: facilities cannot occupy more than 50 % of the total beach surface; facilities must leave a free area of 6 m in width along the shoreline and they must include safety and rescue services. Moreover, these plans regulate and define other common services such as garbage bins, showers, drinking water fonts, nautical activities, WCs, food and drink stands.

In spite of this, the Shores Act does not establish funding responsibilities nor does it guarantee integrated coastal and beach management. In fact, the present situation in some areas on the Spanish coast in general and the Mediterranean coast in particular, reflects the lack of such a policy over the last few decades (Suárez del Vivero & Rodríguez Mateos 2005, Barragán 2003-b, Málvarez García *et al.* 2003). At present, the General Directorate for Coasts of the Spanish Ministry of the Environment has promoted The *Plan Director para el Desarrollo Sostenible de la Costa* (PDSC). This will implement ICZM in Spain, according to the EU Recommendation on ICZM (413/2002/EC).

3.3.4. Results

Sediment management

According to the managers' answers, beach erosion and consequently a lack of sand is the major problem and concern identified in the region. Almost two thirds (20 municipalities) of the managers reported long-term erosion on some of the beaches. This erosion was associated by 75 % of managers with construction work performed in surrounding areas (Table 3.3.3.). The practical consequences of this erosion are that beaches are narrow and the sub aerial surface is not wide enough to fulfil usual beach functions, such as protection and/or recreation (Valdemoro & Jiménez 2006, Eurosion 2004). In addition, 87 % of the municipalities also reported the presence of occasional problems associated with the impact of coastal storms. These problems include damage to infrastructures (e.g. promenades) and water and sediment floods during massive over wash events, when storm waves overtop promenades (Jiménez *et al.* 2003).

Comarca	Municipality	Erosion	Storms	Coastal Works	Nourishment	Sediment redistribution	Blue Flag * & other systems	Annual investment (1000 €)
Alt Empordà AEM	Portbou	N	Y	N	N	Y	Y (1)	3
	Colera	--	Y	Y	N	Y	N	18
	Llança	Y	Y	Y	N	Y	Y (1)	90
	Port de la Selva	N	N	N	N	Y	Y (2)	60
	Cadaqués	--	--	--	--	--	--	--
	Roses	N	Y	N	N	Y	N ISO/EMAS	579.5
	Castelló d'Empúries	N	N	N	N	N	Y (1)	210.4
	St. Pere Pescador	N	--	--	N	N	N	113.35
	l'Escala	Y	Y	Y	N	Y	Y (4)	140
Baix Empordà BEM	l'Estartit	Y	Y	Y	Y	N	N	172.2
	Pals	Y	Y	N	N	N	N	38.2
	Bagur	Y	Y	Y	--	--	Y (2)	70.0
	Palafrugell	Y	N	Y	Y	N	Y (2)	--
	Mont-Ras	--	--	--	--	--	N	--
	Palamós	Y	Y	Y	Y	N	Y (1)	104
	Calonge	Y	Y	Y	Y	Y	Y (4) ISO/EMAS	--
	Platja d'Aro	Y	Y	Y	N	Y	Y (3)	129.6
	St. Feliu de Guíxols	N	Y	N	N	Y	Y (2)	15.8
	Sta. Cristina d'Aro	--	--	--	N	N	N	(in St. Feliu)
La Selva SEL	Tossa	N	Y	N	Y	Y	Y (1)	150
	Lloret de Mar	N	Y	N	N	Y	Y (1) Q quality (2)	845.8
	Blanes	Y	Y	N	N	Y	Y (3)	258.5

Table 3.3.3. Issues related with sediment management, beach management systems and/or awards and annual investments in beaches by municipalities. Number within brackets indicates the number of beaches with the award (N=No, Y=Yes, --=No data).

Comarca	Municipality	Erosion	Storms	Coastal Works	Nourishment	Sediment redistribution	Blue Flag * & other systems	Annual investment (1000 €)
Maresme MAR	Malgrat de Mar	Y	Y	Y	Y	N	Y (1)	62.2
	Sta. Susanna	Y	Y	Y	Y	N	N	8
	Pineda de Mar	--	--	--	N	Y	Y (1)	--
	Calella	--	--	--	N	N	N	170
	St. Pol de Mar	Y	Y	N	N	N	N	55
	Canet de Mar	--	--	--	--	--	Y (1)	--
	Arenys de Mar	Y	Y	N	--	--	N	56.4
	Caldes d'Estrach	N	Y	Y	Y	N	N	36
	St. Vicenç de Montalt	N	N	N	--	--	Y (1)	--
	St. Andreu	Y	Y	N	Y	N	N	24
	Mataró	--	--	--	N	--	N	175
	Cabrera	Y	Y	Y	--	--	N	42.1
	Vilassar de Mar	Y	Y	Y	--	--	N	117.2
	Premià de Mar	Y	Y	Y	Y	Y	N	157
	El Masnou	Y	Y	Y	Y	N	Y (1)	85
	Montgat	--	--	--	Y	N	N	--
Barcelonès BAR	Badalona	Y	Y	Y	N	--	N	--
	Sant Adrià de Besòs	N	Y	N	--	--	N	7

Table 3.3.3. (continued). Issues related with sediment management, beach management systems and/or awards and annual investments in beaches by municipalities. Number within brackets indicates the number of beaches with the award.

Although municipalities are the main "receivers" of erosion-induced problems, actions to solve or counteract them are designed and executed at different administrative levels. Thus, as mentioned before, the General Directorate for Coasts (the Ministry of the Environment) is responsible for protecting the Spanish coasts, including the design and execution of coastal protection works. As a consequence, in many cases there is a time lag between the identification of the problems, which is usually done at the lowest administrative level (local), and the execution of the measures, which is carried out at the highest level (state). Moreover, when the state evaluates the need to take action on a given beach, criteria other than the local ones can affect the final decision. This would not be the case if the local administration was in charge.

About 45 % of the municipalities experiencing erosion problems reported sand nourishment operations on some of the beaches along their coast. In all cases, these operations were carried out on beaches experiencing long-term erosion processes. As the origin of these problems has not been solved, renourishment operations are required. In addition, 48 % of affected municipalities also reported other operations such as sediment redistribution within beaches. This especially occurs in pocket beaches, where this action is needed after extreme shoreline reorientation, to homogenise the beach width.

One of the consequences of these sediment-related problems is that, in many cases, promenades become exposed to unexpected wave action. As a result, they may experience significant damage (Jiménez 2001). A practical consequence of this is that the promenades of some (many) beaches have been reinforced or rebuilt to improve their structural resistance to wave action during storms. These problems were mainly reported for urban beaches (Table 3.3.4.), probably because their importance is measured as a function of the value of the affected resource or use, which will clearly be higher in urban environments.

		SM	SD-CE	S	ES	OV
Beach type	**X^2**	84.832	53.093	87.432	100.120	63.640
	Sig.	0.000	0.004	0.000	0.000	0.000
	df	20	29	33	19	19
	N	125	129	125	125	125

Table 3.3.4. Relationship between type of beaches (urban, urbanized and natural) and management issues. Dependence between variables is significant at 0.01. SM= Sediment Management, SD-CE= Storm damage-Chronic Erosion, S= Services, ES= Emergency Situation, OV= Overcrowding.

All these aspects make problems related to beach sediment management one of the main priorities and concerns of local managers. Moreover, due to the difference between the actors experiencing the problem (local level) and the actors deciding on what action to take (the state), conflicts between local and central government administrators are common.

Number of visitors and beach use

Problems related to the overuse of beaches were not identified as one of the main priorities by local managers in the study area. In Spain, the beach is considered to be saturated from the recreational standpoint when the available surface area is less than 4 m^2/user (e.g. Yepes 1999). In spite of this, 29 % of managers acknowledged that some of the beaches in their municipality were saturated, at least for a few days, during the summer season (21.4 % of beaches). Twenty per cent of these managers stated that the beach was overcrowded during most of the summer. Four municipalities admitted that a reduction in the number of users would be desirable, sometimes in the range of a 20-50 % reduction. However, they did not have a specific plan to achieve this. As expected, urbanized and urban beaches experienced these problems. In order to put these results in context, it should be stressed that this is an area of intensive tourism. In addition, some municipalities have been selected as examples of areas in which the stagnation stage in the tourist cycle of evolution has been reached (Priestley & Mundet 1998).

Despite these occurrences of beach saturation, no monitoring plan for measuring and/or controlling the level of beach use has been implemented, nor is such a plan foreseen in the area. Existing data to quantify the magnitude of the problem are sparse and, in some cases, outdated (e.g. Mora 2004). However, 25 municipalities stated that it would be useful to have tools that enable beach use and state monitoring to be carried out. In this respect, technologies that can provide multipurpose data on beaches for aspects such as protection, safety, use and services are becoming available for use (Jiménez *et al*. 2006).

Organizational issues

Beach management is carried out according to different administrative schemes in the area's municipalities. A significant number (40 %) grouped all beach duties and responsibilities under the jurisdiction of a single department. Four municipalities (Roses, Begur, Calonge and Montgat) have created departments that deal exclusively with beach issues. In most other municipalities, the various aspects related to beach management are shared among different departments. Thus, most municipalities have two or three departments involved in this work (25.7 and 20 %, respectively). In addition to beaches, such departments are in charge of environmental issues (23.2 %), municipal services (16.2 %), urban development (8.1 %), tourism and governance (6.06 %) or other local construction works (4.0 %).

In general, municipalities that share management issues between different departments are the ones that have the largest urban beach surfaces and population. At the same time, they are the municipalities with the largest direct investments in the area of beaches (Figures 3.3.3. and 3.3.4.). The most important issues for managers were sand and water quality, the adequacy of services and beach cleaning.

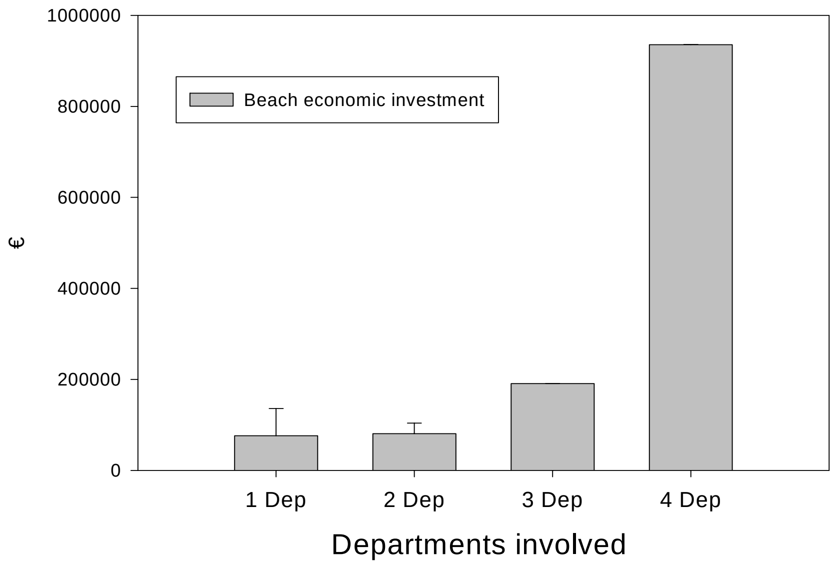


Figure 3.3.3. Number of departments in municipalities involved in beach management organization and economic public investment in beaches.

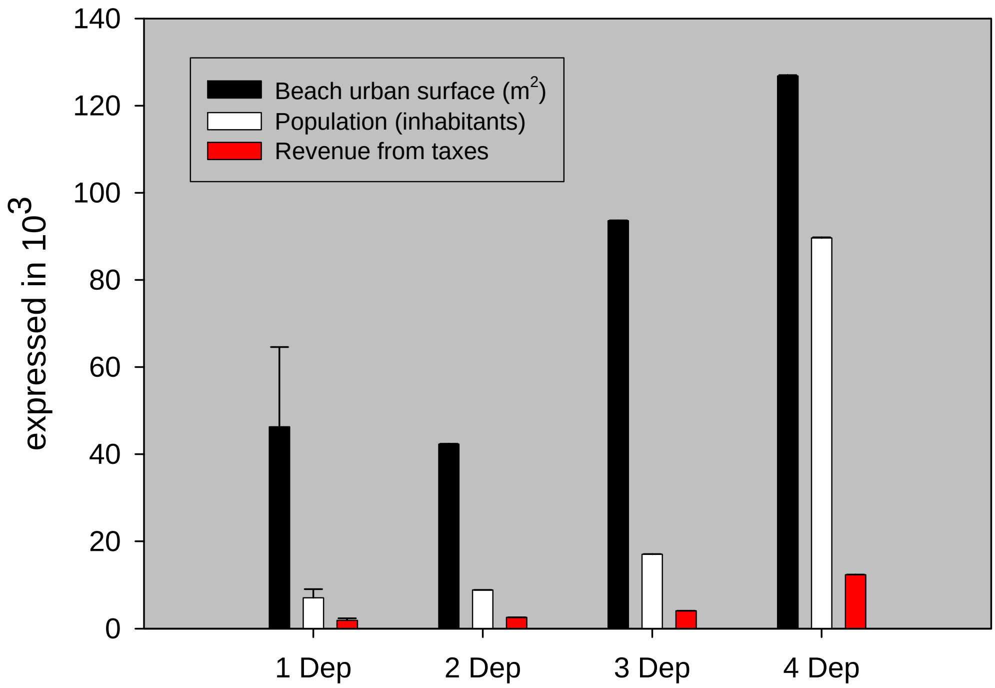


Figure 3.3.4. Number of departments in municipalities involved in beach management organization and some numbers of each municipality.

From the administrative standpoint, the basic and common management practices in all of the area's municipalities is the development of beach use plans. As mentioned before, municipalities must prepare a use plan in which all the beach services and uses must be specified for the bathing season. In many cases, these plans are closely related to beach awards, i.e. most municipalities want to obtain awards for their beaches, so that they are able to present them as a quality product to users. These awards force municipalities to adopt a number of measures in order to fulfil the required criteria. The best-known award is the Blue Flag (www.blueflag.org). In the summer of 2004, 13 % of the beaches in the study area were given this award. This is a proportion similar to the Spanish average. Spain is the country with the highest number of awarded beaches. These percentages increase up to 27 % for urban beaches and 24 % for urbanized ones. Only 7 % of natural beaches have been awarded the Blue Flag. This result is not surprising, since the Blue Flag is mainly designed for recreational beaches offering services to users (i.e. urban and urbanized ones) that natural/rural beaches of the area will rarely be able to offer.

Beside this, other standard management figures are emerging for Spanish beaches (Yepes 2004). Thus, two of the municipalities analysed have implemented a formal environmental management system, ISO 14001 and EMAS (European Union's Eco-management and Audits Scheme) on 11 beaches. Moreover, a new award system that is specifically designed for tourist beaches has recently been promoted by the Spanish Ministry of Industry. This is called the Q of Tourism Quality (at present, it has only been applied to 23 beaches in all of Spain).

Public investments

The average annual declared (public) investment on maintenance, cleaning and conservation by each municipality was €133,113. This cost does not include sand management operations, which are carried out by the Spanish government and are directly funded by the state. However, the range of variation in this average value was extremely high. Lloret de Mar (€845,820) and Roses (€579,555) were the municipalities with the largest absolute budgets dedicated to beaches. Portbou (€3,000), Santa Susanna (€8,000) and St. Adrià de Besòs (€7,000) devoted the lowest investments to their beaches.

If these budgets are standardized according to the sub aerial beach surface in the municipality, the largest investments correspond to Lloret de Mar (6.28 €/m^2) and St. Andreu de Llavaneres (5.58 €/m^2). The lowest correspond to Sta. Susanna (0.09 €/m^2), St. Adrià de Besòs (0.14 €/m^2) and Pals (0.15 €/m^2). The figures for the municipalities' investments were found to be dependent on local socio-economic factors, management organization and beach surface per municipality. The figures were seen to be most closely dependent on waste production, local tax revenues and GDP (Table 3.3.5.).

		BA	**P**	**HL**	**TR**	**SW**	**UBA**	**GDP**
EI	**Coef.**	0.311	0.289	0.273	0.432	0.418	0.268	0.529
	Sig.	0.008	0.013	0.019	0.000	0.000	0.037	0.002
UBA	**Coef.**	---	0.401	--	0.335	0.372	---	---
	Sig.	---	0.002	---	0.009	0.004	---	---

Table 3.3.5. No parametric Correlation. Relationship between municipal economic investment in beaches and local factors. Difference between groups is significant at 0.05. N=36. EI= Economic Investment, UBA= Urban Beach Area, BA= Beach Area, P= Population, HL= Hotel Lodging, TR= Tax Revenue, SW= Solid Waste, GDP= Gross Development Product.

As can be seen in Table 3.3.3., the public investment in beaches by each municipality in the area varies widely in both absolute and relative terms (per m^2 of beach). However, when beaches are grouped into *comarcas*, a more or less clear picture emerges (Figure 3.3.5.). Thus, the average investment per municipality within a *comarca* seems to be independent of the coastline length occupied by beaches. However, there is a strong relationship between this average investment and the accommodation coefficient. The larger the accommodation coefficient, the higher the investment will be. This coefficient can be used as a proxy of the importance of tourism in the area, since it is calculated as the number of hotel beds per 100 habitants. Consequently, this relationship should reflect the aforementioned tourist/service oriented management of the beaches in the area.

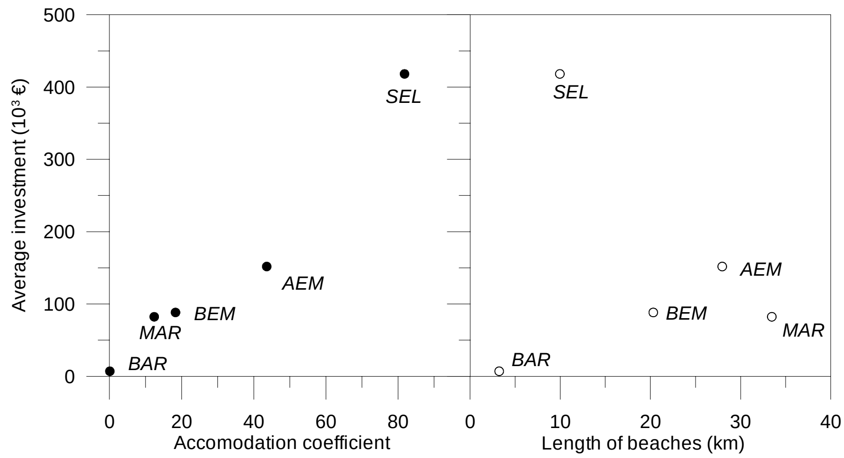


Figure 3.3.5. Comarca-averaged municipal investment vs tourist and physical indicators of each comarca.

Other issues

Emergency situations are not infrequent in the study area. These are understood to be events during which the beach is suddenly affected in a drastic manner. Results indicate that 18 % of the beaches had been closed at least once during the five-year period before completing the questionnaire. The most frequent reason for beach closure (62 %) was either failure of the sewer systems or heavy rain events, which are typical in the Mediterranean basin. Other less frequent factors for beach closure were: bomb scares, fuel pollution, a jellyfish bloom or falling cliffs. This makes weather conditions the greatest natural factor causing emergency situations.

Again, urban beaches (38.8 %) were much more likely to be closed than urbanized (5.2 %) and natural beaches (4.7 %) (Table 3.3.4.). This was mainly due to the presence of nearby sewer systems. It was also a result of street flows during storm events when the urban drainage system was badly designed or inefficient at removing surface runoff. In general, to properly manage such situations, an integral analysis of the drainage system must be carried out. Other elements associated with emergency situations are unpredictable. However, a response plan should be prepared for such events, especially if a list of probable situations becomes available.

Finally, the questionnaire included a final open question to let beach managers specify their main concerns without constraints. Most managers expressed their concerns about quality related aspects (regarding sand, water and services), followed by beach cleaning and sediment management (Figure 3.3.6.). Natural values, litter and pollution were not considered to be such important issues, although they are intrinsically important aspects.

In the area, 45.2 % of managers stated that their beaches have sensitive natural communities that are legally protected, such as dunes or seagrasses. However, only 43 % of these managers expressed their interest in the natural values of these beaches. Moreover, in the case of natural ecosystems that are not legally protected, such as rural environments around beaches, natural values were not considered a priority.

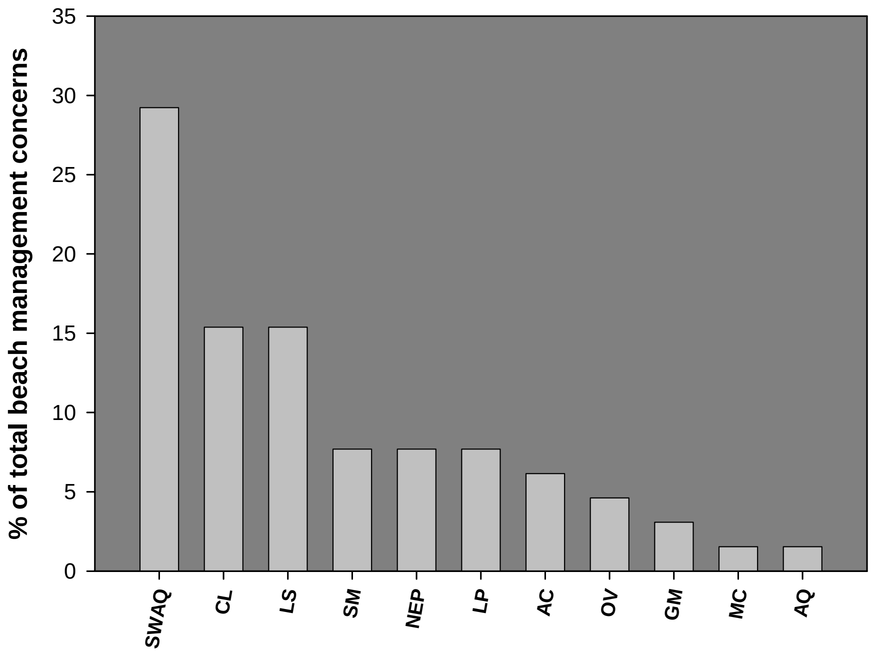


Figure 3.3.6. Other concerns expressed by beach managers. SWAQ= Sand, Water and Service Quality, CL= Cleaning of beaches, LS= Lack of Sand, SM= Sediment Movement inside beaches, NEP= Natural Ecosystem Protection, LP= Litter and Pollution, AC= Activities, OV= Overcrowding, GM= General Maintenance, MC= Managerial Conflicts and AQ= Access Quality.

3.3.5. Discussion

This paper presents the main current local administration practices for beach management. The management options are determined by the socio-economic characteristics of this area, in which tourism is the main economic sector and most municipalities depend on this activity. Therefore, the type of beach management that emerges from the analysis is recreationally oriented (the beach is considered a product/service to be offered to users and visitors). The beach use plan is the main management tool. One of the main outputs of the management plan is the delineation of the beach surface into parcels with an allocated use (e.g. the plan allows company *X* to exploit a beach surface of *x* m by *y* m to rent sun beds and umbrellas).

This is also observed in the more or less common lack of interest in managing natural (or quasi-natural) beaches, unless they are protected by an administrative figure that in some cases strictly regulates the type and intensity of uses to be permitted or promoted. Thus, for some of these beaches with natural values, the only difference in management is the intensity and number or services offered. Other natural beaches are simply not managed.

Although the managers seemed to be interested in the issue of potential overuse of beaches, it is surprising that no periodic quantitative evaluation of the level of use of the beach has been implemented by any of the municipalities. This could be associated with the fact that this is the "normal" situation for beaches with a level of use that is close to the maximum carrying capacity, and which even experience some events above saturation level. As mentioned before, some parts of this area can be considered tourist destinations that have reached the stagnation phase. This means that they have reached the peak number of visitors and capacity levels for many variables (Priestley & Mundet 1998). This implies that users of these beaches are aware of the type of beach they are visiting. Under these conditions, the manager accepts use close to saturation level as a usual and normal feature of a beach. However, this can have serious implications, which make it essential to monitor the level of use. For example, if the sub aerial surface decreases for natural or human-induced reasons, the beach could easily collapse, i.e. the beach will not properly play their functions. When referring to the recreational function an example of this situation should be the existence of an excessive number of users for the available beach surface. Moreover, due to the local administration's lack of jurisdiction for responding to such situations, unless they can predict when they will happen and ask for help from the national government in advance, there will be a lag between the appearance of the problem and the solution. This could affect the "prestige" of the beach as a tourist destination.

With respect to the last observation, it has to be stressed that the main concern of managers in this area were problems related to sediment management. This illustrates the magnitude and frequency of impacts of erosion problems on the beaches. This is in agreement with the results of the Eurosion project (Eurosion 2004), which determined that erosion was the dominant coastal behaviour along European coasts. However, this awareness reflects the main fact that erosion affects beach functions. Thus, as mentioned in the previous point, erosion affects the available surface for beach exploitation, which is a critical issue in intensive-use recreational beaches (Valdemoro & Jiménez 2006). In addition, it affects the protective function of beaches by reducing the available surface for dissipating wave energy during a storm. As a result, many promenades are commonly affected (Jiménez *et al.* 2003, Jiménez 2001). In this case, local managers have to deal with the "unexpected" results, such as promenade reconstruction, waterfront cleaning after over wash events and reparation of minor infrastructures. However, unless they are able to identify the beach's configuration before the storm season (autumn-winter) as a "risky" one, only reactive management options are possible, i.e. to repair damaged infrastructures. As in the case of use analysis, management issues related to sediment and storm-induced damages could be greatly favoured by monitoring the (physical) state of the beach.

Only 45 % of municipalities reporting long-term erosion problems had received the benefits of nourishment works. This reflects the fact that the local administration does not play a relevant part in the decision-making process. Moreover, this issue could also be conditioned by external factors, such as environmental concerns about nourishment operations. Such concerns have meant that a section of society does not have a good perception of these works. This could be a source of conflict between administrations, although it really reflects the difference in the scope of local vs. general (regional or national) approaches and interests.

The municipalities' administrative structure that is dedicated to beach management varies widely within the area of study, from a single department up to a total of four departments. In general, the number of departments involved increases with the size of the municipality (the population and beach surface). However, in many cases the distribution is due to the fact that part of the processes or services included in beach management are the same as those offered for other parts of the village, e.g. parks. Thus, with the exception of those municipalities that have specifically created department for managing beach-related issues, those that share the responsibilities for beaches among several departments lack a figure for beach coordination.

In spite of this, it seems that the usual policy in most municipalities in the study area is to implicitly follow the management guidelines recommended by the Blue Flag award. This is because the users perceive this award as a beach quality index. In fact, every year at the beginning of the season there is detailed coverage in the mass media about the number of beaches and ports given awards along the Spanish coast. This could be acceptable for recreationally oriented beaches. However, since this award does not cover natural and other values of beaches of la Costa Brava, no external guidelines can be followed in these areas.

As mentioned before, local administrations' public investment in the area's beaches seems to reflect tourist oriented beach management. If the budgets given in Table 3.3.3. are combined for each *comarca*, the cumulative values reinforce this idea. Thus, Figure 3.3.7. shows a better-defined relationship between investment and the importance of the tourist sector, measured in terms of the number of hotel beds. If we remove the values obtained for the Alt Empordà (AEM), we can establish that the average annual public investment in beaches in these *comarcas* as a function of tourism is around €30/hotel bed. The values for AEM are about 2.5 times higher than this investment. This high figure is mainly due to the investments made in the municipality of Roses, which were up to 47.7 % of the total.

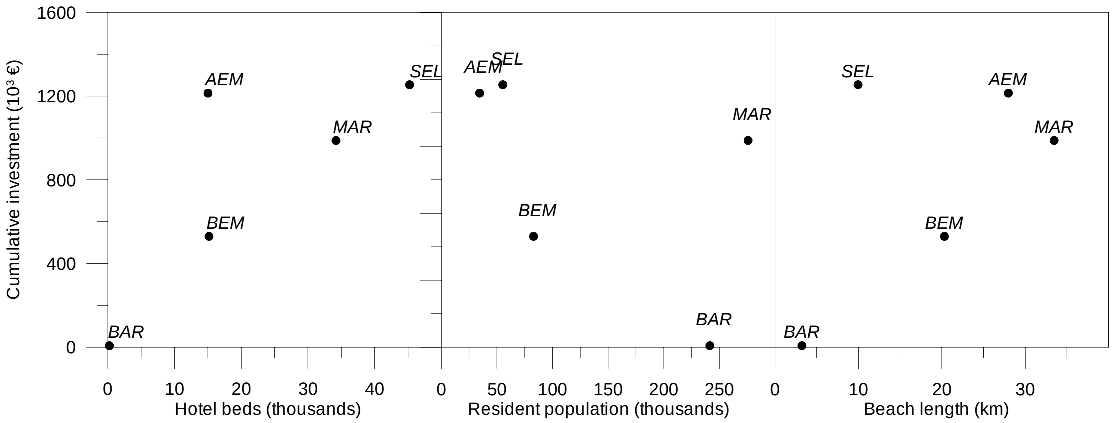


Figure 3.3.7. Comarca-cumulative municipal investment vs socio-economic and physical indicators of each comarca.

In addition, Figure 3.3.7. shows that the cumulative investment in beaches of the *comarca* is not related to the resident population or the beach length. This lack of relationship seems to indicate that public investments in the area's beaches are not guided to a great degree by local variables. Therefore, the unitary amount per bed could be used as a proxy for part of the (beach-related) public services provided for tourist activities. In this respect, this type of cost could be included in a tourist-oriented tax (e.g. Gago *et al.* 2006). However, to put this last point into context, this amount would have to be compared with the economic value of the beaches, understanding this to be the revenues associated with the presence of the beach (Houston 2002). Thus, for instance, Yepes (2004) has estimated an average revenue of 700 €/m^2 for beaches in the region of Valencia (SE Spanish Mediterranean coast).

Emergency situations that force beaches in the area to close are not infrequent. Therefore, they are an important point to consider in beach management plans. Some studies report that users drive managers' water quality related decisions about when to close/open beaches (e.g. Turbow *et al.* 2002). The government of Catalonia's regional administration is increasing dedicated to planning response strategies to emergencies, such as the CamCat (Contingency Plan for Marine Pollution) and the InunCat (Special Emergency Flood Plan). These plans can be used as general frameworks for integrating responses to these events in beaches.

Finally, the persistence of many of the problems that local managers have to face seems to indicate that the actual beach management strategies are not adequate in the study area. One of the most important issues to be solved is how to efficiently integrate the different jurisdictions of the administrations governing the beach. This is related to the fact that it is necessary to reduce the mismatch between receiving the impact of any management (or lack of) and the management capacity (or lack of) that municipalities currently experience.

In addition, the existence of some natural or quasi-natural beaches in the study area should be explicitly reflected in the management approach. These beaches should be managed in a differentiated manner. The most promising approach should be that based on the principles of ecosystem management (James 2000-b and Pirot *et al.* 2000). This approach has recently been included within the recommended guidelines for ICZM at the World Summit on Sustainable Development (Johannesburg, August 26-September 4, 2002). It requires a strong organizational structure. In this respect, Environmental Management Systems are currently being implemented to manage beaches. These include systems such as EMAS, which use the main points in ecosystem management, including data collection, monitoring, interagency cooperation, adaptive management, humans embedded in nature and values. An adaptation of the current product/service oriented beach management is not likely to be appropriate for natural beaches. In contrast, if the ecosystem approach is adopted, it is flexible enough to be applied to any beach.

3.4. CONCLUSIONS

The study of local needs of beach management in the Catalan coast have revealed the existence of important problems to be solved; those deficiencies have not been detected or sufficiently considered by studied performance assessment measurements. a) Some of those factors can be considered: lack of coordination is a persisting factor that affects importantly many components of beach quality; sediment management is the most evident example. No clear proactive planning measures exist to diminish the effect of wave energy, in spite of the fact that problems appear repeatedly and reactive measures need to be applied from time to time b) beach crowding or high frequency of beach closures are other problematic situations that occur in the area and they are not enough covered by Performance standards and/or rating systems c) The management of the natural components of beaches such as dune systems and fragile habitats are not one of the most important concerns of local managers. Due to the fact that performance assessment measurements do not account in depth for natural community of beaches, managers do not have available indicators to tightly assess the state of the ecosystem.

Established performance standards along with legal requirements have been driving the efforts of beach managers during last years. Sand, water and service quality were the most important concerns for them. Probably, if new beach management tools (measuring integral quality robustly) were established and used, managers would also consider other beach aspects.

The fact that problems detected are common for many municipalities and persistent in time, suggests that a new focus should be developed. The new focus should move beyond performance assessment measurements. Requirements established for the ecosystem management approach may probably help in preventing trouble and finding definitive solution to weak aspects of management. The implementation of proactive planning, quantification of resources needed, identification of human impacts and complete monitoring (by an adequate set of indicators that cover most important beach processes) would be very useful for beach management of the area.

Weaknesses of beach performance standards and rating systems have been clearly identified. It does not exist a set of standardised indicators that allow local managers to monitor all important beach processes. Without them it is not possible to adapt practices to necessities and to anticipate or reduce time of response when impacts occur. Combination of a proper set of indicators and EMSBs constitutes a very important step towards the establishment of a proactive management framework. Indicators can be partially adapted from analysed assessment measurement. Some of them however, should be newly developed. They should allow monitoring problematic aspects (sediment, use, emergency and natural issues) and precise and continuous quantification of quality of processes. They should also permit evaluating existence of steady improvement whenever it is required, and defining needed economic investment for each particular beach.

Chapter IV
Study of Environmental Significant Processes of North-Western Mediterranean Beaches

4.1. INTRODUCTION

In beach management as implemented to date, not all aspects have been considered to the same degree in legal/administrative requirements and by managers. The clearest example is water quality. The bathing water directive 76/160/EC establishes specific requirements in regard to methods and standards for assessing microbiological and water quality and other parameters (colour, tar, transparency) for European beaches. Assessment is made weekly during the summer season. The urban wastewater directive 91/271/CEE also establishes criteria for beaches, defining as it does standards for urban and industrial discharges. The water framework directive 2000/60/CEE also regulates beach management, by defining requirements for ensuring the ecological quality of water masses.

The definition of environmentally significant aspects of beach management is clearly related to the characteristics of the area. This section of the thesis reviews geographic, socioeconomic, physical and natural aspects of the studied area and its beaches. This analysis, along with conclusions obtained from the previous section (3.4) led to the definition of the information necessary for monitoring beach quality, and also enabled definition of evaluation criteria for urban and urbanised beaches in the North-Western Mediterranean area. Information can be obtained by specifically monitoring defined factors, or, when processes are changeable and complex, by a general analysis of patterns and variations over time and between beaches.

Two processes are considered in detail in this section: waste and litter dynamics, and beach use. No previous analysis has been made of these processes for the studied area. An analysis of this kind is essential for establishing the quality of beaches but also to improve understanding of existing problems and to improve management practices. If beaches are to be proactively managed, the numbers and activities of users must be monitored, the data studied and the relevant information included in beach management frameworks.

4.2. GENERAL CHARACTERISTICS OF THE STUDY SITE

4.2.1. Geographic and socioeconomic features

The study site is located on the Costa Brava (on the North-Western Mediterranean coast), which is characterised by its abrupt forms and the irregular profile of the coastline. Small pocket beaches and cliffs are abundant, although larger beaches are also to be found in some flatter areas in Alt Empordà, Baix Empordà, or—more isolated—in La Selva. There are also areas of salt marshes and agriculture. During the last 50 years land use has changed drastically in the region. The surfaced area has increased remarkably during this period (Martí 2005). Towns are distributed sparsely throughout the area, sometimes in compact areas and sometimes isolated from other human settlements. The area is classified as a seminatural area in the Environmental Homogeneous Management Units classification (Brenner *et al*. 2006). Climatic regime is typically Mediterranean, with a cold winter characterised by low rainfall, and a warm summer that coincides with the dry period. Rainfall volumes of 700 mm are typical in the area.

The primary sector (agriculture and fisheries) was traditionally the most important economic activity in the region. During the latter part of the 20th century, industrial activity drove economic development on the Costa Brava. The tourism sector started developing from the 1960s, eventually achieving the significance it now entails for the region, which is, by now, very dependent on tourism activity. In a subsequent phase, tourist activity triggered the development of the construction sector. Traditional tourism has mainly been overtaken by residential tourism (tourism by second home users). The current rate of construction of second homes has led to a degradation of nature and landscapes. The structure of the territory and flows within it have been greatly modified by the sun-sea-and-sand tourism model, which is in turn affected by a strong seasonal element, with very different conditions during and outside the bathing season.

4.2.2. Decription of beaches in the study area

Although a sector comprising 40 municipalities was selected to analyse local needs (Figure 3.3.1.), most of the research was concentrated in the area of La Selva, located in the southern part of the Costa Brava, and the municipality of Malgrat de Mar, located in the area of El Maresme (Figure 3.2.2., Figure 4.4.1. and Figure 5.3.1.).

The coastal area of La Selva includes three coastal municipalities: Blanes, Lloret de Mar, and Tossa de Mar. Towards the north in the municipality of Blanes, the first beach is S'Abanell, which has, as its southern limit, the mouth of the Tordera River, and, as its northern limit, the rock of La Palomera. Northwards there is Blanes beach, located in the centre of the town. Starting from this point there is an area of cliffs and streams, very characteristic of the Costa Brava. Beaches are found at the mouth of streams that go to the sea following the fracture lines of rock masses. The Punta de Santa Anna, Cala Sant Francesc and Treumal are pocket beaches in Blanes. The border between the municipalities of Blanes and Lloret de Mar is the southern limit of the Santa Cristina beach. The beaches of Santa Cristina and La Boadella are typical beaches of this area. Towards the north there are residential housing estates in the Santa Cristina and Serrallarga areas and along the coast on Fenals beach. After Fenals, there is Cala Banys. Northwards is the beach of Lloret Centre, located in urban core of Lloret de Mar. After Lloret de Mar there are new housing schemes, including Canyelles, located by Canyelles beach, which has a recreational port bordered to the north by Cala Morisca. Cala Morisca is located on the border between the municipalities of Lloret de Mar and Tossa de Mar. Towards the north there is an area of cliff and the beaches of Santa Maria de Llorell and

Llevadó, with campsites and housing estates. Northwards, there is the urban core of Tossa de Mar, to the north of which are other pocket beaches as Cala Bona, Pola, Giverola and Salionç, whose surrounding areas were urbanised during the 1960s.

These beaches are composed of sediments coming from nearby mountains. There is no longitudinal transport of sediments between beaches in the area, as the headlands act as barriers that block the passage of sediments. Sand grain size is basically coarse to very coarse (d50 over 0.50 mm) and the beaches are mostly reflective. Since being colonised by humans, large areas of the coast have been extended as a consequence of active sedimentation. Some sources, however, suggest that sediment dynamics are nowadays regressive. Wave patterns affecting the area mainly follow an E-SSW direction. Storms coming in from the east and south occur during the year and frequently cause damage to facilities in the backbeach area (Ajuntament de Lloret de Mar 2002).

4.2.3. Natural characteristics of beaches

Beach ecology has been intensively studied in many parts of the world. It is dependent on sediment parameters, wave climate, winds and tides, morphodynamic states, exposure, supralittoral characteristics, nearby rocks and other relevant features (Brown & Mc Lachlan 1990). Abundance and diversity of organisms increase with finer sand and smaller slopes. In general, it is considered that the characteristics of beach communities depend on many parameters, among them grain size and wave action. As in other areas in the Mediterranean coastal zone, there are still many aspects that have not been studied.

Studies carried out on sand zonation have clearly identified three different biological areas: the supralittoral area, the intertidal area, and the submerged area (McLachlan & Jaramillo 1995, Janssen & Mulder 2005). Communities also tend to vary according to the particular characteristics of an area. Interactions such as competition, microclimate conditions, and nutrition also play a role in defining zonation (Colombini *et al.* 2002, Dugan *et al.* 2004, Janssen & Mulder 2005). In the emerged part, the backbeach is influenced by its immediate environment. Dune systems are common in many areas, mainly populated by halophyte plants and terrestrial insects. Some pocket beaches in the area of La Selva have a characteristic *Crithmo-Limonium* community located on the cliffs of the backbeach, with its own vegetation and organisms. In the urban beaches, the emerged portion of the beach is constituted of sand with very little vegetation and a low diversity of fauna. Of the studied area, Malgrat Nord is the beach with the most developed dune system.

Some of the research into natural communities established on beaches has been conducted on arthropod species in the supralittoral area. These studies have analysed diversity and zonation of hexapods in coastal areas. Space partitioning has been detected among burrowed organisms (Jaramillo *et al.* 2003) and distribution has been shown to be dependent on microclimate and nutrition conditions (Colombini *et al.* 2002). Tenebrionid behavioural responses to environmental conditions and their exploitation of chemical and physical gradients (Aloia *et al.* 1999) have also been analysed. In a study in Portugal, Abrantes *et al.* (2002) found that soil microarthropod diversity and equitability were more affected by environmental factors than by anthropogenic factors.

A recent analysis of sand community hexapods has revealed that collembolans are the main group in some beaches in the area of study. A systematic analysis of all the organisms found on the studied beaches distinguished 15 species of collembolans in the area, of which three were considered new species (and so will be fully described). Two of the new species belong to the genus *Archisotoma* and the third to the genus *Lepidocyrtus*.

In addition, *Anuridella calcarata* was found for the first time in Spain and in the Mediterranean, as also *Seira ferrarii*.

For two beaches in the area—Santa Cristina and S'Abanell (Figure 4.2.1.)—the abundance of the different species of collembolans over an entire year was also assessed. *Archisotoma interstitialis* was the dominant species in Santa Cristina and one of the new *Archisotoma* species in S'Abanell.

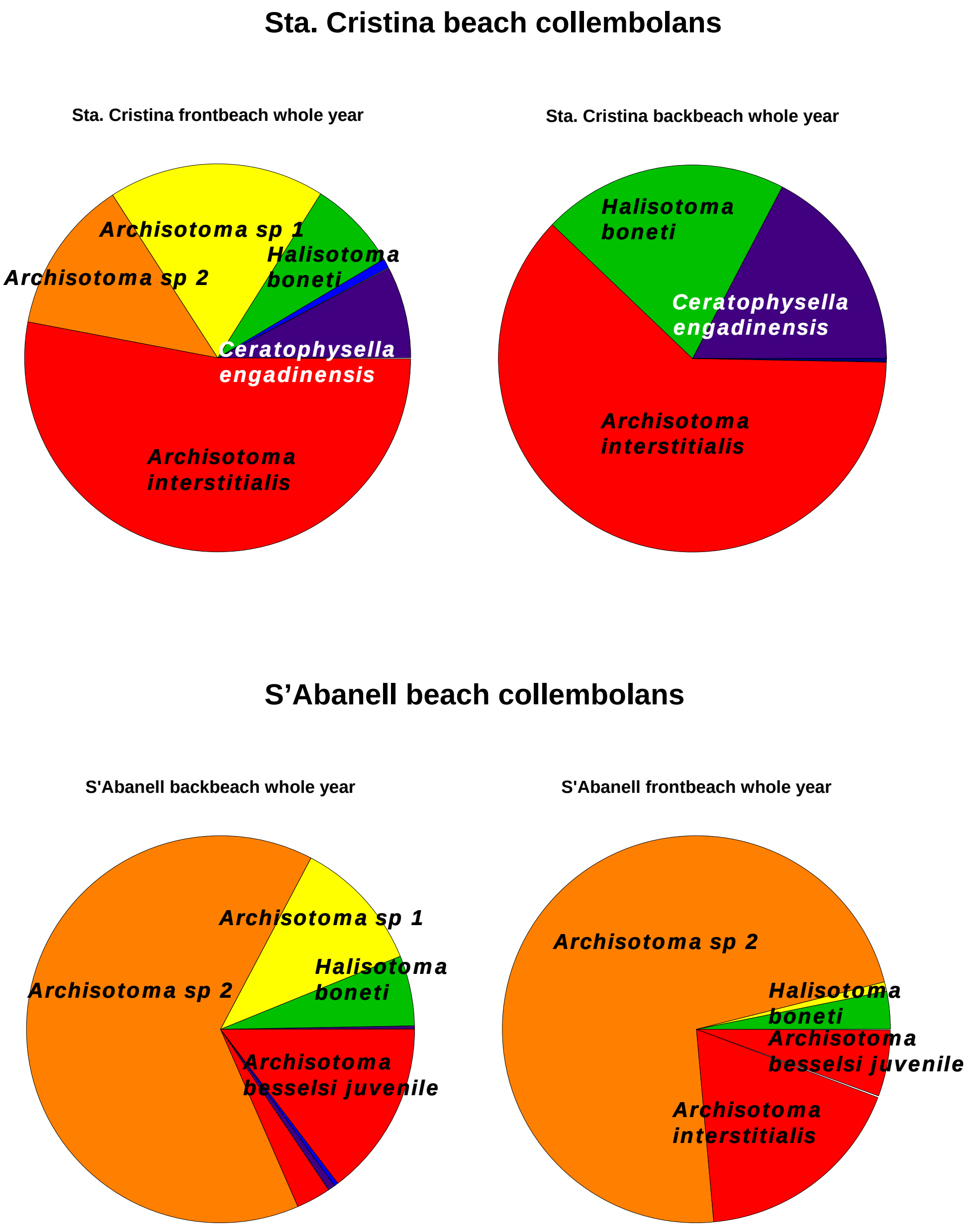


Figure. 4.2.1. Abundance (in %) of the different species of collembolans found on the beaches of S'Abanell and Santa Cristina over an entire year (December 2003-December 2004).

In the intertidal zone, the macrotidal beach distribution of organisms is basically defined by tidal range. The intertidal community is much larger in tidal beaches compared to non-tidal beaches. In the study area, the intertidal area is very limited. No studies have been conducted of these communities, although some studies of macrofauna have been carried out on Mediterranean beaches.

Many beach ecology studies have concentrated on wrack deposition (Polis & Hurd 1996, Colombini *et al.* 2000, Colombini *et al.* 2003, Jedrzejczak 2002, Dugan *et al.* 2003, Orr *et al.* 2005), especially the quantification of wrack deposition rates and composition. The influence of wrack deposits on beach communities has been demonstrated to be very important. The succession of wrack decomposition organisms has also been described. In the area of study, the community feeding on wrack may not be well developed because wrack is periodically withdrawn in cleaning operations.

Other research into beach ecology has concentrated on the value of certain species as indicators of beach quality. The sand hopper *Talitrus saltator* has been considered a good indicator of tourism pressure (Fanini *et al.* 2005) and Ketmaier *et al.* has concluded that talitrid population genetics is also affected by human impact (2003). In a study of diversity composition and zonation of beach meiofauna, Gheskiere *et al.* (2005) has pointed out the value of the nematode community as an indicator of human impact. However, for the study site, no species were detected as being indicators of beach quality.

The consequences of human trampling of macrofauna have also been evaluated. It has been found that few members of the macrofauna are affected at low trampling intensities but substantial damage occurs from intense trampling (Moffet *et al.* 1998). Costa Brava beaches undergo intense trampling activity by beach users in summer. The human impact of mechanical cleaning also has a significant effect on beaches, although this has not as yet been quantified.

In the submerged part of the beach, sand remains permanently water saturated. In general two parts may be distinguished: the surf area, which extends from the shoreline to the point where waves break (an important area of turbulence); and an area that extends from the surf zone to the point of closure depth, where wave action is limited for most of the year. It is estimated that beach closure depth is approximately located at 7 m in Mediterranean beaches. Different organisms live in these areas, depending on nutritional necessities and strategies to overcome the effects of wave energy. In the submerged part, the community of the study site is mainly composed of crustaceans, mollusks and polychaetes.

Two other communities need to be considered on analysed beaches: rock (supra- medio- and infra-littoral) communities, and stream communities. In many beaches, there is a well-established rocky community that is affected by human activity (Ballesteros 1992). The collection by beach users of organisms living on rocks is a common practice in the area. Almost every beach in the region has a stream entering the sea. The stream communities have suffered different impacts due to massive urbanisation of their environments, and have been invaded by many species of allochthonous flora. These communities also frequently suffer the effects of poor water quality and of organic and inorganic waste transported by water.

Natural beach communities are taken account of in management only when nature areas are legally protected (Ariza *et al.* in press-b). In our studied area, two areas classified as protected under the PEIN (*Pla d'Espais d'Interès Natural*) include beaches. These areas are: a) The Massís de Cadiretes, which includes the beaches of Vallpresona, Cala Salionç, Sa Futadera, Cala Giverola, Cala Pola and Cala Bona, located to the north of

Tossa de Mar; and b) the area of Pinya de Rosa, on the border between Blanes and Lloret de Mar, and including the beach of Treumal-Santa Cristina.

4.3. SEASONAL EVOLUTION OF BEACH WASTE AND LITTER DURING THE BATHING SEASON ON THE CATALAN COAST[1]

4.3.1. Introduction

The amount of waste produced is currently a matter of great concern in developed countries, and waste management has been considered one of the most important environmental problems affecting the members of the European Union (Stanners & Bordeau 1995, EEA 2005). The EU's Sixth Environment Action Programme identifies waste prevention and management as one of its four top priorities. Between 1995 and 2003, the amount of municipal waste generated in Western Europe increased by 22%. If current patterns are not altered, by 2020 we may be generating 45% more waste than we did in 1995. Although some countries have fulfilled the requirements established by Directive 94/62/EC on Packaging and Packaging Waste, the amount of packaging waste is still increasing. Furthermore, our "throwaway" ethos frequently transforms waste into litter (Cutter *et al.* 1991), which is increasingly accumulating in many previously unpolluted natural environments.

The deterioration of the environmental quality of coastal areas as a consequence of human activity is a problem that has been recognized worldwide. Overcrowding coastal areas has brought about a sharp increase in waste production in coastal towns (Clark 1983, Mora 2004). As a result of the tourist industry in coastal areas of the Mediterranean regions of Europe, waste production is much higher in summer than during the rest of the year. This variability sometimes makes it difficult to establish proper waste management programmes and facilities aimed at prevention and recycling.

Besides the technical data obtained from the administrative agencies responsible for beach management (e.g. Servei de Prevenció i Medi Ambient 2005), few studies have been made on waste cycles in coastal areas and on beaches. Research on waste components and fluxes has recently been carried out in some urban areas (Tinmaz & Demir 2006, Henry *et al.* 2006) and in tourist resorts (Kuniyal *et al.* 2003). Other waste management research has dealt with consumers' habits and attitudes (Junquera *et al.* 2001).

A number of studies have quantified beach litter and defined its components (Gabrieliades *et al.* 1991, Moore *et al.* 2001, Silva-Iñiguez & Fischer 2003, Rodríguez-Santos *et al.* 2005). Studies on the seasonal variation of litter during the summer season (Frost & Cullen 1997, Somerville *et al.* 2003, Claereboudt 2004) or over the whole year have been made (Golik & Gertner 1992). Long-term litter accumulation trends have been established (Willoughby *et al.* 1997, Uneputty & Evans 1997, Velander & Mocogni 1998, Edyvane *et al.* 2004). Litter burial and exhumation have also been studied (Williams & Tudor 2001). Other related research projects have covered methods for surveying litter (Ribic & Ganio 1996, Velander & Mocogny 1999). The accumulation of plastic in maritime environments has been detected (Thompson *et al.* 2004) and the economic impact of pollution events has been established (Ofiara & Brown 1999, Balance *et al.* 2000). Nevertheless, there are still important misunderstandings in the assessment and management of litter in the beach environments.

Despite the extensive literature, the dynamics in the production and the management of waste and litter over the summer season have not been accurately quantified. Sampling has not been intensively undertaken during the bathing season and the efficiency of

[1] Edited version of the manuscript *Seasonal Evolution of Beach Waste and Llitter during the Bathing Season on the Catalan Coast* by E Ariza, JA Jiménez and R Sardá, submitted to *Waste Management*.

beach management litter removal practices has not been assessed. The amount of waste and litter production in proportion to total municipal waste is unknown. Differences in waste and litter production according to beach types have not been established, and the possibility of separating and recycling waste on beaches has not been widely covered.

Within this context, the main aim of this paper is to analyse the seasonal evolution of waste and litter on beaches during the bathing season on a coast subject to mass tourism. Our aim is to improve waste and litter management given that the factors responsible for this evolution have been identified. Although the paper uses Catalan beaches in northeast Spain to illustrate the processes analysed, the results and approach can be extrapolated to beaches used for similar purposes and under similar management schemes.

4.3.2. Methods

Study area

Our study analyses beaches in three towns of the southern Costa Brava (Girona, Spain), which offers a variety of beach types ranging from highly urban ones to urbanized ones and representing the different ways in which beaches are used. From south to north, these towns are Blanes, Lloret de Mar, and Tossa de Mar. To varying degrees, as is commonplace in other tourist resorts, these towns have suffered over the last decades from the effect of a high concentration of tourists eager to find environments conducive to spending their leisure time. The quantity, composition and characteristics of beach waste were assessed on two urban beaches (Lloret Centre beach and Tossa-Mar Menuda beach) and two urbanized beaches (St. Francesc beach and Sta. Cristina beach). For a detailed description of the beaches of the area, see Sardá *et al.* (in review).

The use of these highly frequented beaches was analysed to determine increases in the number of tourists and possible beach overcrowding problems (Sardá *et al.* in review). These problems occur because most beach use tends to be concentrated between 12 a.m. and 5 p.m. Although beaches cannot be said to be permanently overcrowded, at the peak of the bathing season they reach saturation levels (5 m^2/user in the urban beaches of Lloret and Tossa and 10m^2/user in the urbanized beaches of Sta. Cristina and St. Francesc; Sardá *et al.* in review, Alemany 1984). The highest usage of these beaches as well as most of the Mediterranean coast occurs in July and August (Yepes 2002).

Waste and litter characterization

During the bathing season, the beaches studied were subject to a daily mechanical cleaning and waste withdrawal programme. The garbage bins on all the beaches studied were sampled weekly from July 28 to September 15, 2004. Three garbage bags were collected and analysed on every sampling day. The garbage bags were weighed and separated according to their components. Based on a previous sampling design (own data unpublished), it was found that the waste contained in the three bags showed a consistent composition. Withdrawal was undertaken between 4 and 5 p.m. as this was when the full bags were replaced by the beach cleaning service.

Waste was sorted into the following four categories: a) plastic, wrapping and beverage containers; b) paper; c) glass; and d) organic and other miscellaneous waste. The total amount of waste generated on each beach was obtained after establishing the number of bins on each beach and the frequency of garbage withdrawal at any given time over the summer season.

In order to assess the aesthetic quality of the beaches, we used the rating protocol followed by the personnel from the ACA (Catalan Water Agency). The ACA took qualitative samples from 18 beaches in the area (12 urban and 6 urbanized beaches). In order to detect sudden, short-term changes, beaches were visited at least once a week from May 26 to September 5. Most beaches were visited twice or three times a week. Sampling was based on a visual analysis of water and sand litter. Visual analysis has been considered in other studies on litter (Cutter *et al.* 1991). Water litter assessment included a qualitative score ranging from 1 to 5, based on the overall aspect of the water and follows the administrative procedure established by the ACA. In addition, the presence and abundance of litter components such as oil, foam, tar, human-generated litter, terrestrial and marine vegetation, and jellyfish were recorded each day. Sand assessment was carried out by a comprehensive inspection of beach surfaces. It also included an overall qualitative score and an analysis of litter components (tar, beachgoer's litter, human-generated litter, terrestrial and marine vegetation, and jellyfish).

Because of the importance of small items of litter such as cigarette butts in beach user perception, a specific survey was designed to characterize their evolution over the bathing season. In order to assess the dynamics of these litter items, the beach of Lloret Centre was sampled three times over the summer of 2005 (early July, mid-August and mid-September). Twenty squares measuring 1 m^2 were randomly distributed and sampled on the surface of the beach, which had been previously mechanically cleaned. This is considered a suitable method for surveying litter (Velander & Mocogni 1999). Samples were taken between 7.30 and 9 a.m. before the daily arrival of beach users. Cigarette butts were counted and the total amount of litter collected in each square was weighed. The efficiency of mechanical cleaning was also quantified by sampling the litter withdrawn by mechanical cleaners at the time the beach samples were taken. A representative sample was taken from the total amount of litter collected by the beach trotters. The litter content was sorted by weight into 5 categories: a) plastic, wrapping and beverage containers, b) glass, c) sand, d) cigarette butts, and e) miscellaneous litter. Cigarette butts were also counted. By extrapolation, the total amount of litter collected from the beaches was obtained.

4.3.3. Results

Beach waste evolution and composition

Due to the fact that the urban beaches were bigger and received more users, the total production of waste on them was higher than on urbanized beaches. The maximum period of production was obtained during the first fortnight of August for all the beaches except for Gran de Tossa-Mar Menuda beach, where production was highest in the second fortnight of August. The total amount of waste on all the beaches was similar from the end of July to the end of August but declined sharply at the beginning of September (Figure 4.3.1.). The waste taken from beach surfaces was clearly higher on urban than on urbanized beaches (Figure 4.3.1.). The highest amount of waste collected per square metre was from Tossa-Mar Menuda beach, whereas that of Sta. Cristina was the lowest.

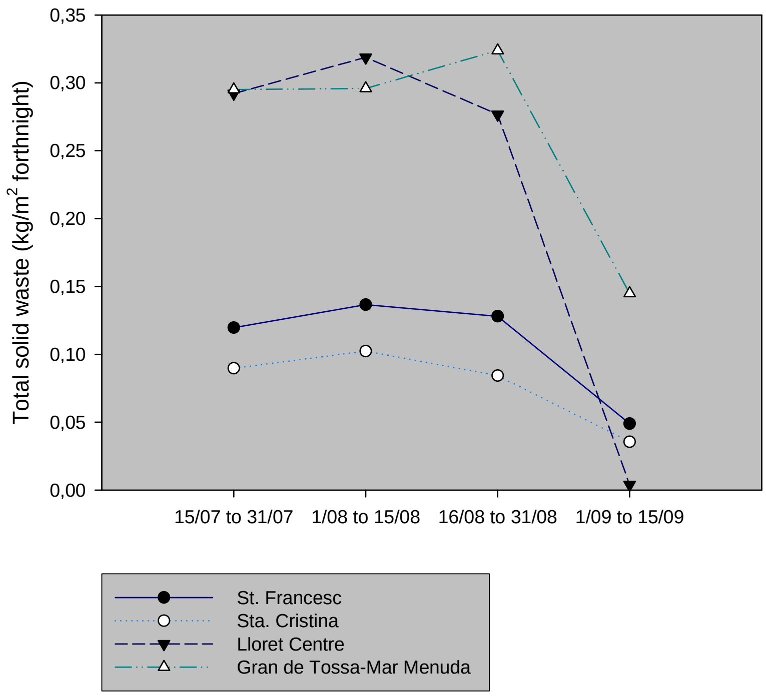


Figure 4.3.1. Seasonal evolution of the amount of produced solid waste/m^2 of Selva Marítima beaches during the 2004 summer season.

In August, two of the beaches studied (Gran de Tossa and Lloret beaches) were compared to assess the amount of waste generated per beach user in kilograms daily. At Gran de Tossa the values were 0.066 kg/user day (August 1-15) and 0.062 kg/user day (August 16-31), and at Lloret Centre they were 0.068 kg/user day (August 1-15) and 0.054 kg/user day (August 16-31) (Figure 4.3.2.).

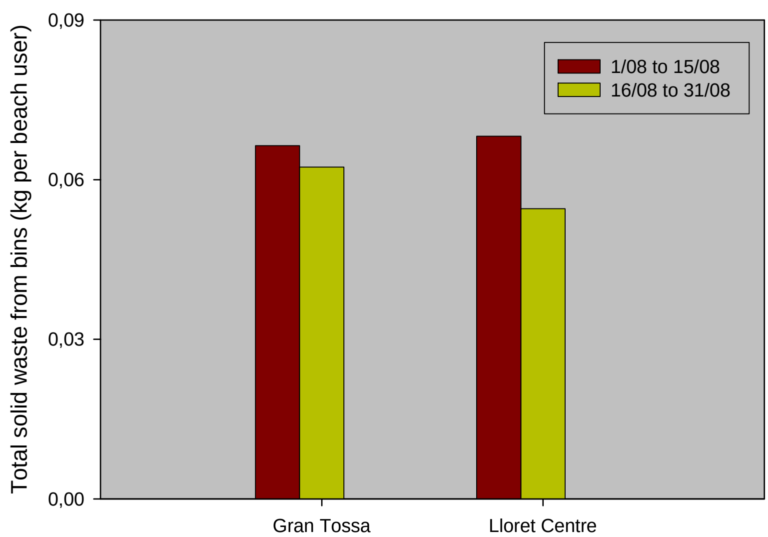


Figure 4.3.2. Waste/user ratio of Selva Marítima beaches during the 2004 summer season.

Waste composition varied over time and space (Figure 4.3.3.). The highest proportion of plastic, wrapping and beverage containers was found at the peak of the season, when the proportion of organic and other miscellaneous waste was at its lowest. The greatest difference between the two kinds of waste measured was found on urbanized beaches, whereas urban ones showed similar quantities for the two categories (Figure 4.3.3.). As the season advanced, the two components showed a divergent behaviour, with an increasing proportion of domestic waste and a decrease in plastic and wrapping.

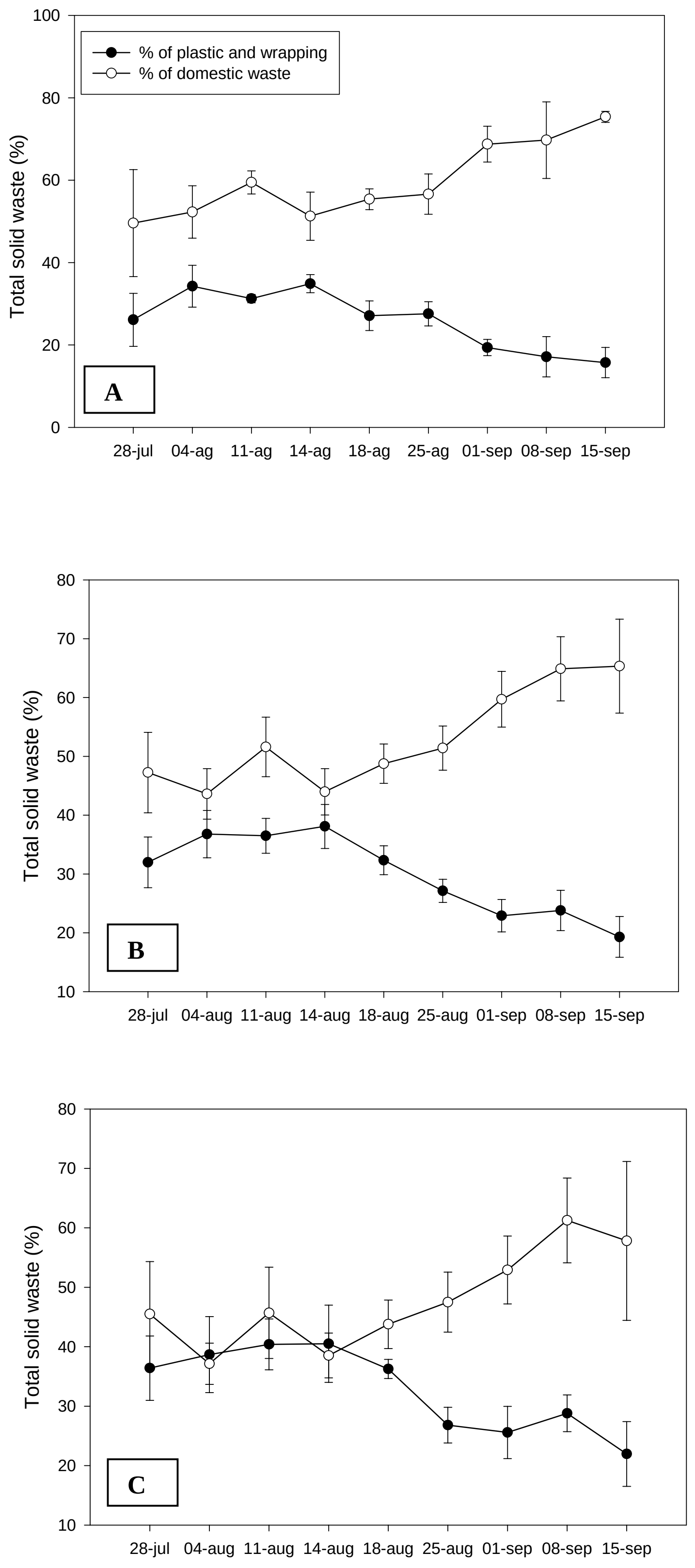


Figure 4.3.3. Evolution in the percentage of main litter constituents during summer season of 2004. A) Urbanized beaches B) All beaches C) Urban beaches.

The mean values for each waste component in August are shown in Figure 4.3.4. Most beaches had a similar composition of waste, which, in ascending order, was as follows: (1) organic, domestic and miscellaneous waste; (2) plastic, wrapping and beverage containers; (3) glass; and (4) paper. The only exception was Lloret Centre, where the two most frequently found components had similar percentages. Moreover, the quantity of glass registered on this beach was much higher than on the other beaches and of the same order of magnitude as the most common components.

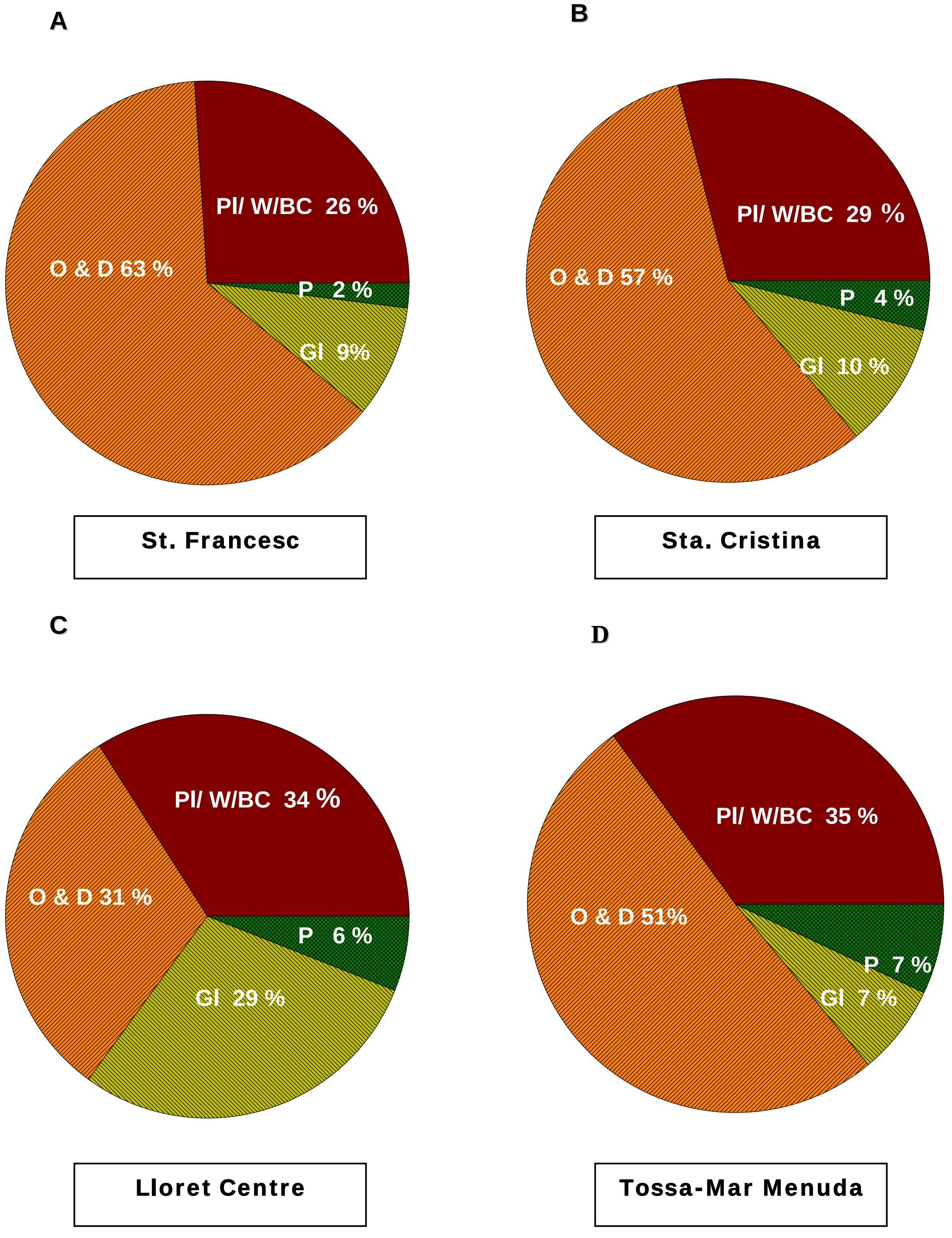


Figure 4.3.4. Waste components (in weight) of the beaches of Selva marítima in august 2004. Data are mean percentage values. Waste components abbreviations: O & M, Organic and Miscellaneous waste; Pl/W/BC, Plastic/wrapping and beverage containers; P, Paper; Gl, Glass. A) St. Francesc. B) Sta. Cristina. C) Lloret Centre. D) Gran de Tossa-Mar Menuda.

Beach litter and aesthetic quality

The average aesthetic quality as measured by ACA personnel is shown in Figure 4.3.5. The rated values were always very good, not falling below 4.4 on the scale of 1 to 5. Visual quality did not depend on wave height and direction. Variations in wave height were not significant over the summer season (just 15 cm) and absolute wave height values were low, which is typical of summer season dynamics.

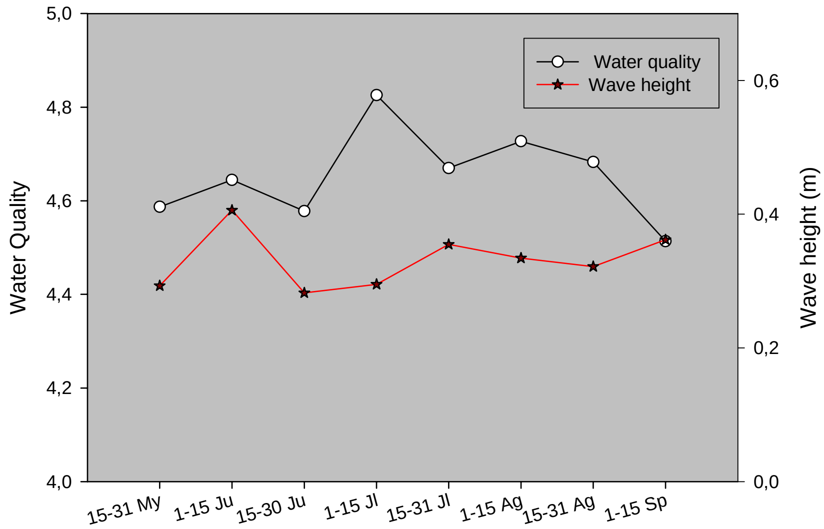


Figure 4.3.5. Evolution of water aesthetic quality in relation to wavelength.

The visual quality of water and sand was better on urbanized beaches than on urban beaches (Figure 4.3.6.), the greatest differences being found in the sand. Sand quality increased significantly at the beginning of the bathing season, remaining constant thereafter until the end of the season. The variation observed in water quality during the summer season was moderate, being no greater than 0.3 in a range of 1 to 5.

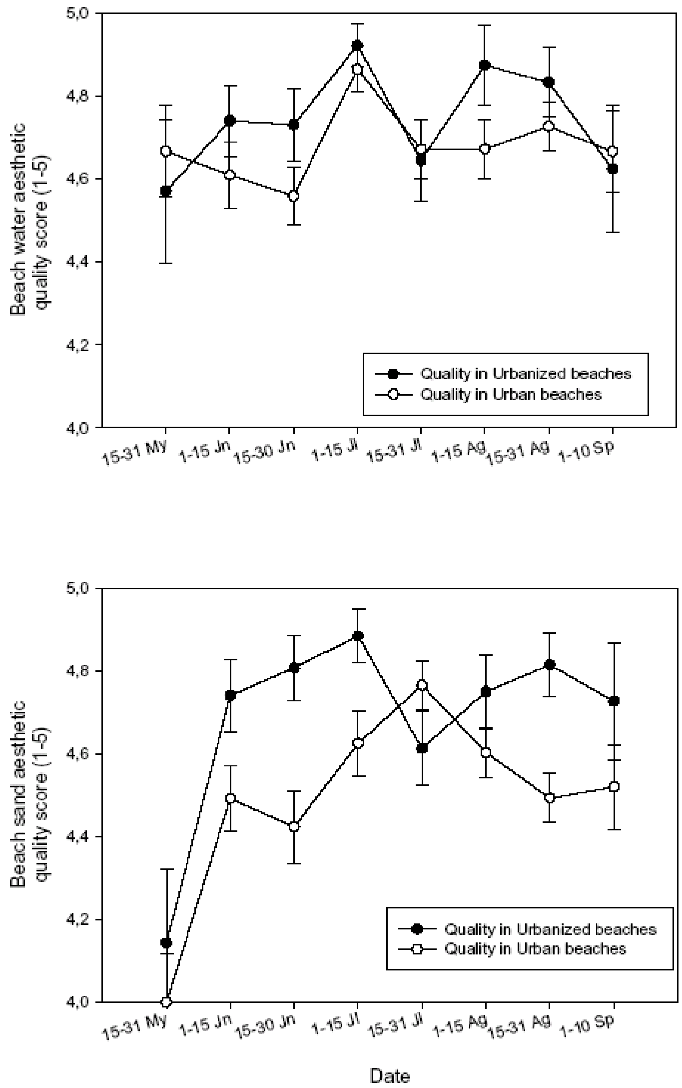


Figure 4.3.6. Evolution of scores of sand and water aesthetic quality of Selva marítima beaches in urban and urbanized beaches. Rating score goes between 1-5.

Small size litter dynamics

Small items of litter on beaches tended to accumulate towards the peak of the summer season (Figure 4.3.7.). The weight of litter was 1.3 gr/m^2 at the beginning of July, increasing to 4.8 gr/m^2 in mid-August and decreasing to 4 gr/m^2 in mid-September. During the season, the number of cigarette butts collected in samples mirrored the general weight pattern: 2.2 unit/m^2 in the first sampling, 3.5 in the second and 2.5 unit/m^2 in the last.

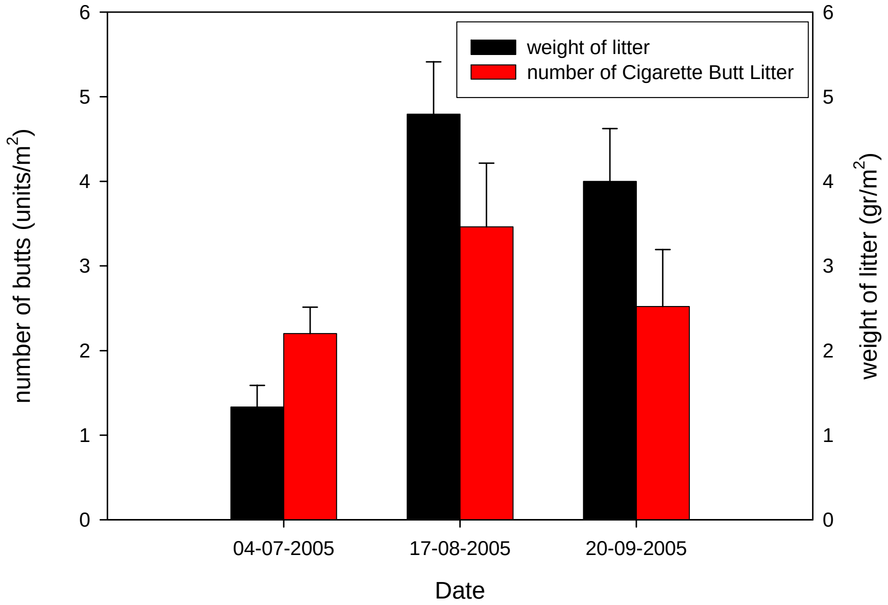


Figure 4.3.7. Evolution of the small size litter of the beach of Lloret Centre during the summer season of 2005.

The accumulation of litter during the bathing season is due to the low efficiency of the daily mechanical cleaning procedure for collecting small-sized litter, particularly cigarette butts. Daily cleaning was only able to deal with the daily production of litter when the number of beach users decreased. A calculation was made of the number of cigarette butts remaining after mechanical cleaning on the area of the beach regularly cleaned by the trotter. This area covered 22.580 m^2 and accounted for approximately 40% of the total beach surface. The total amount of cigarette butts calculated for this area was 49,677 units in early July and 78,128 units in mid-August. The efficiency of mechanical cleaning for cigarette butts was 4.40 % at the beginning of July and 14.4 % in mid-August. When the overall weight of small items of litter was considered, efficiency increased to 87% at the beginning of July and to 29% in mid-August. Mechanical cleaning is less effective for withdrawing cigarette butts than general small-sized litter. A further fact for consideration is that during the daily mechanical cleaning procedure on Lloret Centre beach, an extremely high proportion of the material collected from the beach is sand, which is retained by the trotter when withdrawing small pieces of litter. In percentage terms, the weight of real litter that was collected by the machine was just 2.72 % (± 2.4) at the beginning of July, and 17.13% (± 10.99) in mid-August.

Waste and litter withdrawal

The quantification of the different components of waste and litter collected from bins and sand by the beach cleaning service is shown in Figure 4.3.8.

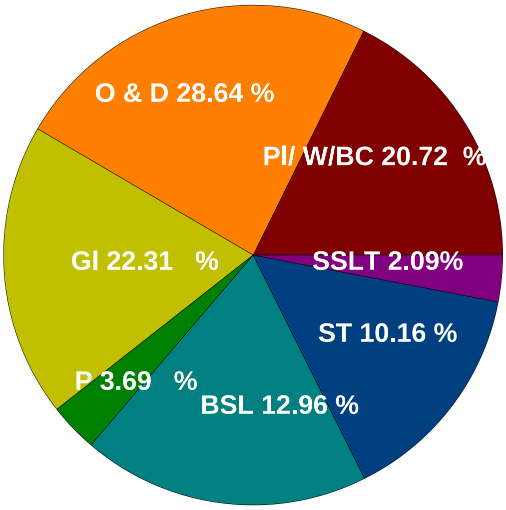


Figure 4.3.8. Average composition of the waste and litter fractions from Lloret Centre beach in August 2005. (Floatable debris and waste from stand are not included). Waste components abbreviations: Pl/W/BC, Plastic/wrapping and beverage containers; O & D, Organic and Miscellaneous waste; Gl, Glass; P, Paper; BSL, Big size Litter on sand; ST, Sand withdrawn by trotter; SSLT, Small size litter withdrawn by trotter.

This figure includes the waste and litter left by beach users. On Lloret Centre beach, the highest proportion of waste collected from bins fell into the category of organic and miscellaneous materials (28.64%), with glass waste coming in second (22%). Sand collected by mechanical cleaning also formed a significant proportion of the waste and litter withdrawn for beach management (10.16%). Table 4.3.1. shows the percentages in weight of waste and litter collected by the cleaning service on all of Lloret de Mar's beaches. These figures are expressed as a proportion of the total amount of waste collected in the town in the period June-September (15,842.6 t).

	Lloret Centre (%)	All Lloret beaches (%)
June	1.27	2.48
July	2.14	4.65
August	1.37	3.17
September	1.07	2.64
Average	1.46	3.24

Table 4.3.1. Percentage of beach waste and litter (of the beach of Lloret Centre and all Lloret beaches) of the total amount of waste collected in the municipality during summer. Waste and litter values from Lloret Centre include litter retired from trotters. Waste and litter from all beaches of the municipality do not.

Although the percentages obtained for all the beaches are somewhat short of their value in real terms, because it was impossible to determine quantities of the litter collected by mechanical cleaners for all the beaches, the amount of waste and litter from beaches was quite high. Taking 3.24 % to be the average value at this time of the year, the beaches of

Lloret de Mar (without considering litter retired by trotters) produced an amount of total solid waste of 513.3 t.

4.3.4. Discussion

The total production of waste, the components of such waste and the proportion of waste generated per square metre are related to urbanization. Urban beaches—Lloret Centre and Gran de Tossa-Mar Menuda— are generally larger and have more users than other types of beaches such as urbanized or natural beaches, and consequently, yield larger quantities of wastes. Due to the higher quantity of plastic found in urban beach waste (and the fact that this study took weight rather than volume into consideration), when quantities of waste were measured per user, there was a remarkably low proportion of waste (kg/user) collected on the beaches of Lloret Centre and Gran de Tossa. These results are in agreement with other studies carried out on other massively used beaches, such as Sant Sebastià beach in Barcelona, where 0.046 kg/user day was estimated (Declaració Ambiental de la platja de St. Sebastià 2004). This is far removed from current amounts of waste generated per user in municipalities. Due to different beach usage patterns over the summer season, the composition of waste on beaches varied throughout this period. The higher proportion of plastic, wrapping and beverage containers on urban beaches was probably a consequence of the proximity of these urban beaches to supermarkets and suppliers and the time that beachgoers spent on them.

Municipal waste generation in tourist resorts continues to grow and our studied towns showed the same tendency. Recycling procedure should be facilitated. On average, 49.4% of the total amount of waste generated on the beaches is composed of plastic, wrapping, beverage containers, glass and paper, though recyclable organic materials also make up a significant proportion of waste. If we compare the waste produced on Lloret's beaches and the total waste produced in the town, recycling beach waste would increase the total amount of waste recycled in the town by around 1%. However, these figures are far from satisfactory (e.g. the amount of packaging waste recycled in Lloret de Mar was just 5.37% in 2004, which does not even remotely approach the target of 25% for 2001, as set out in the EU Packaging Waste Directive 62/94, or 60% for 2005). There would possibly be a slight improvement in this situation if beach waste were recycled.

With regard to the aesthetic quality of larger items of litter on the sand and in the water, conditions remained constant throughout the summer season. This was probably due to the predominant fair weather conditions, which did not seem to significantly worsen water and sand conditions on the Catalan coast, as observed in a different study (Lee *et al*. 2006). The differences in the aesthetic quality of sand on urban and urbanized beaches were not clearly related to any one particular factor. Nevertheless, there was usually more litter of marine origin on urban than on urbanized beaches, which is probably related to the fact that urban beaches are longer and more exposed to wave energy than urbanized beaches. Litter from marine and terrestrial vegetation was an obvious exception. Plant communities were more frequently found in urbanized beach areas, which attracted litter more easily.

Though according to public administration criteria the general aesthetic quality of the water and sand remained constant throughout the season, small-sized litter accumulated on the sand of Lloret beach. This fact makes us very cautious about current methods used by agencies for the assessment of aesthetic quality. It must be ensured that litter assessment methods take small items of litter into consideration. Other authors have also found this kind of litter to be highly significant (Rodríguez-Santos *et al*. 2005). The decline observed in September is a consequence of the weather conditions towards the end of the summer season. Bad climatic factors affected beach use and, subsequently, litter production dropped. There was an evident accumulation of such litter throughout the summer and it was not until September, when beach usage dropped, that the amount of small items of litter found was seen to decrease noticeably. Mechanical cleaning was then able to absorb litter production rates. However, cleaning procedures at the time proved to be insufficient to absorb the litter produced during the peak season. These problems are especially evident in the case of cigarette butt withdrawal. Cleaning devices use a sieve that is unable to retain most butts, but which picks up sand from beaches. The result of this is that trotters withdraw more than 50 kg of sand per hour of work. In Barcelona (Servei de Prevenció i Medi Ambient 2005), the sand withdrawn during mechanical beach cleaning operations also accounted for a very high proportion of beach litter (80% in weight). It is highly likely that this is a general problem for mechanical beach cleaners on intensively used beaches. Reducing the size of the sieve's holes would improve litter retention, but at the same time would increase sand withdrawal. Sand withdrawal is a problem for beaches, but also for managers, because the cost of litter management increases as a result of collection, transport and disposal operations. All of the above, in addition to the impact of mechanical cleaning on sand communities (Llewellyn & Shackley 1996) and dust dispersal as a result of turning the sand over, are compelling arguments that should be taken into account in decision-making on the most suitable beach cleaning practices in coastal areas.

The quantification of the origin of waste and litter demonstrated that waste and litter management can be significantly improved. Twelve percent of waste and litter collected from the Lloret Centre beach was left on the sand by users, which had highly adverse effects on beach quality. It has been demonstrated that beach user behaviour affects the amount of litter found on beaches (Rodríguez-Santos *et al*. 2005). On the one hand, it significantly diminishes the aesthetic quality of the beaches on summer days. On the other hand, it increases the cost of beach-cleaning operations. Although no systematic sampling was undertaken in this study, a significant part of large items of litter collected from the sand (28-56%) was recyclable material that is not currently separated and is disposed of in Lloret de Mar's landfill facility. As a proportion of total municipal waste and litter, the separation of beach waste in Lloret would only consist of 0.7-0.9% of the total amount of waste produced in Lloret de Mar in July and August 2005. Efforts to improve recycling attitudes of beach users and their behaviour concerning cigarette butts left on the beach could also be seen as an educational tool that would go towards improving municipal recycling patterns outside beaches.

In conclusion, this study demonstrated that waste and litter management on Catalan beaches could be substantially improved. A specific management programme for waste and litter on beaches (including objectives and targets) could be set up, which could also take responsibility for separating and recycling beach waste. This programme could take place inside Environmental Management Systems for Beaches (Ariza *et al*. in press-a). Furthermore, litter assessment methods used by the autonomous government and litter withdrawal practices used by local organizations in special mechanical cleaning operations should be reviewed. Environmental awareness programmes targeting beach users may be very useful in achieving this desired improvement. These measures would reduce management costs, enhance beach health and make beaches more attractive to users.

4.4. DECADAL SHIFTS IN BEACH USER SAND AVAILABILITY ON THE COSTA BRAVA (NORTH-WESTERN MEDITERRANEAN COAST)[2]

4.4.1. Introduction

In the Western Mediterranean, beaches are mainly considered to be natural areas available for leisure use. Over the past decades, they have been the most valuable asset for many tourist destinations on the coast. It was in these regions that the term “sun and sand tourism” was born, based on the assumption that the availability of beaches was a clear prerequisite for the development of tourism. This particular type of tourism became the most important model for mass tourism destinations. There is no doubt that mass tourism brought income and jobs to these areas, facilitated the understanding of other cultures and increased investment in infrastructures, which in turn brought social and cultural benefits (Sardá & Fluvià 1999). However, in many places these processes occurred in parallel with the destruction of habitats, the degradation of landscapes and competition for scarce natural resources (Stanners & Bordeau 1995), particularly on beaches and seafronts as a result of overexploitation.

During the nineties, several authors (Morgan 1991, Priestley & Mundet 1998, Knowles & Curtis 1999) claimed that mass tourism destinations in the Western Mediterranean were entering into the stagnation-decline phase of Butler’s life cycle model for tourist destinations (Butler 1980). Other authors such as Aguiló *et al*. (2005) gave a slightly different analysis, hypothesizing that a considerable restructuring process within a framework of sustainable development could ensure the survival of the sun and sand model. If we consider the number of tourist arrivals or the income recorded in tourist regions, it appears that the model as a whole is far from being in decline. In the Autonomous Community of Catalonia (Spain), the contribution of tourism to GDP has averaged approximately 9-11% over the last decade, and around 75% of this contribution has been related to the so-called “sun and sand” tourism model (Turisme de Catalunya). The numbers of national and foreign tourists arriving between 1996 and 2001 (the five years previous to the period studied in this paper) grew at a mean annual rate of almost 6%, from 13.4 million to 17.7 million (70% of these tourists were foreigners). These numbers are still maintained today (18.5 million tourists in 2004). Annual institutional surveys of tourist behaviour consistently show that climate and beaches (the physical space and its associated qualities) are the two main reasons for the selection of holiday locations, which bears out the validity of the “sun and sand” model.

In Catalonia, the Costa Brava is one of the most successful tourist destinations (Sardá & Fluvià 1999). The warm Mediterranean climate makes summers in the region ideal for the development of the “sun and sand” tourism model. In addition, the landscape and quality of life have attracted national and foreign visitors to the whole region (Barbaza 1988), making this the most popular tourist destination in Catalonia (the most visited Autonomous Community in Spain, which ranks third in world for foreign tourist arrivals). Almost one third of all foreign tourists visiting Catalonia each year select the Costa Brava as their final destination. The arrival of mass numbers of tourists was a generalized process during the second half of the last century. From 1950 onwards, the number of visitors increased every year and the current forecast stills predicts continuous growth, largely thanks to new and improved facilities, low-cost travel and the restructuring of the tourism sector. As a result of increased human frequentation, the beaches on the Costa Brava–the area’s most valuable asset for attracting visitors–could have suffered from

[2] Edited version of the manuscript *Decadal shifts of beach user sand availability in the Costa Brava (North-Western Mediterranean Coast)* by R Sardá, J Mora, E Ariza, C Ávila and JA Jiménez submitted to *Ocean & Coastal Management*.

overcrowding, with the logical consequences of damage to and the depletion of its natural resources.

Surveys indicate that beaches are one of the main reasons for selecting the Costa Brava as a tourist destination. As beach capacity is mainly influenced by the available subaerial surface (Valdemoro & Jiménez 2006), if tourist numbers increase year by year but the available space remains more or less constant (although it is probably decreasing due to global erosion patterns (Eurosion 2004)), we may conclude that either a) the carrying capacity threshold of these beaches has not yet been reached; b) tourist numbers are not as dependent on beaches as the definition of the “sun and sand” model seems to indicate; or c) there are other hidden effects explaining the patterns observed that we should begin to consider. Although considerable effort is put into beach management to support its socio-environmental functions and some frequentation studies can be found in the literature (De Ruyck *et al.* 1997, Pereira da Silva 2002, Yepes 1999 and 2002), only a few studies have been conducted to analyse the development and recreational use of beaches in Catalonia (Alemany 1984, Breton *et al*. 1994, Breton *et al*. 1996). Moreover, these studies do not focus on frequentation dynamics or study the evolution of beach users over the last decades.

The main aim of this paper is to discuss the use of frequently visited Mediterranean beaches in the light of increases in tourist frequentation and possible overcrowding problems. We calculate the number of beach users in the southern part of the Costa Brava, taking in the municipalities of Blanes, Lloret de Mar and Tossa de Mar (which make up the administrative district of La Selva), and compare the present situation with the corresponding frequentation patterns from 1982. We analyse beach surface availability per user for selected beaches with differing degrees of urban development and facilities. We then discuss this data with reference to the development of the population and of economic activity in the region. The data obtained through this research allow us to establish relationships between the frequentation and beach use profiles on different sites and to identify the patterns of tourism in the region.

4.4.2. Study area and methodology

Description of the area

Our study analyses beach use dynamics and frequentation patterns in three municipalities on the southern part of the Costa Brava (Girona, Spain). This area offers a variety of beach types with varying degrees of urban development that cater for various possible social uses. From south to north, the municipalities studied are Blanes, Lloret de Mar, and Tossa de Mar. Over the last decades, these municipalities have experienced an increase in the concentration of tourists seeking suitable environments in which to spend their leisure time.

This southern part of the Costa Brava belongs to administrative region of La Selva (Figure 4.4.1.). Its coastline contains approximately 30 beaches (10 kilometers), which have a number of different characteristics. Some are urban, others moderately pristine, some are exposed while others are more sheltered, and ease of access differs in many cases. In order to attain maximum variability, nine of these beaches (4.99 kilometres) were selected and studied (Table 4.4.1.), all of which were large enough to be representative and could be sampled using aerial photographs. The physical characteristics of the analysed beaches were obtained from a beach database compiled by the Spanish Ministry of the Environment (http://www.mma.es/costas/guia_playas) and our own GIS database of the area (Ariza *et al*. in press-b).

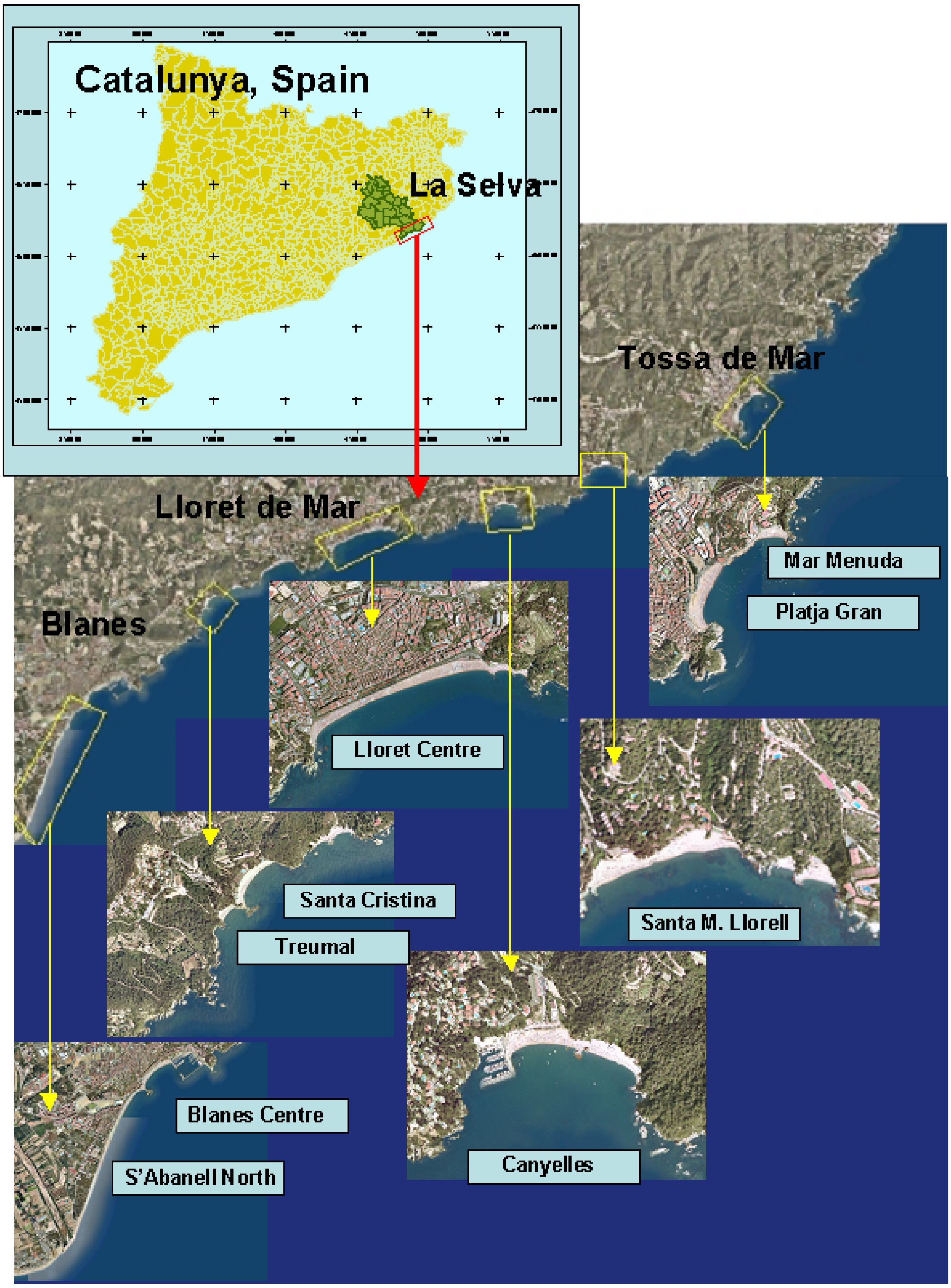


Figure 4.4.1. Studied municipalities in Selva Marítima and selected beaches for the study of beach use dynamics.

	S'Abanell North	Blanes Centre	Treumal	Sta. Cristina	Lloret Centre	Canyelles South	Sta. M Llorell	Platja Gran	Mar Menuda
Municipality	Blanes	Blanes	Blanes	Lloret Mar	Lloret Mar	Lloret Mar	Tossa Mar	Tossa Mar	Tossa Mar
Length (m)	1,500	630	111	335	1,300	200	385	370	160
Total beach surf (m^2)	49,500	27,090	3,441	13,400	55,900	6,600	13,310	19,980	4,800
Average width (m)	33	43	31	40	43	33	35	54	30
Category	Urban	Urban	Urbanized	Urbanized	Urban	Urbanized	Urbanized	Urban	Urban
Promenade	Yes	Yes	No	No	Yes	No	No	Yes	No
Beach services	Complete	Complete	Medium	Medium	Complete	Complete	Medium	Complete	Complete
Harbour/Marina	No	Yes	No	No	No	Yes	No	No	No(*)
Hinterland	Urban town	Urban town	Forest + L.D.U.	Forest + L.D.U.	Urban town	Forest + H.D.U.	Forest + H.D.U.	Urban town	Urban town
Sampled surface (m^2)	812	953	852	1,020	830	195	1,725	1,140	615
Sampled width (m)	33	35	31	35	35	33	35	45	30
Useful beach surface (35 m stretch) (m^2)	49,500	22,050	3,441	11,725	45,500	6,600	13,310	16,650	4,800
Maximum number of beach users (people)	5,486	3,313	444	1,414	15,752	2,521	1,582	3,608	1,475
Minimum sand availability (m^2 user)	9.02	6.66	7.75	8.29	2.89	2.62	8.41	4.61	3.25

Table 4.4.1. Descriptive and obtained data for the nine selected beaches used in this study in 2000 (LDU= Low density urbanization, HDU= High density urbanization).

Every year the monthly distribution of national and foreign tourists in the region increases sharply from June, reaching its seasonal peak during August. As our analysis was primarily designed to assess the periods of maximum frequentation, we decided to focus on the peak of the season, during the month of August. Nine beaches were studied: S'Abanell North, Blanes Centre and Treumal (municipality of Blanes); Santa Cristina, Lloret Centre and Canyelles South (municipality of Lloret de Mar); and Santa Maria de Llorell, Platja Gran and Mar Menuda (municipality of Tossa de Mar) (Figure 4.4.1., Table 4.4.1.). Based on a GIS analysis of the main types of land use in the coastal hinterland (500 m wide strip), these beaches can be grouped into two general categories: urban and urbanized (Sardá *et al*. 2005-a). Urban beaches are considered to be those located within the main town centre (high density). Urbanized beaches are those found in residential areas on the outskirts of a town (low density). By analysing orthophotographs of these beaches taken in 1996, we determined that most users were located on a 35 m stretch of sand.

Frequentation measures

Sand availability dynamics (using m^2 per user as the basic indicator) were calculated using high resolution, oblique, digital photos of the sample areas. Photographs were taken from different observation sites, ranging from high buildings located behind the sampled beaches to nearby elevated locations. The aim was to choose areas representing the average distribution of individuals on beaches, which was based on a preliminary field study carried out in 1999. Sampling areas mostly consisted of stretches of sand with a maximum width of 35 m (from the water line to the edge of the sandy area). We decided to study a wider stretch of sand (up to 45 m) on the Platja Gran beach in Tossa de Mar because tourists were clearly using this portion of the beach. Using these sample areas, we calculated the total surface area of the beach and the useful beach area (35 m stretches in all cases except for a 45 m stretch on Platja Gran) (Table 4.4.1.). Sand availability indices and beach user numbers are given for the useful beach area in each case, that is, the part of beaches that is usually occupied.

The study was carried out from 1999-2000 in two successive stages:

a) During August 1999, a pilot study was carried out by making daily observations of the Treumal beach. Aside from developing the methodology used, the aim of this study was to carry out research into the differences between weekdays and weekends during the peak tourist season. Four pictures were taken every day at 11:45 h, 13:45 h, 15:45 h and 18:45 h.

b) The complete study for the nine selected beaches was carried out during August 2000. Every beach was sampled once a week on a weekday. Photographs were taken every hour between 9:00 h and 20:00 h, providing a total of 10 photographs a day for each beach. The surface area of the sample areas photographed had been calculated previously. The number of users in each sample area was calculated by viewing the images using Adobe Photoshop software. To determine the overall number of users, we counted the people on the beach in well-defined spaces (i.e. towels, hammocks and/or parasols) and included towels on the sand under the assumption that they belonged to people who were bathing when the photograph was taken. After counting the number of users and calculating the sand availability per user, an extrapolation was made for the whole beach using the useful beach area measures, which are shown in Table 4.4.1.

Three of the sample beaches were analysed in more detail. In these cases, the beach user rotation coefficient (11 daily "beach hours" measured/average length of stay by beach users) was obtained by calculating the total number of daily users and their arrival/departure patterns. Using markers, individual users were identified in every photograph and were monitored in consecutive pictures to calculate their arrival and departure times, and consequently the length of stay on the beach. New arrivals were counted and the total was then added to previous values to obtain a cumulative frequentation pattern.

Comparison of beach use between 1982 and 2000

Data about beach size, sand availability per user and number of users in 1982 were obtained from Alemany (1984). The author studied the whole of the Catalan coastline by analysing aerial photographs of its beaches to calculate sand availability during the most crowded hours of the day at the peak of the season. Aerial photographs were taken from a plane on 1 August 1982 between 11:00 h and 14:00 h, using a high resolution to obtain very good quality images. Pictures taken of La Selva region were obtained between 12:15 h and 12:45 h. Some fieldwork was done in parallel at several selected beaches to determine conversion factors. This made it possible to obtain values that could be used for purposes of comparison with the totals observed in the pictures at peak times of the day. These conversion factors were the ratio between users on the sand and users in the sea; and the relationship between the number of users at a given time and the number of users at peak times (Alemany 1984).

In order to compare the Alemany study with our own, we used the minimum sand availability between 12:00 h and 15:00 h from the photographs taken during the first week of August. When estimating the total number of beach users, we accepted the principle adopted by Alemany in 1984. He considered only people located within 30 metres of the water line (useful beach width), regardless of the total beach width and its use. As most of our sample stretches were 35 m wide (except Platja Gran), we subtracted the total number of beach users in the section 30 to 35 m from the water line (30 to 45 m in Platja Gran) from our calculation in order to perform the decadal comparison. In Alemany (1984), the sample space included the bathing area. In our study, to determine the overall numbers of users, we continued to make the assumption that the towels on the sand belonged to people who were bathing when the photograph was taken.

Between the time of the Alemany study and our own, the sizes of some of the beaches have changed. The difference in the total surface area of some of the beaches is due to erosion and sediment management work. However, the differences are such that comparisons can still be made. In our study, beach size was calculated using Arc View software, a highly accurate Geographical Information System (GIS).

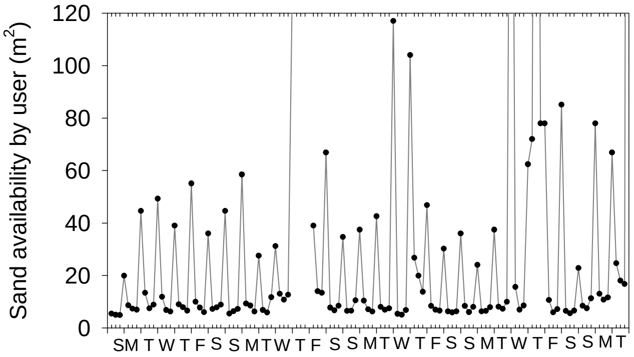
Geographical information system analysis

We used an existing GIS project developed for the coastal towns of La Selva (Sardá *et al.* 2005-a) at a scale of 1:5000 to create applications for managing geo-related information and to calculate surfaces and buffers. In addition to other physical measurements for the beaches studied and the length of the water line, a new GIS layer was created by identifying the swimming pools visible in two sets of orthophotographs (1996 and 2000) and aerial photographs (1977) taken of the region. All images were obtained from the Institut Cartographic de Catalunya (ICC). The total available swimming pool area was then calculated. Using the orthophotographs taken in the summer of 2000, we used the GIS to calculate the total beach area and the mean average width (Table 4.4.1.) of the beaches.

4.4.3. Results

The frequentation of beaches showed pronounced daily fluctuations at the peak of the season. Beach users started to arrive at around 9:00 and all of them had left the beach by 20:00. Overcrowding problems occurred because most beach users tended to concentrate their stays in period of a few hours, mainly from 12:00 h to 17:00 h. The upper graph in Figure 4.4.2. shows the daily pattern of frequentation (measured as sand availability per user) on Treumal beach during August 1999, starting the first day of the month, which fell on a Sunday. Except for three days of bad weather (coincidentally the Thursday of the second, third and fourth weeks) all measures showed the same pattern: sand availability was between 5 and 13 m^2 per beach user at 11:45 h, 13:45 h and 15:45 h. It was much greater when measures were taken at 18:45 h.

Weekends were not a significant factor in reducing sand availability per beach user on these types of beaches. No large differences in sand availability were observed between weekdays and weekends (Figure 4.4.2., lower graph). Although a slightly higher number of users was detected at 11:45 h and 18:45 h, during the hours of heavy use the data were almost identical.



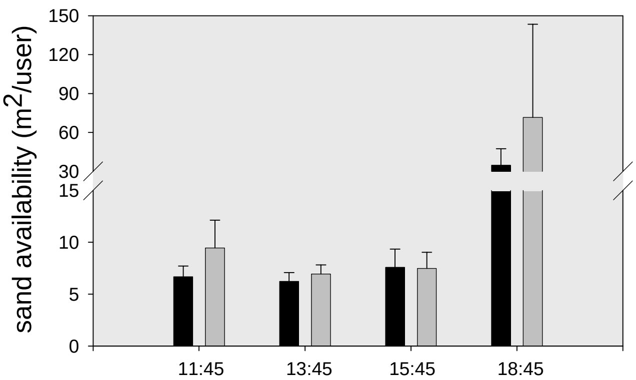


Figure 4.4.2. Upper graph ; daily fluctuation of sand availability per beach user in Treumal beach (August 1999). Bottom graph ; average monthly sand availability at four day moments in Treumal beach (August 1999).

In the data for 2000, the occupancy level of the analysed beaches (Figure 4.4.3., A-C) also shows pronounced hourly fluctuations. On plotting the average weekly dynamics of sand availability per user in the useful beach area during August (Figure 4.4.3.), three main situations become clear:

a) With the exception of Lloret Centre and Santa Maria de Llorell, the minimum values of sand availability for all beaches were recorded around mid-day. The general pattern was characterized by a steady increase in the number of beach users during the morning, reaching a peak between 12:00 h and 14:00 h (least sand availability). This was followed by a slight decrease and then a second small increase to a second, lower peak, which was reached at 17:00 h. After this time, a sharp decrease was observed during the remaining hours studied.

b) When we compared the general pattern observed between towns (Figure 4.4.3., A-C), the municipalities of Lloret de Mar and Tossa de Mar showed more similarities between them–with four beaches heavily used (basically the urban ones) and two others less frequented (the urbanized ones) – than with those of the municipality of Blanes, where patterns of occupation were similar for urban and urbanized beaches.

c) Using the sand availability per user as an indicator, beaches can be classified into two groups. At a given point in the day, four of the analysed beaches (Lloret Centre, Canyelles South, Platja Gran and Mar Menuda) reached values of sand availability below 5 m^2 per user. In Canyelles, values below this threshold were obtained during most of the day (Figure 4.4.3., B-C). All of these beaches were heavily used at some point during the day. The values of sand availability for the other five beaches (S'Abanell North, Blanes Centre, Treumal, Santa Cristina, and Santa Maria de Llorell) were generally above 10 m^2 per beach user and minimum sand availabilities were between 6.5 to 9 m^2 per user (Table 4.4.1.). The average monthly sand availability per beach user between 12:00 h and 17:00 h for the nine studied beaches is shown in a box graph in Figure 4.4.4.

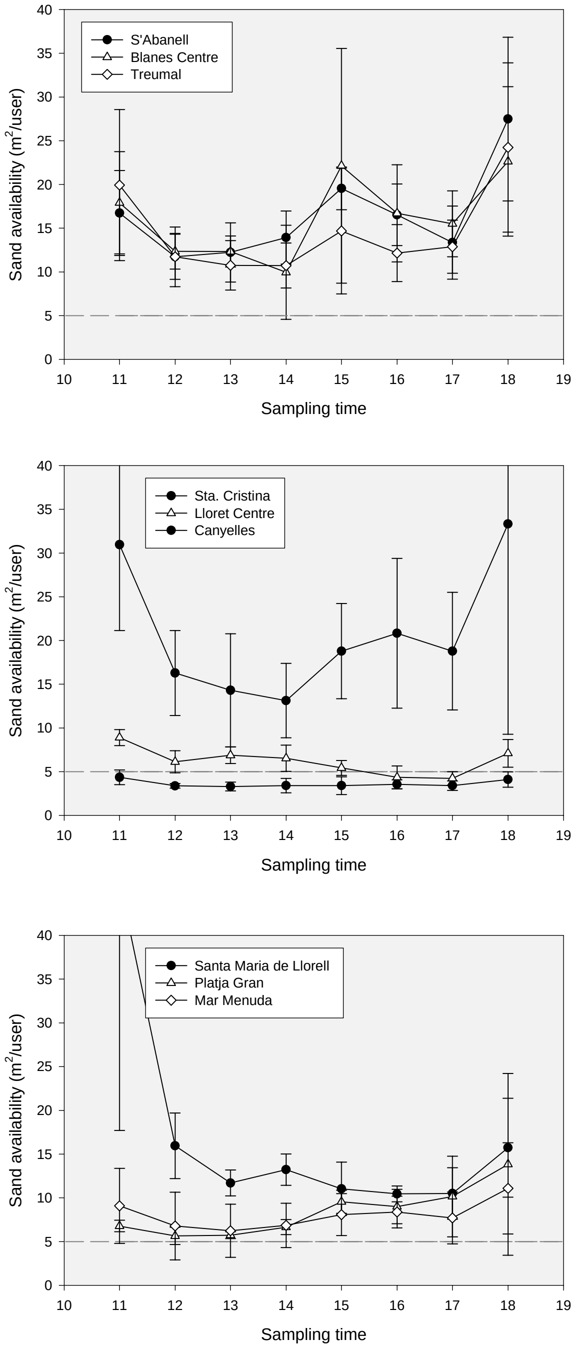


Figure 4.4.3. Average monthly sand availability per beach user in the nine studied beaches (August 2000). Upper graph; beaches of Blanes. Middle graph; beaches of Lloret de Mar. Bottom graph; beaches of Tossa de Mar.

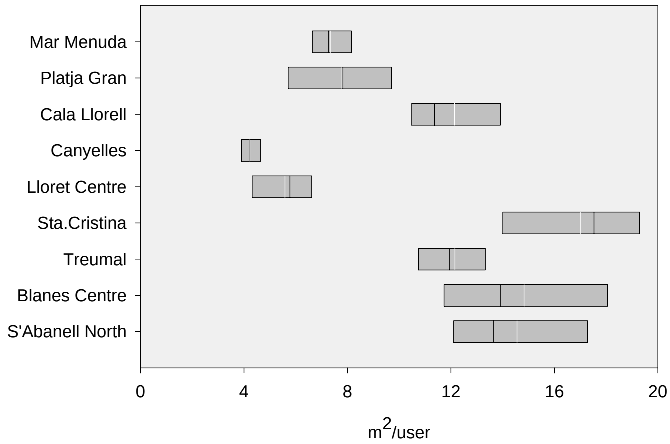


Figure 4.4.4. Box graph representing the average monthly sand availability per beach user in each beach during August 2000.

Several authors in the literature have suggested a value of 4-5 m^2 per user as the limit at which a beach may be considered saturated and/or overcrowded (Alemany 1984, Yepes 1999). In order to calculate the level of saturation of the beaches analysed here, we considered three different scales (hourly, daily and monthly) for the considered time period (11:00 h to 18:00 h). Based on the above saturation value, the only beach with a monthly mean value below this figure would be Canyelles South. Values close to this threshold were found in Mar Menuda and Lloret Centre. When the daily values were considered, a mean value below 5 m^2 per user was also found in Lloret Centre at 17:00 h. If we just focus on hourly values, we find that four of the nine beaches selected showed density ratios of less than 5 m^2 per user at some point in the summer: Mar Menuda on 7 and 28 August, Lloret Centre on 8 August and Canyelles South on 1, 8, 22 and 29 August. As indicated above, beaches in Blanes were less saturated than those in Lloret de Mar and Tossa de Mar.

The arrival and departure times of beach users were spread throughout the day and followed a similar pattern for all but two beaches. Although beach users arrived continuously between 10:00 h and 17:00 h, most arrived between 11:00 h and 13:00 h. Lloret Centre and Santa Maria de Llorell deserve particular attention. In these cases, although people also arrived throughout the day, the largest numbers arrived in the afternoon. In Lloret Centre, the continual increase of the density ratio from 12:00 h onwards indicated that most beach users spend their leisure time at night and therefore go to the beach late in the day, probably after lunch. In Santa Maria de Llorell, a large proportion of beach users came from a large campsite nearby. After having lunch, due in part to the fact that several hours of the day still remained and because beach recreation is a key activity for visitors to coastal campsites, a large number of these people went to the beach, joining other people who had been arriving throughout the morning to spend the day there.

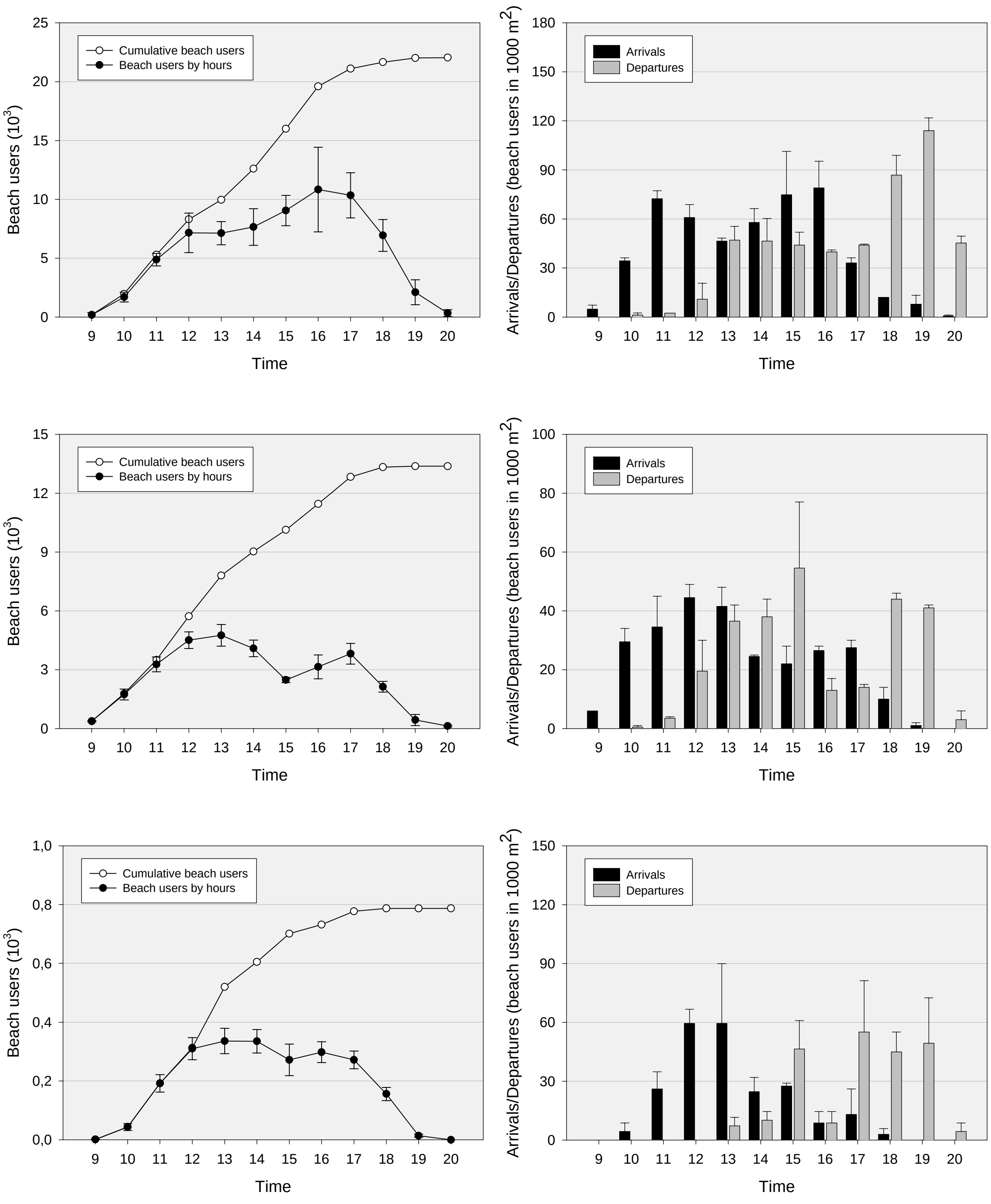


Figure 4.4.5. Average daily dynamics and daily cumulative curve of beach users (left graphs) and arrival at and departure from the beach (right graphs) for three selected beaches of the region. Upper graphs, Lloret Centre. Middle graphs, S'Abanell. Bottom graphs, Treumal.

The average daily beach user dynamics for the three selected beaches and the cumulative curve of beach users during the day are shown in Figure 4.4.5. Lloret Centre is the beach with the highest daily number of beach users. After Lloret Centre (22,036 beach users per day during the first week of August) are S'Abanell (13,375 beach users per day) and Treumal (787 beach users per day). The rotation coefficient for Treumal was lower (2.90) than for Lloret Centre (3.54) and S'Abanell (4.78), indicating that the average time spent on the beach per user was greater for Treumal (3.74 hours) than for the other two beaches (3.11 and 2.30 hours respectively). The length of stay on the beach was greater among visitors arriving during the morning and was also greater for urbanized beaches than for urban beaches (Figure 4.4.6.).

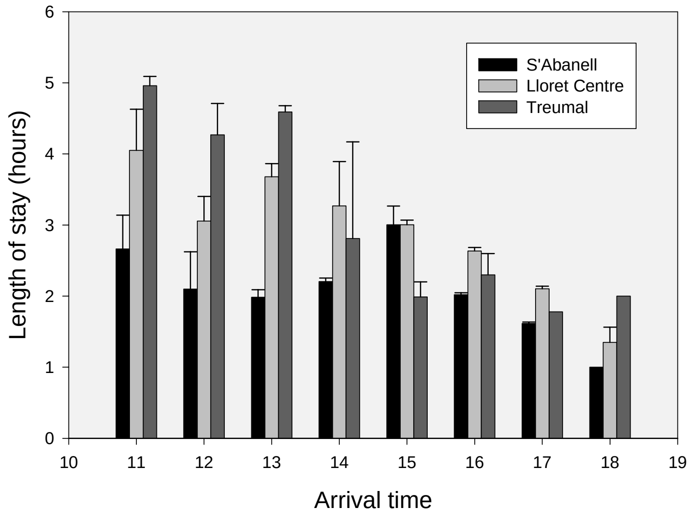


Figure 4.4.6. Length of stay of beach users depending on arrival time for three selected beaches of the region.

Arrival and departure times in the high season were concentrated into short spurts. For most of the beaches, peak arrival times were between 11:00 h and 13:00 h, with a second, smaller peak between around 16:00 h and 17:00 h. However, in Lloret Centre the trend is reversed and the highest peak was observed during the afternoon and not during the morning. Departure times for all beaches were usually between 13:00 h and 14:00 h, before lunch time, and at the end of the day, between 18:00 h and 19:00 h.

	1982 (30 m strecht)				2000 (35 m strecht)				2000 (30 m strecht)		
	TBS (m^2)	UBS (m^2)	MSA (m^2/user)	MNU	TBS (m^2)	UBS (m^2)	MSA (m^2/user)	MNU	UBS (m^2)	MSA (m^2/user)	MNU
S'Abanell North	108,000	54,000	8.7	6,207	49,500	49,500	12.9	3,837	45,000	11.7	3,837
Blanes Centre	18,000	18,000	9.6	1,875	27,090	22,050	13.1	1,683	18,900	11.2	1,683
Treumal					3,441	3,441	9.7	355	3,330	9.4	355
Sta. Cristina	15,000	15,000	8.9	1,689	13,400	11,725	17.9	655	10,050	16.3	616
Lloret Centre	54,000	40,500	5.5	7,350	55,900	45,500	4.9	9,276	39,000	4.6	8,441
Canyelles	16,000	12,000	10.5	1,140	6,600	6,600	2.6	2,521	6,000	2.6	2,310
Sta M. Llorell	11,550	11,550	27.2	425	13,310	13,310	8.3	1,604	11,409	7.1	1,604
Platja Gran	17,000	10,200	3.9	2,631	19,980	16,650	5.4	3,716	11,100	3.7	2,973
Mar Menuda	3,200	3,200	4.4	750	4,800	4,800	6.6	726	4,800	6.6	726
TOTAL	242,750	164,450	--	22,067	200,621	180,176	--	26,895	155,589	--	24,855
Mean SA	**--**	**--**	**--**	**7.45**	**--**	**--**	**--**	**6.70**	**--**	**--**	**6.26**

Table 4.4.2. Comparison between 1982 (Alemany, 1984) and 2000 of mean sand availability per user and beach user numbers in the studied beaches. TBS= Total Beach Surface, UBS= Useful Beach Surface, MSA=Minimum Sand Availability, MNU= Maximum Number of Users, Mean SA= Mean Sand Availability.

Comparison of beach use between 1982 and 2000

During this eighteen-year period, changes in beach size were observed for the studied beaches (Table 4.4.2.). These changes were caused by heavy erosion in the case of S'Abanell beach (Jiménez *et al*. 2003, Sardá *et al*. 2000) and moderate erosion solved by beach nourishment practices in Blanes Centre (Serra 1998), Platja Gran, and Mar Menuda. In addition to these erosion problems, for several beaches it also was necessary to carry out sediment redistribution. In these cases, the action of waves accumulated sediment at the edges of the beaches and relocation operations had to be performed each year before the start of the bathing season. In S'Abanell North beach decreased from 108,000 m^2 in 1982 to 49,500 m^2 in 2000. In contrast, the area of four other beaches increased: in Blanes Centre from 18,000 m^2 to 27,090 m^2, in Platja Gran from 17,000 m^2 to 19,980 m^2, in Mar Menuda, from 3,200 m^2 to 4,800 m^2 and in Sta. Maria de Llorell from 11,550 m^2 to 13,310 m^2. In the rest of the beaches the area remained largely the same: Lloret Centre (54,000 m^2 and 55,900 m^2), Treumal-Santa Cristina (15,000 m^2 and 16,841 m^2) and Canyelles (16,000 m^2 and 13,200 m^2).

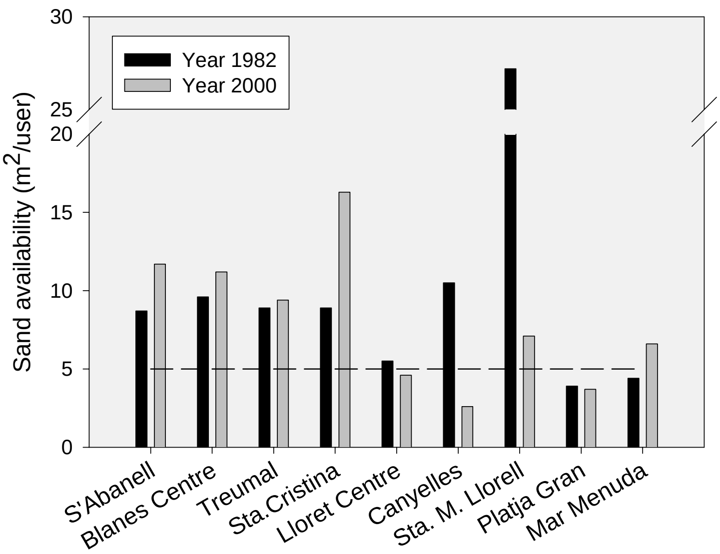


Figure 4.4.7. Comparison of the mean sand availability per beach user between 1982 and 2000, during the first week of August at the nine studied beaches. Data of 1982 was extracted from Alemany study (1984).

When we compared the data from Alemany study (1984) with the minimum sand availability between 12:00 and 15:00 during the first week of August (Table 4.4.2., Figure 4.4.7.) obtained in our study, we noticed that for most of the studied beaches sand availability per beach user was greater in the year 2000 than eighteen years earlier. The most notable result was obtained in Santa Cristina, where sand availability per user increased from 8.9 m^2 in 1982 to 16.3 m^2 in 2000. Other notable increases were observed in S'Abanell North (from 8.7 m^2 to 11.7 m^2), in this case even despite a reduction in size, in Blanes Centre (from 9.6 m^2 to 11.2 m^2) and in Mar Menuda (from 4.4 m^2 to 6.6 m^2). Values in Treumal, Lloret de Mar and Platja Gran did not change significantly (Table 4.4.2.). In contrast, a considerable decrease in sand availability was observed for the other two beaches compared, Canyelles and Santa Maria de Llorell. The Llorell indicator fell from 27.2 m^2 to 7.1 m^2 and the corresponding value for Canyelles fell from 10.5 m^2 to 2.6 m^2, the smallest area registered in the study.

Comparing the data of (Alemany 1984) with our data, the number of beach users at the peak time of the day decreased in S'Abanell North, Blanes Centre, Santa Cristina-Treumal and Mar Menuda (Table 4.4.2.). The greatest decrease occurred in S'Abanell North, where the estimated number of users was 6,207 in 1982 and 3,837 in 2000. The number of users of the other beaches increased dramatically (Table 4.4.2.), particularly in the case of Canyelles.

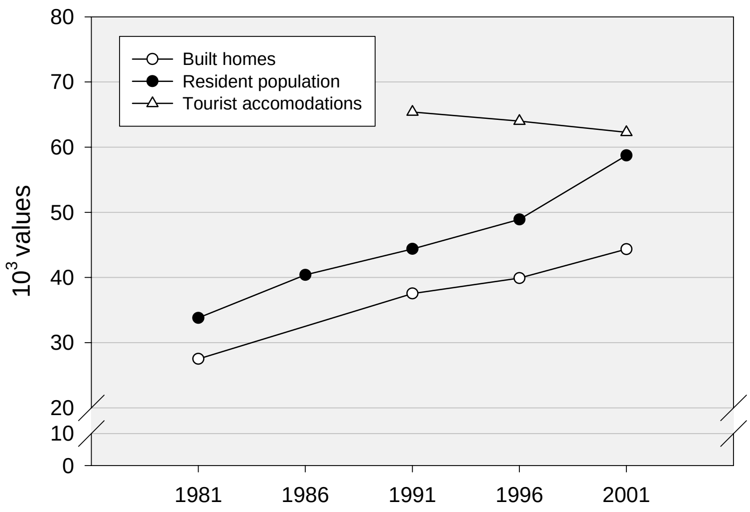
4.4.4. Discussion

Despite international competition between tourist destinations, the number of tourists on the Costa Brava has increased year by year for decades. Measured through official surveys, these increases still seem to be based on a "sun and sand" model. In recognition of the importance of beaches as highly valuable tourist resources, European and national strategies have made considerable efforts to enhance the excellence of such natural areas by improving the hygienic quality of the sand and water (Bathing Water Directive) and through the introduction of different Quality Awards and International Standards that are essentially user-oriented (Ariza *et al*. in press-b). As a consequence, more formal beach management processes are seen to be put in practice every day, following ideas explained by James (2000-b). Nevertheless, in a recent questionnaire sent to beach managers along the Catalan coast (Ariza *et al*. in press-b), it was surprising to discover that no periodic quantitative evaluation of the level of beach use was carried out in any municipality. It seems that beach managers do not consider the possibility of any problems derived from beach frequentation patterns. If a saturation problem occurs, managers may either see it as a "normal" situation that should simply be accepted or assume that beach users will restructure their behaviour according to the availability of the resource.

Although the studied area is not affected by a generalized erosion problem, some acute problems have been detected, such as in S'Abanell North, where more than 50.000 m^2 of the beach surface have disappeared in the eighteen years considered. Nevertheless, if we disregard this particular beach, the remaining beach surface in the region has increased by approximately 10% thanks to sediment management work. The relationship between beach size and the number of users is obviously important, since beach users generally remain within 35 metres of the water line. This consideration applies to all studied beaches except for Platja Gran in Tossa de Mar, where users were located up to 45 m from the sea. This is important when beach nourishment is required. If nourishment needs to be carried out, areas beyond 35 m from the water line will essentially be used as sand reservoirs if erosion rates have been studied or extra services will be established there. However, the additional space will not be used to attract more people to the beach.

Comparison of the patterns observed in 1982 and 2000 showed that, except for Lloret Centre, urban beaches have maintained or increased the sand availability ratios measured in 1982. A specific comparison for urbanized beaches revealed two clear patterns. The 1982 data for Treumal and Santa Cristina were aggregated and both beaches were considered to have the same sand availability ratio; the data from 2000 revealed slight differences between the two beaches, but it was clear that the sand availability ratio had not decreased on either of them. In contrast, a considerable decrease in sand availability was observed in Canyelles South and Santa Maria de Llorell. The increase in beach users observed in Canyelles South and Santa Maria de Llorell and the resulting decrease in sand availability ratios was probably due to the extensive urban development of the surrounding area during this eighteen-year period. The lowest mean sand availability ratio was recorded in Canyelles South. Urban development in the area has been permitted on a massive scale and a marina has been built. Canyelles has therefore become an urban beach despite its original rural nature (Martí 2005). The huge increase in the number of beach users must clearly be closely related to the new marina.

The total number of beach users increased slightly between 1982 and 2000 (Table 4.4.2.) but the redistribution of these users changed the frequentation patterns from those observed in 1982. In general, the number beach users in Blanes is lower than it was in 1982; in the Lloret de Mar and Tossa de Mar, the frequentation patterns are fairly similar for urban beaches and noticeably higher for urbanized beaches. When we compared the minimum sand availability data for 1982 and 2000, based on the useful beach area availability in a 30 m strip (Table 4.4.2.), similar aggregated values were observed: 7.45 m^2 per user in 1982 against 6.26 m^2 per user in 2000. The beach area available to the entire beach user population in the region was only slightly different to the corresponding area in 1982. However, these patterns of beach use were concurrent with a rapid increase in the use of land by people and businesses, a sharp increase in the resident population and the urban development of the area (Figure 4.4.8., topmost graph). Although the resident population and the number of second homes in the region increased sharply during the period considered and the number of tourist accommodations remained the same, the maximum number of beach users at the peak time of day did not increase at the same rate.



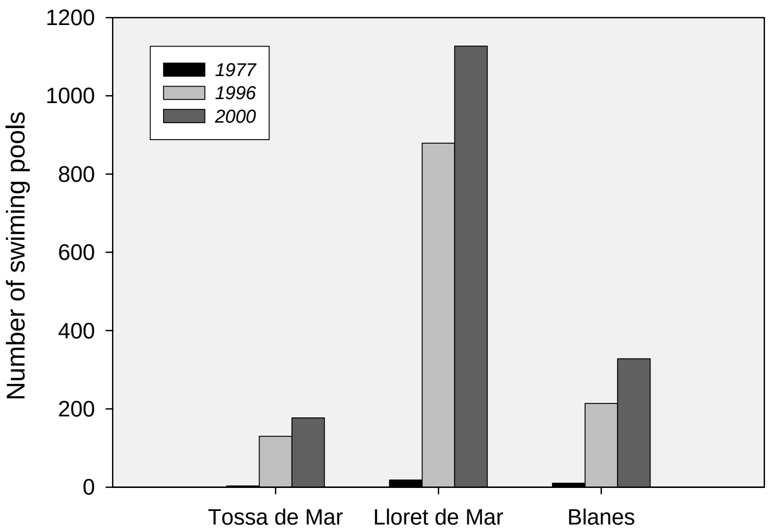


Figure 4.4.8. Upper graph; evolution of some socio-economic data in the coastal municipalities of La Selva region. Bottom graph; evolution of the number of swimming pools in these three municipalities.

Beach frequentation numbers did not increase at the same rate as the resident population and the number of tourist activities available in the region. There are at least three possible explanations for this observation, which may be complementary: a) the total number of beach users in 2000 may have been much higher than in 1982 but the length of stay on the beach was much shorter; b) the availability of other tourist activities in the region increased so tourists had a far greater range of facilities to choose from, other than the beach, than in 1982; and, c) beach users may have restructured their behaviour so that they now substitute all, or part, of the time spent on the beach for the use of private swimming pools. Unfortunately we have no cumulative data on the length of the stay of beach users in 1982. However, we do know that the regional tourist authorities have promoted the diversification of other tourist facilities near beaches to provide new leisure experiences. Furthermore, our observations of the orthophotographs of the area (Figure 4.4.8.-lower graph) revealed that the construction of swimming pools had grown at an average of at least 7% over the last four years. This growth is higher than the construction of new homes in the region (Sardá *et al*. 2005-b). Potential beach users may now choose to bathe at home rather than go to the beach or to combine both types of leisure activity, thus reducing the length of the stay at the beach. Moreover, the total available area of swimming pools in the coastal towns of La Selva (7.65 Ha) would in theory cover rectangular area measuring 8.24 m in width and of a length equal to the combined total of all the beaches in La Selva. A combination of these three factors may be bringing about a change in the preferential behaviour of the average beach user in the region.

The concept of tourism in La Selva was originally based on its main attractions: the beaches and seafront (Cals 1982). This is no longer supported by current data, and official surveys indicate that tourist behaviour is not solely dependent on beaches. Furthermore, the average tourism growth rate in the region does not indicate a decline for this destination. Although many of the doubts over certain tourist destinations are based implicitly on the capacity of their principal attractions, it seems that the available beach area is not as significant as it was decades ago. The traditional concept of (mainly holiday) tourism, based essentially on the “sun and sand” model, has been modified by a new form of tourism in which residential tourism is becoming an increasingly important factor, the degree of repetition is increasing and a new “home and pool” model is developing in parallel to the traditional “sun and sand” model. There are also changes in tourist behaviour; the number of holidays per year has increased, while the length of stay has decreased (Alegre & Pou 2006) and a greater turnover of traditional tourists. This behaviour could also be extrapolated to the way in which these tourists use the beaches during their leisure time. Given the limits of some of the natural resources that previously attracted visitors to the area, such as beaches, new artificial attractions like swimming pools or nearby attractions and activities (water parks, visits to gardens, historical monuments, etc.) are developed. As described for other Mediterranean areas (Aguiló *et al*. 2005), the tourism market on the Costa Brava is continuing to grow, but this is based on the restructuring of the market and of tourist behaviour rather than its beaches, although their aesthetic and natural qualities will always be essential.

Besides these new leisure trends, beaches are still the main asset for many Mediterranean coastal resorts and the proper management of the beach environment is therefore needed. The management of beach ecosystems must move beyond the use of performance standards and performance rating systems and the use of Environmental Management Systems (EMSs) for beaches should be highlighted (Ariza *et al.* in press-a). EMSs provide an overall framework that nevertheless allows different approaches to be taken according to the particular characteristics of each beach. The measurement of frequentation patterns should be considered essential in such frameworks, not only to monitor decadal tendencies of beach use, but also to manage and limit further overcrowding problems.

4.5. CONCLUSIONS

The most important human influences in the Costa Brava—associated with tourism and construction dynamics—have significantly affected the functioning of beach ecosystems in the second half of the 20th century. The fact that there is a great demand for beaches with good accessibility and services has influenced beach characteristics and management practices. Sediment management is a clear example. During the bathing season, beaches are required to have a suitable surface and condition (slope). Beaches in the studied area, however, have special characteristics: they are cells closed off to the passage of sediment, nourished by streams, and subject to the periodic redistribution of sediment by storm energy. Therefore, managers need to invest important efforts every year to prepare their beaches for the summer season and repair winter storm damage.

Beaches in the area are heavily used, especially during the peak season. Some beaches have sand availability values lower than the 5 m^2/user defined as the threshold for overcrowding on urban beaches. Moreover, these beaches have been intensively used for a long time (at least from the beginning of the 1980s). This permanent situation of beach crowding has triggered important consequences for the state of beach ecosystems. One of the most evident—although not studied in detail—is the impact on natural beach communities. Dune systems, dry sand communities, rock or stream communities have been clearly transformed. One of the most significant impacts is trampling. Although not precisely quantified, in some beaches it may be intense and is likely to have affected a wide range of communities. Other evident human impacts—mostly affecting the stream community—are the presence of allochthonous species, poor water quality and the presence of organic and inorganic waste.

Another important consequence of the high density of users on beaches is the production of waste and litter. The amount of waste is closely related to beach use throughout the season, at its highest, typically, at the beginning of August (except for the Gran de Tossa-Mar Menuda beach). Beaches with more users had a higher production of waste. Habits of users also impact waste characteristics, with waste composition differing throughout the season and between beaches. At the peak of the season, plastic, wrapping and beverage containers represented the highest percentage of waste, and organic and domestic waste the lowest percentage. As the season advances, these components show a divergent behaviour. Organic and domestic waste increases and plastic, wrapping and beverage container waste decreases. This variation is probably related, in part, to the length of time spent on beaches by users.

Beach use (along with cleaning practices) also affects visual water and sand quality. When Lloret Centre beach use is at a maximum, mechanical cleaning practices cannot deal with the litter produced by users. As a consequence, small-size litter accumulates over the season, only decreasing at the end of the season when beach use also diminishes. The fact that litter accumulates in sand has important consequences. When mechanical cleaning systems are used for this litter, due to characteristics of both the sand (coarse) and the machines, a significant amount of sand is collected with the litter (10.16% of the total amount of waste and litter collected) through the filters of beach trotters.

The most important conclusion to be extracted from the obtained results is that current management of beach use and its effects could be substantially improved in the area. Beaches and their managers are not capable of dealing with the number of visitors who come to La Selva Marítima during the summer season, especially at its peak. Further action requires more studies of the natural beach communities, measures to regulate beach use, plans for the minimisation, segregation and recycling of beach waste, and improved mechanical cleaning practices.

Chapter V
Development of a Beach Quality Index (BQI) for Beaches in the Selva Marítima Area of the Costa Brava[1]

5.1. INTRODUCTION

The growth of tourism in coastal areas of the North-Western Mediterranean has increased sharply in recent decades (Sardá & Fluvià 1999). As beaches are the main tourism assets in the region, this has increased pressure on the beach ecosystems and threatens their use as economic, recreational and aesthetic resources. These tendencies have important consequences for beach management, which is now primarily concerned with satisfying user expectations (Ariza *et al.* in press-b) and the recreational function of beaches, whereas the natural and protective functions are considered secondary. In addition, beach management is essentially reactive rather than proactive due to a lack of defined goals and responsibilities, and the response to problems is limited by the absence of mid/long-term planning. Some of the main problems faced by local beach managers include the loss of sediment (which currently affects many European coastlines (Eurosion 2004)), beach cleaning (human pressure causes litter to accumulate during the summer season (Ariza *et al.* in review)) and emergency situations (beach closures are common in the North-Western Mediterranean area (Ariza *et al.* in press-b)).

Beach management is currently service-oriented, and quality is guaranteed by means of performance standards and performance rating systems for each particular beach. The most widespread of these standards and rating systems have been reviewed in the literature (Williams & Morgan 1995, Cagilaba & Rennie 2005, Ariza *et al.* in press-a). They focus extensively—and in some cases exclusively—on water quality monitoring, following the standards established in the EC Bathing Water Directive 76/160/EEC (EEC 1976). However, in most cases the quality measurements are qualitative and cannot be used to quantify variations over time or between beaches (this is the case for service and facility evaluations). It is therefore necessary to broaden the scope of beach management beyond performance assessment measurements because nowadays, once performance standards are reached and/or rating systems get good scores, management is not improved any further. For that to change, it is necessary to establish a framework in which all quality criteria can be applied, adapted, and substituted when necessary (Ariza *et al.* in press-a).

More proactive beach management and new tools should be applied taking into account the physical, natural and socio-economic characteristics of beaches, including the functional aspects of beach structure (Ariza *et al.* in press-b) that are not considered in existing standards and rating systems. In recent years a new initiative has been launched to create Environmental Management Systems for beaches (EMSBs) in Spain (Ariza *et al.* in press-a). These systems constitute a challenging new framework for proactive and dynamic beach management, which will require new performance measures in order to monitor one of the most important goals of EMS: continuous improvement. Quantitative indicators are needed so that beaches can be continuously monitored, controlled and managed. This will make it possible to carry out periodic reviews of the beach management process and to establish new objectives when necessary.

[1] Edited version of the manuscript *Development of a Beach Quality Index (BQI) for Beaches in the Selva Marítima Area of the Costa Brava* by E Ariza, JA Jiménez, R Sardá, M Villares, J Pintó, R Fraguell and M Fluvià, intended for publication.

Current performance assessment measurements may be included in EMSBs, but Ariza *et al.* (in press-a) have demonstrated that none of these covers all of the management requirements of north-western Mediterranean beaches. The factors that are not currently considered in the management of heavily used beaches, include the quality of surroundings, safety and rescue services and the quantification of general services. In addition, many current performance standards/rating systems fail to evaluate the natural environment of heavily used beaches.

The main aim of this paper is to develop a new Beach Quality Index (BQI) for assessing beach quality in urban and urbanised beaches in the North-Western Mediterranean area. The Selva Marítima region (southern Costa Brava in Catalonia) was chosen as the area in which to apply the indicator. One of the issues to consider when using these indicators is that they generate a large amount of data and a wide variety of measurement units. Therefore, in order to make valid comparisons and achieve the desired results it is necessary to introduce methods for integrating or aggregating different parameters from different levels of analysis by developing a composite indicator. The BQI is such an index, and is intended to form part of a general beach management framework (EMSBs) as a tool for assessing continuous improvement in beach management systems that take into account beach environments (James 2000-b) and allow the ecosystem management approach to be applied (Ariza *et al.* in press-b). Function analysis has been included in the index so that beach characteristics are considered as well as temporal variability when evaluating quality.

5.2. METHODOLOGY

5.2.1. Proposal for a Beach Quality Index

Individual components associated with the three main functional aspects of a beach ecosystem (the natural function, the protective function, and the recreational function) were included in the Beach Quality Index (BQI). The BQI was designed to include three sub-indices: the Natural Function sub-Index (NFI), the Protective Function sub-Index (PFI) and the Recreational Function sub-Index (RFI) (Ariza et al. *in press*-a) (Table 5.2.1.). The sub-indices were designed to aggregate different partial indices from selected individual components. The individual components were extracted from several published documents containing expert opinions on beach quality assessment (Breton *et al.* 1996, Morgan *et al.* 1996, Nelson *et al.* 2000, Buceta 2000, Brown & McLachlan 2002, Yepes 2002, Yepes & Cardona 2000, Diputació de Barcelona 2003-a and 2003-b, Yepes *et al.* 2004, Diputació de Barcelona 2005-a and 2005-b, Universidad de Cantabria 2002, Valdemoro 2005). It was attempted to avoid double counting when selecting and using the appropriate components of partial indices. For the beach quality assessment, nine individual components—and therefore partial indices—were considered in the construction of the RFI, three were considered in the construction of the NFI and one was considered in the calculation of the PFI (Table 5.2.1.).

The structure of the BQI was also devised in order to assess beach quality according to previously defined goals for each beach. These goals were dependent on the urban environment surrounding the beach and varied according to whether the beach was located in an urban or an urbanised environment (no natural environments were considered in this study). Urban beaches were considered to be those located in the main town centre (high density). Urbanised beaches were those located in residential areas on the outskirts of a town (low density) (Ariza *et al.* in press-b). Goals were entered into the BQI by regulating the different weights assigned to each function (p-coefficients) in its formulation (Table 5.2.1.). The weight of the p-coefficient was changed without altering the composition of the sub-indices, according to the particular beach and its environmental characteristics. Weights for calculating the p-coefficients were obtained from expert opinion questionnaires.

In the formulation of the BQI all the scores for the three sub-indices and their associated partial indices were normalised in an interval between 0 (bad) and 1 (good). This allowed large amounts of information to be presented in a clear and simple manner (Jiménez & Van Konigsveld 2002).

$$\mathbf{BQI}= p_{1(A,B)}(\mathbf{RFI})+p_{2(A,B)}(\mathbf{NFI})+p_{3(A,B)}(\mathbf{PFI})$$

$$\mathbf{RFI}= \alpha\ [\ t_1(IC)+t_2(IEQ)+t_3(ISerF)+t_4(IAct)+t_5(IAcPar)+t_6(IComf)+t_7(IS)+t_8(IBS)]$$

$$\mathbf{NFI}= u_1(IN)+ u_2(IWSP)+ u_3(IPQ)$$

$$\mathbf{PFI}= IPP$$

	Urban beaches	Urbanized beaches
RFI	p1A	p1B
NFI	p2A	p2B
PFI	p3A	p3B

BQI Index	Sub-indices	Partial indices
BQI: Beach Quality Index	**RFI: Recreational Function**	**α:** Microbiological Water Quality **IC:** Beach Crowding **IEQ:** Environmental Quality **ISerF:** Services and Facilities **IAct:** Activities **IAcPar**: Access and parking **IComf:** Comfort Quality **IS:** Surrounding Area Quality **IBS:** Beach Safety
	NFI: Natural function	**IN:** Natural Conditions **IWSP:** Water-Sand Pollution **IPQ:** Physical Quality
	PFI: Protective Function	**IPP:** Protection

Table 5.2.1. Structure of the Beach Quality Index.

In order to include the current resources considered in beach management systems, the BQI was calculated by considering existing beach management practices on the Catalan coast (e.g. in Catalonia, the Catalan Water Agency (ACA) is currently developing a sand and water quality monitoring programme, so the methods it used were reviewed and included in our index). Finally, other coefficients were assigned to each particular partial index (t_1 to t_8, for the partial indices used in the RFI, and u_1 to u_3, for the partial indices used in the NFI). As only one partial index was used in the construction of the PFI sub-Index, no coefficient was used for this sub-Index. The weights assigned for calculating these coefficients (t and u) were obtained from the user and expert questionnaires. This method was previously used in the construction of other composite indicators (Nardo *et al*. 2005).

The information compiled by the BQI can be presented disaggregated by sub-indices and/or by partial indices. The final results can be considered as a potential management scorecard that can be used to analyse the information from individual components as separate blocks. The scorecard can be used as a tool for analysing significant environmental aspects related to beach management frameworks and/or in monitoring programmes.

5.2.2. Partial indices

The Microbiological Water Quality index (α) provides criteria for evaluating the established requirements of the EC Directive 1976/160/EC on the quality of bathing waters, recently repealed by 2006/7/EC. As the latest Directive has not yet been transposed to Spanish legislation, for the purposes of this paper we consider the principles included in Directive 1976/160/EC, incorporated into Catalan legislation by the ACA. The values in Table 5.2.2. will have to be modified when the new requirements established in Directive 2006/7/EC come into force. Although the index varied between 0 and 1 depending on the total or partial fulfilment of the proposed limits in these directives, situations in which the mandatory values were not obtained were given a score of 0 (Table 5.2.2.). The least favourable of the three established values (Total Coliforms, Faecal Coliforms and Faecal *Streptococcus*) is used in the index. The final results were obtained by calculating weekly averages during the whole season, so variations in the index during the bathing season could also be calculated in weekly intervals.

As the EC Bathing Water Directives are designed to protect human health, no recreational activity that compromises public health should be allowed. Consequently, this partial index that contributes to the RFI index has been considered as a coefficient factor that multiplies the rest of the contributing partial indices.

	TC	FC	FS	α value
Very good	≤500	≤100	≤100	1
Good	≤2.000	≤500	≤500	0.8
Moderate	≤10.000	≤2.000	≤2.000	0.5
Deficient	≤100.000	≤20.000	≤20.000	0
Bad	>100.000	>20.000	>20.000	0

Table 5.2.2. Microbiological water quality assessment. The table is based on the requirements outlined in Directive 76/160/EC and the classification criteria established by the Catalan Water Agency (ACA). TC= Total Coliforms, FC= Faecal Coliforms, FS= Faecal *Streptococcus*. Values are expressed in ufc/100 ml.

The Beach Crowding index (IC) considers beach use patterns. Increases in tourist frequentation and possible overcrowding problems were considered to be important factors for assessing the recreational function of beach environments (Ariza *et al.* in press). We considered two threshold values for crowdedness based on crowding measures defined in the literature (MOP 1970, PAP 1997): 4 m^2/user and 8 m^2/user, for urban and urbanised beaches respectively. We also defined optimal situations in which sand availability is greater than 8 m^2/user for urban beaches and 12 m^2/user for urbanised beaches. We defined a crowding score of 0.2 to indicate the point at which overcrowding occurs and a score of 1 to indicate optimal conditions. The remaining index values were ranged between these two scores (Fig. 5.2.1.). In order to calculate the partial index we used the highest beach use values obtained during the bathing season (May-September).

The partial index can also be calculated at weekly intervals provided data on beach use at such frequency be available.

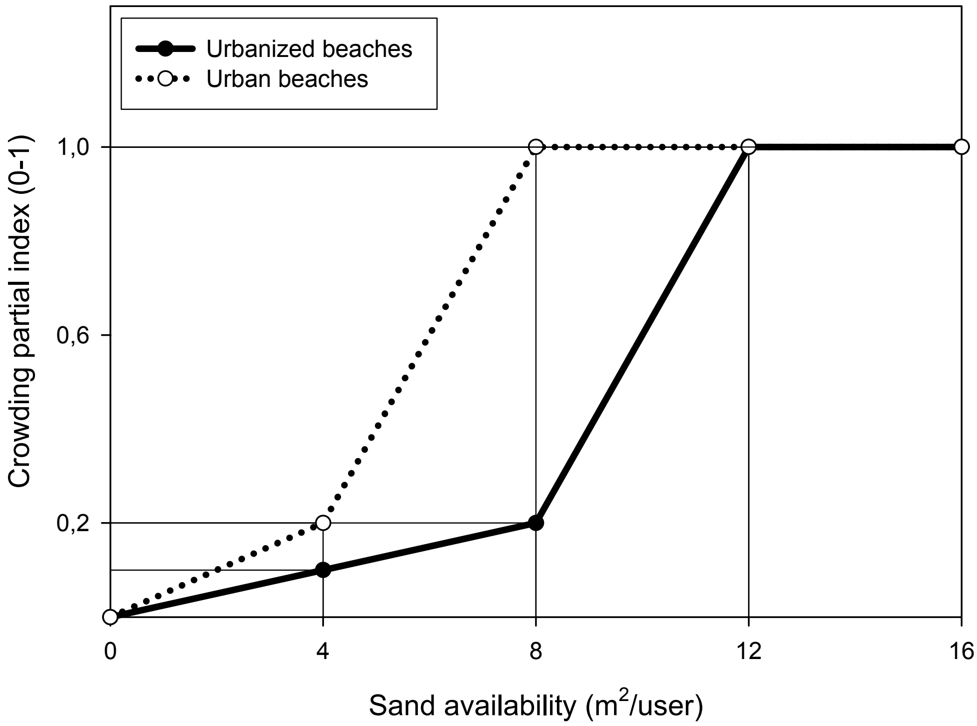


Figure 5.2.1. Values of the IC partial index. Standards of crowding and optimal values are defined for the two types of assessed beaches.

The Environmental Quality index (IEQ) provides an integrated measure of the aesthetic and hygienic environmental quality of beaches. It has been demonstrated that small items of litter accumulate on beaches during the bathing season (Ariza *et al.* in review) and that beach users consider this to be an important factor (Morgan *et al.* 1996). The ACA is currently carrying out a visual assessment programme of water and sand quality that rates the conditions of a beach between 1 (bad) and 5 (excellent). The water quality parameters analysed are colour, transparency, solid anthropic waste, plant waste, marine plant waste, foam, tar, odour, oil and the presence of jellyfish. The sand quality parameters analysed are beach user waste, anthropic waste, plant waste, marine plant waste, tar and the presence of jellyfish. We averaged the global quality values obtained in this monitoring programme for water and sand quality during the bathing season and normalised the values to the range between 0 and 1 (Table 5.2.3.). The presence of a rainwater outfall on the beach was considered as a factor that penalises the final score by subtracting 0.2 points. Each beach closure due to pollution during the assessed bathing season also incurred a penalisation of 0.25 points. The ACA carried out visual assessments of the beaches twice a week during the bathing season, so we were also able to present this information at weekly intervals.

Factors	Scores
Water quality	1-5 score
Sand quality	1-5 score
Rainwater outfall	Subtracts 0.2
Closures episodes	Each event subtracts 0.25

Table 5.2.3. IEQ partial index assessment. Values of water and sand quality were averaged and normalised in the range 0-1. The presence of a rainwater collector exit pipe or beach closure incurs a penalisation of 0.2 or 0.25 respectively.

The components included in the Services and Facilities index (ISerF) were determined from standards available in the Shores Act 22/88 and in previous quality requirements established for Spanish beaches (Yepes 2002). We finally decided upon 11 items to be assessed in this partial index (Table 5.2.4.). Three different states were established for each item (good, regular and bad) except for the “children facilities”, “information”, and “sport facilities” items, for which we only assessed the presence (good) or absence (bad).

The ISerF items were not considered to be equally important in the two types of beach. For urban and urbanised beaches they were classified as basic, important and not considered. The basic items were considered first for both types of beach when the partial index was calculated; if any basic services was absent from these beaches (classified at least as regular, based on expert judgement criteria, see Table 5.2.5.) the score assigned to the assessed beach was 0. When all basic items were classified as regular, the score was 0.45 for urban beaches and 0.6 for urbanised beaches. Finally, 0.05 was added to the score for urban beaches and 0.033 to the score for urbanised beaches for each basic item that were classified as good. Consequently, the maximum score was 0.8 for urban beaches and 0.7 for urbanised beaches when all basic services were present and classified as good. Each important item added 0.05 to the score if it was classified as good or 0.025 if it was classified as regular for both urban and urbanised beaches. Overall, if both basic and important items were present and classified as good, the final score for this partial index was 1. For the three cases in which only two categories were differentiated (presence and absence) we considered only the classifications “good” and “bad”. This partial index was designed to be calculated at the beginning of the season and should remain valid for the whole season.

Services/facilities	Urban beaches	Urbanized beaches
Beach guarding	Basic	Important
Showers and feet washers	Basic	Basic
Umbrellas and hammocks	Important	Important
Bins	Basic	Basic
Children facilities	Important	No
Restaurant/bars and kiosks	Basic	Important
Handicapped facilities	Basic	Important
Telephone	Important	Important
Information	Basic	Important
Sanitary facilities	Basic	Basic
Sports facilities	Important	No

Table 5.2.4. Importance of the items considered in the ISerF partial index for the two types of beaches.

	Good	Regular	Bad
Beach guarding	Permanent	Punctual	Non existent
Showers and feet washers	Showers/feet washers separated < 150 m	Showers/feet washers separated between 150 and 250 m	Showers/feet washers separated ≥ 250 m
Umbrellas and hammocks	Maximum occupied surface < 30 % of beach surface	Maximum occupied surface between 30 % and 50 % of beach surface	Maximum occupied surface > 50% of beach surface
Bins	Bins separated < 50 m (with support and hermetic closing) Segregated waste disposal on the beach	Bins separated between 50 m and 100 m	Bins separated > 100 m
Children facilities	Existing	Non existing	
Restaurant/bars and kiosks	Seasonal facilities in the DPMT separated at least by 200 m. They should be well maintained and with minimal impacts	Seasonal facilities in the DPMT	Permanent facilities in the DPMTor no facilities
Handicapped facilities	At least 1 accessible point	Accesses adapted	No accesses adapted or accessible point
Telephone	No further than 150 m from any point of the beach	Between 150-300 m from any point of the beach	Further than 300 m from any point of the beach
Information	Existing	Non existing	
Sanitary facilities	Facilities separated at maximum 300 m	Facilities separated between 300-500 m	Facilities separated further than 500 m
Sports facilities	Existing	Non existing	

Table 5.2.5. Expert judgement criteria to score the items considered for the ISerF partial index.

An Activities index (IAcT) was developed to include the detected presence of annoying and other undesirable behaviour. Sports outside specific areas, the presence of pets, fishing during bathing hours and sailing activities in bathing areas were considered to have a negative impact on the enjoyment of most beach users. As these activities were thought to be detrimental to beach quality, each activity detected reduced the final score by 0.2 points from an initial score of 1. This partial index should be measured once a week during the bathing season and an averaged value was used to calculate the final score.

The Access and Parking index (IAcPar) provides a measure of the accessibility of the beaches and is an important factor in the selection of beaches by users. It consists of three different factors: access to the beach surroundings and signposting (IAcces), access to the beach itself (IAcState), and the availability of parking and other available methods of transport (ITrans). This partial index is measured at the beginning of the summer season and the score lasts for the whole season. The score is calculated on the basis of expert judgement criteria shown in Table 5.2.6.: a possible total of four points for IAcces, five points for IAcState and five points for ITrans. The final partial index is also given a score between 0 and 1 as the sum of the different scores shown in Table 5.2.6. is divided by the maximum possible score of 14 points.

Beach surroundings (IAcces)		Good	Regular	Bad
Accessibility		Well asphalted (2 points)	Asphalted with irregularities (1 point)	No asphalted (0 points)
Signposting		Signposting further than 200 m (2 points)	Signposting within 200 m (1 point)	No Signposting (0 points)
Accesses (IAcState)		**Good**	**Regular**	**Bad**
Distance parking-beach		< 200 m (1 points)	Between 200-300 m (0.5 points)	≥ 300 m (0 points)
Distance between pedestrian accesses		< 50 m (1 points)	Between 50-100 m (0.5 points)	≥ 100 m (0 points)
State of accesses		Easy and safe (1 points)	Safe but not easy (0.5 points)	No safe, no easy (0 points)
Distance between traffic accesses		< 500 m (1 points)	≥ 500 m (0 points)	
Distance between footbridges		< 100 m (urban beaches) In urbanized beaches in main accesses (1 points)	≥ 100 m (urban beaches) In urbanized beaches no in main accesses (0 points)	
Transportation (ITrans)		**Good**	**Bad**	
Parking		Existing (4 points)	Non existing (0 points)	
Other ways of transportation	**Public transportation**	Existing (0.5 points)	Non existing (0 points)	
	Parking bicycles	Existing (0.5 points)	Non existing (0 points)	

Table 5.2.6. Expert judgement criteria to score the items considered for the IAcPar partial index.

The Comfort index (IComf) includes the aspects of the beach structure and climatic conditions that affect the recreational experience of users. Eight comfort factors were included in this partial index: beach width, beach slope in dry and wet areas, physical obstacles that obstruct bathing, step, abrasive materials on the shoreline, water temperature and the percentage of sunny days. The water temperature measure was averaged during June, July and August, while the percentage of sunny days was calculated over the period from May to September. Although beach managers cannot change the fundamental characteristics of the beach, it is important to detect possible areas of user dissatisfaction when the aspects assessed vary between beaches. In order to score the comfort factors, the criteria considered were modified from those created for the CEDEX Index (Buceta 2000) after analysing beach properties and user opinions about the geomorphologic characteristics of beaches. This partial index is calculated at the beginning of the bathing season for morphological characteristics or whenever any of the parameters are known to have changed, and weekly for climatic factors. The calculation follows the criteria shown in Table 5.2.7. The final partial index is also given a score between 0 and 1 as the sum of the different scores shown in Table 5.2.7. is divided by the maximum possible score of 8 points.

Beach factors	Good	Moderate	Bad
Width	20 m to 35 m	15-20 m or 35-50 m	< 15 m and ≥ 50 m
Slope of dry area	0º-4º	4º-6º	Above 6º
Slope of wet area	1º-5º	0º-1º or 5º-8º	Above 8º
Obstacles	No Obstacles	Obstacles present in less than 15% of the shoreline	Obstacles present in more than 15% of the shoreline
Step	Step < 10 cm	Between 10 cm and 20 cm	Step ≥ 20 cm
Abrasive material	Without abrasive material or disperse	Accumulation important that do not difficult entry and exit of water in the 75% of the shoreline	Accumulations that difficult entry and exit of water in more than 25% of the shoreline
Water temperature	23º to 27º	21º-23º or 27º-29º	< 21º or ≥ 29º
% of sunny days	From 0 (no sunny days) to 1 (all sunny days)		

Table 5.2.7. Expert judgement criteria for scoring the items considered in the IComf partial index. Each of the eight items scores 1 point (good), 0.5 (moderate) or 0 (bad).

The <u>Quality of Surrounding Area index (IS)</u> was designed to include two different indices: the landscape index (IL) and the aesthetic value index (IA) (Table 5.2.8.). The landscape index consists of three different factors of equal weight: the percentage of impervious surface in the hinterland (a band of 500 m around the beach), the percentage of coastal defence works against beach length, and the percentage of the water table enclosed by harbour and/or marina developments in a band of 200 m offshore from the emerged beach. The final index is obtained by averaging the three percentages and dividing the final score by 100.

The aesthetic value index was scored by calculating the percentage of rural/ agricultural and impervious land use in the viewshed of the beach (the viewshed is the portion of a surface that is visible from a given point on or above it) (Table 5.2.8.). Both indices should be calculated every five years.

Aspect	Measurement	
	Landscape index (IL)	
Impervious space (Is)	Impervious Area / 500 m Buffer Area	
Beach coastal defence works	Beach coastal defence works / Beach total length	
Surface of port in the maritime hinterland (Ispm)	Surface of water table closed by harbour developments / total surface in a 200 m buffer in the maritime area.	
	Aesthetic index (IA)	
Impervious land use in the view shed basin (Ia)	< 5% Impervious	0
	5-20 % impervious	0,33
	20-60% impervious	0,66
	> 60 % impervious	1

Table 5.2.8. Criteria used for the assessment of the IS partial index.

The Beach Safety index (IBS) provides an integrated measure of the safety and rescue services allocated in a particular beach. Both, urban and urbanized beaches were considered with identical requirements for this particular partial index. The Spanish regulation establishes responsibilities for local authorities but it does not define which are the mandatory standards in terms of personnel and facilities that should be provided. In the present index, we followed the requirements established in the “Beach Safety Plan of Barcelona” (Diputació de Barcelona 2003-a, Annex III). Twelve components were reviewed and selected as criteria for its evaluation (Table 5.2.9.). The final score was achieved by adding number of fulfilled criteria and dividing this number by the total number of criteria (12).

Evaluated components	
Standards of facilities	presence (1) / absence (0)
Standards of transport material	presence (1) / absence (0)
Standards of communication material	presence (1) / absence (0)
Standards of rescue material	presence (1) / absence (0)
Standards of sanitary material	presence (1) / absence (0)
Emergency warning	presence (1) / absence (0)
Buoying	presence (1) / absence (0)
Signposting of dangerous areas and activities	presence (1) / absence (0)
Risk assessment of each beach	presence (1) / absence (0)
Preventive plan	presence (1) / absence (0)
Indicators of accidents	presence (1) / absence (0)
Absence of wave regime risk	presence (1) / absence (0)

Table 5.2.9. Assessment criteria for the IBS partial index. The criteria were developed following the Beach Safety Standards for the Barcelona metropolitan area.

The Natural Conditions index (IN) is designed to assess the quality of the natural systems present in the wind-controlled upper part of the beach (Brown & McLachlan 1990). It consists of three different factors: the vegetation representation coefficient (Cr), the surface coefficient (Cs) and the development of the habitat coefficient (Cd). The representation coefficient provides the percentage of beach plant species found on a particular beach with respect to a catalogue of the 30 characteristic species that can be found in the local area. The surface coefficient measures the total vegetated area with respect to the area behind the storm drift line, which is the wind-controlled part of the beach. Finally, the development of the habitat coefficient provides a measure of the state of dune belts based on expert visual evaluation (Table 5.2.10.). This partial index is initially calculated as INprev = log [Cr*Cs*Cd] and the score is then scaled from 0 (INprev = 0) to 1 (INprev = 4.6 as the maximum possible value).

Factors	**Measurement**
Representation coefficient (Cr)	Number of beach species / number of beach species in the catalogue.
Surface coefficient (Cs)	Surface of vegetation / beach surface over drift line.
Development of habitat Coefficient (Cd)	Score 1, 2, 3 or 4 following: 1-Beaches cleaned with heavy mechanical devices: no development or very low development. 2-Beaches with vegetated sand, leaning on promenades, other artificial structures or rocks in the border of the beach. 3-Beaches with patches of incipient dunes. 4- Beaches with existence of a dune belt.

Table 5.2.10. Assessment criteria for the IN partial index.

The Water-Sand Pollution index (IWSP) was included to monitor pollution events because they often cause beach closures in the area (Ariza et al. *in press*-b). Pollution events were considered when a particular beach had to be closed completely or when bathing was prohibited due to a particular polluted episode during the bathing season. 0.25 points are subtracted from an initial score of 1 for each total or partial closure.

The Physical Quality index (IPQ) represents the effect of human changes on the physical properties of beaches (McLachlan 1996). This index was designed to quantify changes in grain size (Igr), beach area (Ibs) and wave regime (Iwr) as a result of human activity during the last 10 years. The index does not consider whether natural conditions (i.e. grain size) are good or bad for beach users, but simply records variations of the original condition of beaches. The observed alteration is described as moderate or severe for the three selected factors; it is considered moderate when it affects less than 30% of the beach area and severe in all other cases. A score of 0 was awarded in the case of severe alterations, 0.5 for moderate alterations and 1 for cases in which no alterations were observed. The index can be calculated at the beginning of the bathing season. The final score was achieved by adding the three obtained values and dividing the result by three.

The Protection index (IPP), which represents the importance of beaches in protecting coastal features in the area of study, was defined in previous studies (Jiménez *et al.* 2002, Valdemoro & Jiménez 2006). In the BQI structure the Protection index consists of a single partial index that measures a beach's capacity to dissipate wave energy and prevent damage to promenades and maritime facilities. The factors included are: (i) the effective beach width (EBW) which is the distance between existent infrastructures and the shoreline (ii) the storm reach (SR) which is the beach width potentially eroded by a storm of a given return period; and (iii) the minimum beach width (MBW), which is the minimum width required to have an operative beach for protection purposes, i.e. beach infrastructures to remain protected after storm impacts. It must be defined by managers and based on scientific knowledge. In this study, the SR has been estimated for the study area in 13 m (for the effect of a storm with a return period of 10 years, and using the Sbeach model-Larson & Kraus, 1989) and MBW has been set 13 m.

IPP1= EBW/ (SR+MBW)

IPP= L (IPP1>1)/ Ltotal

where:

IPP1= Partial Protection index (for a particular point of the beach).

IPP= Partial Protection index (for the whole beach).

L(IPP1>1)= The total beach length in which the value of IPP1 is 1 or higher.

Ltotal= Total length of the beach.

5.2.3. Coefficients used

The contributions of each sub-index to the BQI and of each partial index vary according to predefined goals. The relative importance of each element was assigned using different weighting factors. The weights reflect the contribution of each particular index to the final composite index and were determined after consulting various interested parties (experts, members of the public and beach managers).

Two levels of coefficients were used. We calculated p-coefficients (Tables 5.2.1. and 5.2.11.) to assign weights to the three specific beach functions for urban and urbanised beaches. In July 2006, a questionnaire was distributed to obtain expert opinions on the functional priorities and important areas of beach management for these two different types of beach. We obtained responses from 16 experts in coastal management which were then averaged to calculate the final p- and u-coefficients (Table 5.2.11.). The survey included questions about the intensity of functions on different types of beach and the importance of several factors in assessing beach quality.

	Urban beaches	Urbanized beaches
p-coefficients		
Recreational function (RFI)	p1A= 0.60	p1B= 0.30
Natural function (NFI)	p2A= 0.10	p2B= 0.40
Protective function (PFI)	p3A= 0.30	p3B= 0.30
t-coefficients		
IC	t1= 0.08	t1= 0.12
IEQ	t2= 0.22	t2= 0.20
ISerF	t3= 0.08	t3= 0.06
IAcT	t4= 0.12	t4= 0.12
IAcPar	t5= 0.08	t5= 0.08
IComf	t6= 0.12	t6= 0.12
IS	t7= 0.12	t7= 0.12
IBS	t8= 0.18	t8= 0.18
u-coefficients		
IN	u1= 0.15	u1= 0.20
IWSP	u2= 0.50	u2= 0.50
IPQ	u3= 0.35	u3= 0.30

Table 5.2.11. P-coefficients, t-coefficients and u-coefficients obtained after consulting 16 coastal management experts and beach users through questionnaires.

During the 2004 and 2005 bathing season beach user questionnaires were distributed on the beaches of Malgrat Nord, S'Abanell, Treumal-Sta. Cristina, Lloret, Canyelles and Tossa de Mar-Mar Menuda. The weights of partial indices of the RFI (t-coefficients) were obtained by averaging the scores given by users (Villares *et al.* in prep). We obtained 113 valid questionnaires from users of urbanised beaches and 131 from urban beaches.

5.3. APPLICATION OF THE BQI TO BEACHES IN THE SELVA MARÍTIMA AREA OF THE COSTA BRAVA (NORTH-WESTERN MEDITERRANEAN)

5.3.1. BQI assessment area

The BQI was applied to six beaches on the Catalan coast: Malgrat Nord, in the district of Maresme, and S'Abanell, Treumal-Sta. Cristina, Lloret, Canyelles and Tossa-Mar Menuda in the district of La Selva (See description of beaches 4.2.). By performing a GIS analysis of the main types of land use in the coastal hinterland (500 m-wide strip), we were able to group the beaches into two general categories: urban and urbanised. S'Abanell, Lloret and Tossa-Mar Menuda were considered urban beaches, while Malgrat Nord, Treumal-Sta. Cristina and Canyelles were considered urbanised beaches. Malgrat Nord is comprised in the stretch of the beach that is situated between the urban area of the municipality of Malgrat and the Tordera river. The main features and views of the selected beaches are shown in Table 5.3.1 and Figure 5.3.1.

Beach		Type	Exposure	Lenght	Width
Platja Malgrat Nord	**Mal**	Urbanized	High	2500	63.5
Platja S'Abanell	**S'Ab**	Urban	High	1500	35
Platja Treumal-Sta. Cristina	**T-SC**	Urbanized	Moderate	446	31-40
Platja de Lloret Centre	**LLo**	Urban	High	1300	49
Platja de Canyelles	**Cany**	Urbanized	Moderate	400	35
Platja Tossa-Mar Menuda	**T-MM**	Urban	High	530	70-30

Table 5.3.1. Main characteristics of beaches where the Beach Quality Index has been applied.

The different partial-indices were measured during the 2005 and 2006 summer seasons. No substantial changes in most important beach factors occurred during the period between the two measurements in any of the studied beaches, so it can be reasonably assumed that the conditions were essentially the same for all beaches. Beach crowding and environmental quality were measured in 2005 and the remaining partial indices were measured in 2006.

Figure 5.3.1. Beaches assessed by the Beach Quality Index.

5.3.2. Partial indices

Microbiological Water Quality index (α). Although some limits were exceeded in certain weekly readings, the median values for the whole 2006 bathing season classified all beaches in the “very good” category. Table 5.3.2. shows the results and scores obtained for this partial index.

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
TC (ufc/100 ml)	16.52	148.97	67.4	43.52	36.58	88.02
FC (ufc/100 ml)	10.35	65.58	39.1	21.94	16.3	71.97
EF (ufc/100 ml)	3.41	6.91	14.1	6.91	15.35	12.61
α Score	**1**	**1**	**1**	**1**	**1**	**1**

Table 5.3.2. Results and scores obtained after analysing microbiological water quality. TC-Total coliforms; FC-Faecal coliforms; EF-Faecal *Streptococcus*.

Beach Crowding index (IC). Daily beach use at the peak of the summer season was high for both urban and urbanised beaches. As a result, the measured quality was low. The only cases in which crowding was not observed were the larger beaches of Malgrat Nord and S'Abanell. The overcrowding threshold was exceeded at certain points during the 2005 season at Treumal-Sta. Cristina, Canyelles and Gran de Tossa-Mar Menuda. Obviously, if the values are expressed as daily, monthly or season-long averages the scores are more positive.

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
m^2/user	18.5	10.8	6.9	5.6	7.4	3.6
IC Score	**1**	**1**	**0.17**	**0.52**	**0.18**	**0.18**

Table 5.3.3. Results and scores obtained for the beach use analysis.

Environmental Quality index (IEQ). A rainwater outfall (or similar) was found on all of the studied beaches. In addition, the Malgrat-Nord beach was closed once during the 2006 bathing season and yielded a lower overall score than the other assessed beaches. The scores for water and sand environmental quality (taken from the global water and sand quality values calculated by the ACA during the summer of 2005) were high for all beaches.

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
Rainwater outfall	YES	YES	YES	YES	YES	YES
Water	0.92	0.93	0.95	0.95	0.96	0.96
Closures	1	0	0	0	0	0
Sand	0.81	0.94	0.95	0.91	0.95	0.99
IEQ Score	**0.41**	**0.73**	**0.75**	**0.73**	**0.75**	**0.77**

Table 5.3.4. Results and scores obtained for the analysis of water and sand quality.

Services and Facilities index (ISerF). In general, all of the studied beaches had a very good level of services and facilities except Malgrat Nord, which did not satisfy the minimum criteria established for basic services. However, we identified several common problems during the assessment, such as a lack of public telephones, sanitary facilities and litter bins with hermetic seals. In addition, although the area reserved for umbrellas and sun-loungers did not exceed 30% on any beach, water sports facilities and equipment occupied a significant proportion of the total beach area. On the Lloret Centre and Tossa-Mar Menuda beaches the total area occupied by umbrellas/sun-loungers and water sports facilities and equipment was 20.7% and 49.8% respectively, which limited the space available to beach users.

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
Beach police	0	1	1	1	1	1
Showers and foot washers	0	1	1	1	1	1
Umbrellas and hammocks	1	1	1	1	1	1
Bins	0	0.5	0	0.5	0.5	0.5
Children facilities	-	1	-	1	-	1
Restaurant/bar/kiosks	1	1	1	0.5	1	1
Handicapped facilities	1	1	0	1	1	1
Telephone	0	0.5	0	0.5	0.5	0.5
Information	1	1	1	1	1	1
Sanitary facilities	0	0.5	1	0.5	1	0.5
Sport facilities	-	0	-	0	-	1
ISerF Score	**0**	**0.825**	**0.866**	**0.775**	**0.941**	**0.875**

Table 5.3.5. Results and scores obtained for the analysis of services and facilities.

Activities index (IAcT). Few disturbing activities were detected for the studied beaches. The presence of a police service probably has a considerable effect on beach activities. The lowest scores were recorded at Malgrat Nord (no police service) and Canyelles. The most common disturbances detected were the presence of pets and recreational fishing. Water sports activities were also present on the studied beaches but they respect the areas reserved for bathing.

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
Sports on the sand	NO	NO	NO	NO	NO	NO
Domestic animals	YES	NO	YES	NO	YES	NO
Fishing	YES	NO	NO	NO	YES	NO
Nautical act. (bathing areas)	NO	NO	NO	NO	NO	NO
Other bothering activities	NO	NO	NO	NO	NO	NO
IAcT Score	**0.6**	**1**	**0.8**	**1**	**0.6**	**1**

Table 5.3.6. Results and scores obtained for the analysis of disturbing activities.

Access and Parking index (IAcPar). Very good scores were recorded for the studied beaches, which were easily accessed from the surrounding area and adequately signposted. Parking facilities were available close to all of the beaches. Access to urban beaches was generally easy and safe while access to urbanised beaches was generally safe but not easy, with the exception of Sta. Cristina where access was neither safe nor easy. The two most common shortcomings of the analysed beaches were the lack of footbridges every 100 m and bicycle parking. The only beach to provide a specific area for bicycles was S'Abanell.

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
Access to the area	2	2	2	2	1	2
Signposting	1	2	2	2	2	2
Distance parking-beach	1	1	1	1	1	1
Distance pedestrian accesses	1	1	1	1	1	1
State of accesses	0.5	1	0	1	0.5	1
Distance traffic accesses	1	1	0	1	1	1
Distance footbridges	0	0	0	0	1	1
Parking	4	4	4	4	4	4
Public transportation	0.5	0.5	0.5	0.5	0.5	0.5
Parking bicycles	0	0.5	0	0	0	0
Score	**0.78**	**0.93**	**0.75**	**0.89**	**0.86**	**0.96**

Table 5.3.7. Results and scores obtained for the analysis of access and parking.

Comfort index (IComf). The studied beaches generally scored well for comfort. The highest score was recorded by Sta. Cristina, due to grain size and lack of irregularities and abrasive material. It is important to note that the submerged slope is quite high for all studied beaches in the area. Beach width was classified as good at S'Abanell, Treumal-Sta. Cristina and Canyelles, bad at Malgrat Nord and Gran de Tossa-Mar Menuda and regular at Lloret. A moderate presence of abrasive material was recorded at three of the studied beaches: Malgrat Nord, S'Abanell and Gran de Tossa-Mar Menuda.

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
Width	0	1	1	0.5	1	0
Submerged slope	0	0	0	0	0	0
Emerged slope	1	0	1	1	1	1
Irregularities	1	1	1	1	0.5	1
Step	1	1	1	1	1	1
Abrasive material	0.5	0.5	1	1	1	0.5
Water temperature	1	1	1	1	1	1
% sunny days	0.6	0.6	0.6	0.6	0.6	0.6
Score	**0.64**	**0.64**	**0.82**	**0.76**	**0.76**	**0.63**

Table 5.3.8. Results and scores obtained for the analysis of comfort of beaches.

Quality of Surrounding Area index (IS). The beaches showing the greatest transformation of the surrounding area were S'Abanell and Lloret, while those showing the least transformation were Treumal-Sta. Cristina and Gran de Tossa-Mar Menuda. The highest aesthetic quality was recorded for the urbanised beaches Sta. Cristina and Canyelles, but not for Malgrat. No beach obtained a very high score (Sta. Cristina received the highest with 0.66) and the score was lower than 0.5 in three cases (Malgrat Nord, S'Abanell and Lloret).

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
IL	0.122	0.248	0.084-0.097	0.262	0.273	0.083-0.287
IA	1	1	0.66-0.33	1	0.66	0.66-1
IS Score	**0.44**	**0.38**	**0.66**	**0.37**	**0.53**	**0.54**

Table 5.3.9. Results and scores obtained for the analysis of the quality of the surrounding area.

Beach Safety index. Although some safety services are available at the studied beaches, they do not meet the general safety standards established for beaches in the Barcelona area. The lowest level of services was recorded at Malgrat: it does not have a preventive plan and no risk assessment has been carried out. The most common shortcomings are a lack of facilities, transport, rescue and sanitary material. The wave regime also presents a potential risk in all of the studied beaches.

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
Standards of facilities material	NO	YES	NO	NO	NO	NO
Standards of transport material	NO	NO	NO	NO	NO	NO
Standards of communication material	YES	YES	NO	NO	NO	YES
Standards of rescue material	NO	NO	NO	NO	NO	NO
Standards of sanitary material	NO	NO	NO	NO	NO	NO
Emergency warning	NO	NO	NO	YES	NO	YES
Buoying	YES	YES	YES	YES	YES	YES
Signposting dangerous areas/activities	YES	YES	YES	YES	YES	YES
Risk assessment of each beach	NO	YES	YES	YES	YES	YES
Preventive plan	NO	YES	YES	YES	YES	YES
Indicators of accidents	YES	YES	YES	YES	YES	YES
Wave regime risk absence	NO	NO	NO	NO	NO	NO
Score	**0.33**	**0.58**	**0.42**	**0.50**	**0.42**	**0.58**

Table 5.3.10. Results and scores obtained for the analysis of beach safety.

Natural Conditions index. As was expected, the score for natural conditions was higher for urbanised beaches than for urban beaches. The highest scores were obtained at Malgrat Nord and Treumal-Sta. Cristina. The highest score for urban beaches was recorded at S'Abanell and the lowest score was recorded at Lloret. Coefficient of representation (Cr) was clearly highest at Malgrat Nord. The surface area coefficient (CS) was highest at Treumal, Mar Menuda and Malgrat Nord. The highest development of habitat coefficients (Cd) were recorded at Malgrat Nord and Treumal-Sta Cristina.

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
Cr	16.67	6.67	10	3.33	3.33	3.33
Cs	16.34	9.53	22.65-12.24	1.38	12.54	8.75-18.09
Cd	3.00	2.00	3.00	1.00	2.00	2.00-1.00
Score	**0.63**	**0.46**	**0.62-0.56**	**0.14**	**0.42**	**0.38-0.39**

Table 5.3.11. Results and scores obtained for the analysis of the natural conditions of studied beaches.

Water-Sand Pollution index. Only the beach of Malgrat Nord was closed due to water quality problems during the summer of 2006. No pollution episode was recorded in any of the other beaches during this period.

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
Closures 2006	1	0	0	0	0	0
Score	**0.75**	**1**	**1**	**1**	**1**	**1**

Table 5.3.12. Results and scores obtained for the analysis of the water-sand pollution partial index.

Physical Quality index. No changes in grain size or shape, wave regime or beach area due to human activity were detected in the six studied beaches. Although the S'Abanell beach is currently affected by erosion dynamics, studies have demonstrated that the problem is not related to human activity.

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
Grain size/shape	NO	NO	NO	NO	NO	NO
Wave regime	NO	NO	NO	NO	NO	NO
Beach surface	NO	NO	NO	NO	NO	NO
Score	**1**	**1**	**1**	**1**	**1**	**1**

Table 5.3.13. Results and scores obtained for the analysis of physical quality.

Protection index. The lowest score for the Protection sub-index was recorded at S'Abanell. The protective capacity of Malgrat Nord varies along the beach: the score for the northern section was 1 while the southern section received 0. Low scores are associated with exposure to wave energy. The highest scores were obtained at Canyelles, Sta. Cristina and Gran de Tossa-Mar Menuda, which are more sheltered beaches.

Beaches	Mal	S'Ab	T-SC	Llo	Cany	T-MM
Score	**0.5**	**0.48**	**1**	**0.61**	**0.83**	**1**

Table 5.3.14. Results and scores obtained for the analysis of the protective function of studied beaches.

5.3.3. BQI results

We aggregated the results of the different partial indices into two types of composite indicator: function indicators and the overall score or BQI (Table 5.3.15.). The lowest score for the recreational function indicator was recorded for the Malgrat Nord beach, the scores for the urbanised beaches were lower than those for the urban beaches, and the highest score was recorded for the S'Abanell beach, which was due in part to the high scores it obtained for beach use compared with the other urban beaches. The scores for the natural function index were very high for all studied beaches, although the results for the natural conditions partial index were low (Lloret) or moderate (the rest). This is mainly due to the values obtained for IWSP and IPQ, which were very high for all beaches and were given greater weight than the Natural Conditions partial index by the experts consulted. The lowest score was again recorded at Malgrat Nord, due to a pollution episode during the summer of 2006. The scores for the protective function index depend strongly on the degree of exposure. It is very high at Sta. Cristina, Canyelles and Gran de Tossa-Mar Menuda and moderate at Malgrat, S'Abanell and Lloret. The BQI scores were either good or very good for all of the studied beaches: the lowest score was recorded at Malgrat Nord, the results for S'Abanell and Lloret were similar, and the highest scores were recorded at Treumal-Sta. Cristina and Gran de Tossa-Mar Menuda, followed by Canyelles.

	Mal	**S'Ab**	**T-SC**	**Llo**	**Cany**	**T-MM**
RFI	0.53	0.73	0.63	0.68	0.60	0.69
NFI	0.80	0.92	0.91	0.87	0.88	0.91
PFI	0.50	0.48	1	0.61	0.83	1
Global score	**0.63**	**0.67**	**0.85**	**0.68**	**0.78**	**0.81**

Table 5.3.15. Scores obtained for the different functions and the overall score.

Robustness studies of the composite indicators have identified certain weaknesses in construction processes (Munda & Nardo 2003). The two most important problems are the issues of preferential independence and compensability. We used an alternative method (Munda & Nardo 2003) to produce three different rankings of the studied beaches. The urban and urbanised beaches were ordered separately according to the levels of quality measured. The ranking of the urbanized beaches, from the highest quality to the lowest, is: Sta. Cristina, Canyelles and Malgrat Nord. The ranking of the urban beaches: Tossa/MarMenuda, Lloret and S'Abanell. We also produced a third ranking that combined both urban and urbanized beaches. Only four beaches were selected due to the difficulty of calculating values in two cases. The ranking is: Tossa-Mar Menuda, Sta. Cristina, Lloret and S'Abanell. The rankings were compared with the final results obtained by aggregating all of the scores for the partial indices. The results are the same for both methods in the first two analyses, but some differences are observed in the results for the final method. The ranking obtained by using the quantified partial indices scores is Sta. Cristina, Tossa-Mar Menuda, Lloret and S'Abanell (Sta. Cristina and Tossa/Mar Menuda exchange positions with respect to the previous ranking).

5.4. DISCUSSION

The Beach Quality Index (BQI) was developed as a tool for monitoring and assessing the overall quality of beaches. It represents an improvement on previous indices such as the CEDEX index (Buceta 2000) because it was designed to include the three main functional aspects of a beach ecosystem: the natural function, the protective function and the recreational function. By considering different aspects related to these three main functions, we were able to incorporate important elements such as landscape, beach use and degree of protection into the BQI (Ariza *et al.* in press-a).

The BQI was designed so as not to penalise the natural variability of beach environments in socio-ecological systems. Inherent beach properties such as the colour of sand or grain size, which can show a high degree of homogeneity over extensive areas, were not included in the Index, although changes to the original characteristics of beaches caused by human action were (in the physical quality index).

Different time scales can be used when calculating the BQI. Micallef & Williams (2002) pointed out the need to consider the temporal dimension. It is important to understand the possible evolution of beach quality during both the bathing season and other periods of the year if the BQI is to be integrated into EMSBs. Some of the partial indices considered in this study may remain constant during the bathing season (ISerF, IAcPar, IS, IBS, IN and IPQ) while others may vary (α, IC, IEQ, IAct, IComf, IWSP and IPP), but most vary over the course of the year. Different scales of analysis were used in the present study so that, for example, factors varying during summer season were considered differently. We used the average value of all samples taken during the bathing season for microbiological water quality; the maximum value of beach use at the peak of the season for beach crowding; and average values over the whole bathing season for environmental quality, activities and comfort. Coastal managers can choose how to use this tool by determining how to apply the index. It has to be remarked however, that beach use monitoring is quite difficult. Not many studies have been developed, and annual and weekly data are seldom available.

The principal novelty of the BQI lies in its design as a hierarchical scoring system. By including beach functions we have made it possible to use the Index to identify and achieve more specific goals, and the function analysis is considered very useful for achieving sustainability (Micallef & Williams 2003). It is possible to identify the sub-indices and components associated with partial indices and the structure of the BQI makes it easier to detect strong and weak areas than when other established beach management tools are used (Micallef & Williams 2004). The BQI has been designed so that it may be integrated into more general beach management frameworks (EMSBs). We did not incorporate managerial aspects into the BQI. These are main requirements of EMSBs (compliance with existing legislation, specific emergency plans, proactive planning and the allocation of resources and responsibilities) and must be assumed by the beach management organisations, independently of the monitoring function provided by the BQI. However, legal requirements are included in both the BQI (in the form of derived quality criteria) and specific EMSBs.

The BQI allows coastal managers to set benchmarks and develop independent management plans. The set of partial indices can be used in EMSBs to provide relevant information to the management framework. When the BQI is applied to benchmark beaches, the partial indices must be used carefully and without global aggregation (Munda & Nardo 2003). The aggregate values of the different Beach Quality Index components should be used for guidance purposes only and should always be considered together with the segregated analysis and ranking analysis. The overall value can be used to quantify the ongoing improvement required by EMSBs. Regarding the aggregation process, the sensitivity analysis developed in the Annex IV (Figure A42), shows that the allocation of weighting of partial indices according to user and expert opinion triggers very similar results of RFI and BQI scores. The scores obtained when all indices have the same weight are also very alike. This fact seems to indicate that user and expert opinion converge. They consider that beach quality should be measured by a balanced assessment of a wide range of factors. In other coastal areas opinion of users and expert may trigger different results.

By applying the BQI to the studied area, we demonstrated that the quality of urban and urbanised beaches on the Costa Brava was good for certain criteria but also that there is room for improvement. In general, the main strengths of the studied beaches were related to the management of services, which is consistent with the current trend of giving priority to the satisfaction of short-term user requirements (water quality, environmental quality, services and facilities, activities, comfort and the absence of water/sand pollution). The only exception was beach safety. In contrast, the weaknesses identified were associated with areas affected by strong human pressure (beach crowding and the protection of coastal facilities in some beaches, quality of surrounding areas and natural conditions) and the physical quality of beaches. The results obtained for the recreational and natural function indices were good for all studied beaches (0.53-0.73, and 0.80-0.92 respectively). The protective function index was very high for sheltered beaches and only moderate for the more exposed beaches (it was the index that recorded the greatest degree of variation between the studied beaches).

The beaches with the best score are Tossa-Mar Menuda and Treumal-Sta.Cristina. Tossa is a highly used beach with a good quality of surrounding area. Beach safety score is the highest of studied beaches. Sta. Cristina is also an overcrowded beach. In this case, absolute m^2/user available are higher than those found in urban beaches as Tossa-Mar Menuda. However, as overcrowding thresholds have been defined differently for urban and urbanised beaches (due to varied profiles of beaches and users), scores of both beaches in terms of beach use quality are very similar. Sta. Cristina has as weak points, the existence of bothering activities and safety. Accessibility to beaches is regular due to its rough morphological profile. Comfort, quality of surrounding area and natural conditions scores are higher than in other beaches. Malgrat Nord is the beach with the poorest management and scores. Sand environmental quality, services and facilities, safety, bothering activities and signposting scores are the lowest. It has also problems of protection. In spite of the fact that it is not an urban beach, its surroundings have been really transformed, although it maintains an area of dunes in good natural condition. Management measures are reduced and due to the fact that it is a very human pressured area, global quality is low. The beach of S'Abanell has also important problems of protection of the coastal facilities. Lloret Centre is a quite visited beach. The score of the Comfort index is high (there is not abrasive material). The one of beach safety is moderate and quality of surrounding area and natural conditions low. Canyelles is also a very used beach, with good comfort and service and facilities scores. Quality of surrounding area is high and bothering activities are present.

The values obtained by the BQI and its partial indices could be used to determine future beach quality improvement plans, and efforts should focus on all of the weaknesses detected. In order to prevent the emergence of irreversible processes, it is important to adopt measures such as controlling beach use, transforming the surrounding areas and monitoring the evolution of the natural community. Beach safety should be treated as a priority to guarantee a pleasant leisure experience for users and facilities should be protected against potential damage caused by wave energy. Other areas of improvement identified by the study include cleaning services to prevent the accumulation of litter, the control of the total beach area occupied by facilities and the installation of footbridges and parking areas for bicycles.

EMSBs should ensure ongoing improvement in beach quality practices. The BQI could clearly be used to identify important environmental aspects or to monitor existing management programmes. Of the beaches evaluated in this study, only Lloret Centre has taken a step forward in the development of EMBSs: it uses the “Q for Quality” system and is currently being audited to obtain the ISO 14001 and EMAS certifications. We believe that by including aspects of EMSBs it will be possible to substantially improve the overall quality of beaches in the area. The BQI and its partial indices may be used more efficiently.

Beach closures are used as a proxy of pollution events in the Water-Sand Pollution partial index to detect pollution events that affect beaches in the area considered. Although pollution may affect beaches without producing closures and many different forms of pollution may be present on beaches, only significant pollution events are detected by this partial index. However, if we consider the requirements established by The Water Framework Directive 2000/60/EC (European Parliament & the European Council 2001), it may be advisable to extend the index to integrate indicators that monitor the ecological quality of the water masses at assessed beaches, once they have been fully standardised.

Finally, more data about other beaches are needed in order to assess the relationships between partial-indices, the correlations between them (Marull *et al.* 2004) and the measurement of a single construct (Saisana & Tarantola 2002). It would therefore be beneficial to apply the BQI to other beaches on the Costa Brava and in other similar areas. By performing a combined analysis of the results obtained and the characteristics of the beaches studied, we could test the capacity of the BQI for quantifying quality of beach factors in other coastal areas.

Chapter VI
Discussion

6.1. GENERAL DISCUSSION

The study of assessment and identification of all relevant processes in the management of beach environments was carried out on a section of the Catalan coast. The zone experiences the socioeconomic, cultural and physical pressures common to many Mediterranean coastal areas and consequently, the conclusions of this thesis may be extrapolated to other coastal areas experiencing the effects of intensive tourism.

Our project focused on unknown but necessary aspects of developing integrated beach management: the inclusion of beach management in Integrated Coastal Zone Management (ICZM) strategies as a specific topic, the analysis of assessment measurements used or potentially used in the area of study, the focus and situation of municipal management, and the study of beach use and waste and litter pollution patterns. All these studies were considered in terms of the Spanish legal framework. The results and conclusions obtained in these partial studies were used to develop a set of partial indices that enable the state of beaches to be tracked more globally and permanently; moreover, they can also be applied to more formal environmental management frameworks.

6.1.1. Beach management practices in the studied area

Beach management in the studied area has been traditionally restricted to water and sand quality control and beach use planning. A preliminary survey was conducted with beach managers to determine main management principles. Results demonstrate that beaches are being managed in accordance with the concept of service management (Ariza *et al.* in press-b). The vision of managers was rarely integrated. Quite common was a managerial concept that considers beaches as static elements for which plans are established seasonally. Management plans were active at most for 6 months of the year, with little variation from year to year; they only covered the imminent summer season, and were excluded from long-term programmes and proactive planning.

Like other countries (James 2000-a), Spain does not implement a beach policy that enables coordinated inclusion of different beach management aspects in a common framework. There is no system for establishing proactive planning on the basis of the most important beach characteristics, which has consequences in the way in which beach management is developed in practice. The inclusion of sustainable beach management practices in new managerial models—such as ICZM—is difficult, given the information traditionally available.

Besides these limitations, new managerial approaches have appeared to guide principles of sustainability in managing the coast. A master plan for coastal sustainability (*El Plan Director para el Desarrollo Sostenible de la Costa*, or PDSC, 2005), which was created to apply ICZM principles to the Spanish coast, has established new indicators to monitor some traditionally neglected beach processes (physical integrity, natural functionality, landscape condition, and beach use). It also contains indicators of accessibility and parking facilities, uses, services, activities and measures of protection. In regard to the studied area, the development of an integrated coastal management strategy for Catalunya (*Pla Estratègic per a la Gestió Integrada de les Zones Costaneres*) may be a good tool for improving management practices. It is thought that the problem of a lack of information could, at least, be partially palliated in the near future. Some of the existing limitations resulting from the absence of a beach policy have been overcome in the last decade by the requisites of costal legislation (the Shores Act 22/88) and the wide use of performance standards such as the Blue Flag award. Without these, information on beaches would be even scarcer; moreover, they have triggered improvements in Spanish beach management in recent years. By now, however, further action is required.

6.1.2. EMSBS: needs, characteristics and adaptation to North-Western Mediterranean beaches

The characteristics of beach management tools available at present are such as not to guarantee effective direction (Micallef & Williams 2004). In order to properly adapt an ecosystem management philosophy to beach management, a further step is being taken, namely, the implementation of EMSBs. The use of EMSBs may ensure the permanent and proactive management provided by the *Ley de Costas* 22/88 (Yepes 2002), and may make it easier to manage a single, complex socio-ecological system. Its application may be overcome by the typical division into natural and human ecosystems (Redman *et al.* 2004). This management approach, however, needs to be supported by applied researchers working on beaches (Underwood 1995), by the constant establishment of new management goals, and by local managers assuming the principle of subsidiarity and thereby assuming the responsibility for planning and decision making at the lowest practical level in the governance hierarchy (Olsen 2001).

In spite of the fact that natural beaches are not within the scope of this thesis, EMSBs is valid for use both with very urbanised and very pristine beaches and could serve to integrate all available information in a single conceptual framework. Its main utility is that it is capable of integrating specific defined functions and of assigning resources and responsibilities that allow for temporal proactive planning for individual beaches. Guidelines established for beach management, such as local management directives, conservation programmes, and the development of design and valuation tools (Micallef & Williams 2002, Simm *et al.* 1995), are in perfect accordance with the EMSBs. Recommended is the establishment of indicator function weights based on knowledge of the processes occurring on beaches. In order to obtain the necessary information, different dimensions of beach management need to be considered (Micallef & Williams 2002), and the definition of patterns of consumption, exploitation of resources, and waste production should be assessed.

The use of EMSBs could solve some of the problems detected in beach management at the local level (Ariza *et al.* in press-b), as follows:

a) Organisational change is necessary in order to coordinate the interventions by different authorities and to adequately respond to local sediment problems.

b) Proactive planning would enable the development of more definitive solutions to storm problems and avoid repeated investment in repairing infrastructures damaged by wave energy year after year.

c) Coordinated action between local managers and central government is needed to avoid chronic overcrowding of beaches (by developing plans to limit beach use, for example).

d) Proactive planning is necessary to prevent beach closures and to develop emergency plans that minimise the impact of emergencies whenever they occur.

The study of local beach management structures reveals that most local councils do not have a specific beach management body. Beach management is typically included in departments in charge of environmental issues (23.2%), municipal services (16.2%), urban planning (8.1%), tourism and governance (6%) or public works (4%). The implementation of EMSBs may help to establish the necessary municipal beach management structures and avoid a dispersion of responsibilities among different municipal authority areas.

An important advantage of devising a more formal and permanent planning approach is that it will allow managerial goals to be implemented. Once the first priorities have been achieved, others can be considered and monitored. This would permit a diversification of management actions and the introduction of a continuous improvement principle. Our study of local beach management needs revealed that the efforts of managers were focused on a few objectives, primarily, water, sand and service quality, beach cleaning, and the lack of sand (Ariza *et al*. in press-b). This vision is not compatible with the vision of a beach environment in which the integration of natural, sociocultural and managerial systems requires managers to work in different areas in parallel (James 2000-b).

As has been stated above, EMSBs need to include indicators so as to monitor continuous improvements in all beach processes (physical, social and biological). This would assure environmental performance, defined as a weak point in ISO 14001 when no specific indicators are used (Elefsisiotis 2005). Most of the analysed beach performance standards and assessment measurements do not cover all the aspects relevant for Mediterranean beaches. Consequently, although they can be used to monitor partial aspects, other indices need to be added within the framework of the EMSBs. For this reason, a new beach quality index (BQI) has been created, which includes new partial indices in its structure (beach use, transformation of surrounding areas, waste composition, protection of human infrastructures, etc.). It also quantifies aspects that are treated qualitatively in other management tools (for example, services and facilities, or beach safety). The inclusion of new partial indices has many potential benefits. Landscape assessment is especially necessary, due to construction dynamics in the area of study and the importance assigned to landscape by users. Before the development of the BQI, this feature had only been considered in few beach management tools (Morgan 1999-a, Micallef & Williams 2004). In the case of beach use, despite the fact that municipalities have not established monitoring measures, local managers consider that beach use control may be profitable for planning and management purposes (Ariza *et al.* in press-b). The study of beach use is essential for assessing and understanding the quality of other beach processes. In the studied area, beaches are highly used, which explains, at least in part, the problems of waste and litter management described previously. Beach use is not constant during the bathing season, so cleaning services (segregated waste collection, educational campaigns, and the withdrawal of small-size litter) should be adapted to its temporal variability.

A central focus of this thesis is the inclusion in beach management of function analysis, which had previously only been seldom considered (Micallef & Williams 2003). This new focus enables different management practices to be implemented according to beach characteristics and seasons. Taking into account the regional climate of the study area, Valdemoro & Jiménez (2006) proposed a cyclic change in beach managers' target. Thus, during winter and spring, beach managers should look for a beach optimum from the protective function perspective, because is the period in which incident wave energy is the highest. On the other hand, their interest should change to the recreational function during the summer, because the number of beach users drastically increases whereas storms will hardly affect the beach. Therefore, beach management must be developed throughout the whole year and not just during the bathing period, as has traditionally been the case in the area. The definition of management priorities is very important in assuring the high integral quality of beaches. Results obtained in the application of the BQI partial indices to the area reflect the importance assigned by managers to different aspects of beach ecosystems in recent decades (Ariza *et al.* in press-b, Ariza *et al.* in preparation). In this thesis new priorities have been defined for urban and urbanised beaches. They take into account user and expert opinions and a study of the available literature. These priorities are defined in the selection of partial indices and the definition of its weights and for the function sub-indices.

Monitoring carried out with the BQI partial indices may help to accurately characterise particular beaches and define needed investment and resources. The partial indices could also help to define the economic value provided by beach ecosystem services. Current economic investment by local managers is not linked to resident populations or to the beach surface, but to tourism (Ariza *et al.* in press-b). Although this thesis provides some data on municipal investments on beaches in the study area, more detailed data are required, including a better description of investments, and revenues and services provided by beach environments. It would enable the development of economic analyses and the verification of a clear financial return. This data is still not included as an indicator of adequate management, although it has been recommended (Micallef & Williams 2002). Economic beach analyses are very important if solid and balanced management guidelines are to be established for the Mediterranean coast. They should, moreover, include an analysis of the multiplicative effect produced in coastal municipality economies.

The thirteen partial indices can be used at different stages of the EMSBs (Renau & Planas 2004, Ariza *et al.* in press-a). Environmental Diagnosis may be based on the results obtained for the different partial indices (Figure 3.2.1.). Environmental policy may be formulated on the basis of an Environmental Diagnosis and expert and user opinions of beach quality priorities. The joint use of the BQI and EMSBs could serve to advance the proactive requirements of beach management, as also the inclusion of the much-needed functional analysis in the management of coastal environments. The establishment of environmentally significant aspects and of an environmental programme may be based on partial index scores. Although not directly reflected in these scores, other goals could be included in the programme, such as improving litter assessment methods, parking facilities, or bathing facilities for handicapped people. Accessibility to urbanised beaches managed by neighbourhood communities (which establish parking fees for external beach users) should also be considered, as well as the requirements established in the bathing water quality directive 2006/7/CE and the water framework directive 2000/60/CE (Ariza *et al.* in preparation). In monitoring, measurement and operational control, the set of established partial indices may also be a very useful tool. EMSBs also could enable procedures for technical operations to be formulated, and those for beach management for the study site could consider beach use regulations and waste and litter management.

6.1.3. Beaches and beach management in the Selva Marítima

Results obtained for the different partial indices indicate that human pressure in the region is the main factor responsible for the low quality of the surrounding areas and the natural beach communities. Future efforts should be directed at improving beach use control and maintaining the natural and landscape beaches communities. In this sense, the coastal master plan (*El Pla Director Urbanístic del Sistema Costaner*, or PDUSC) is aimed at protecting areas that still have not been urbanised (Departament de Política Territorial I Obres Públiques 2005). This plan will play a key role in directly protecting the areas surrounding non-urbanised beaches. Indirectly it will help to limit beach use and improve the quality of the natural communities. Its requirements should also be taken account of in the EMSBs.

This thesis has not specifically studied natural beach communities, but some aspects known for the area and have been taken into account in the research. For example, the dry sand community is very scarce compared to other Mediterranean beaches (Colombini *et al.* 2003), probably because human pressure does not allow the natural sand community to develop. Of the studied beaches, Malgrat Nord is the beach with the highest number of littoral vegetation species (5). However, this number is low, bearing in mind that up to 30 species have been found on some beaches on the Catalan coast. In spite of the fact that the number of natural beaches has been reduced as a consequence of the massive urbanisation of Catalan coastal areas since the 1950s (Martí 2005), our analysis reveals that the number of urbanised and natural beaches is still important (Ariza *et al.* in press-b); of these, 45 (in the sector Sant Adrià de Besòs-Portbou) are located in protected areas.

Taking into account this significant number of beaches with non-urban characteristics, as well as the fact that important differences exist in the environments of urban, urbanised and natural beaches (use profile, waste and litter characteristics, etc.), it seems reasonable to establish alternative management practices for different types of beaches. No specific management measures are applied at present. Practices are based on the degree of urbanisation in the vicinity, but the principles of management are generally similar, with few exceptions. Future research should also concentrate on the ecology of beaches, so that more information is made available for monitoring processes for the natural beaches. The ecology of many Mediterranean beaches is not fully understood, and none of the analysed awards/rating systems have defined indicators for more natural beach communities. Consequently, the impact of human activity on beach communities remains largely unknown. Local characteristics, in spite of being considered important for beach management (Micallef & Williams 2002), have not been explicitly included in these systems. In the case of the physical state of beaches, its inclusion (in some cases) is related to comfort, not to other important processes, such as protection of the coast or the inherent physical condition of beaches.

Although beach users, in general, prefer fine-grained sand and gentle slopes, they tend to adapt to the reflective beach profile of the analysed beaches (coarse-grained sand and steeper slopes). The wave regime, as in all Mediterranean regions, is not as intense as for oceanic beaches, although there are currents that trigger risk for bathers and which are a main cause of sediment problems during storm episodes (when sand is reallocated inside beaches or removed by waves). Human density is very high on the coast and in the whole region. The overcrowding of beaches is not a recent phenomenon in the southern Costa Brava. Some beaches have experienced overcrowding for many years, since long before the increase in resident population numbers and the second-home explosion (Sardá *et al.* in review). Users and managers are quite adapted to it, according to information collected in the questionnaires (3.3.4. and 5.2.3.). Reducing beach use is not a priority for them, in spite of the detected problems and that local managers consider tools for controlling and monitoring beach use, interesting.

The fact that the aggregated BQI scores were high for all the studied beaches (Ariza *et al*. in preparation) should not trigger any confusion about beach quality in the area. Most beaches scored low in key partial indices (beach crowding, surrounding quality, beach safety and natural condition), and for S'Abanell beach, the protection partial index was also low. These scores indicate that important beach processes are not functioning properly. Sustainable management of beaches must be reflected in an established minimum value for all partial indices. The best-managed areas are those traditionally most in demand by users, and the areas with most problems are those that require some limitations to be imposed on the expansion of human use. The exceptions are physical quality, safety, and protection of infrastructures. The physical quality scores for beaches were high for the six beaches in the study because no sand management practices (nourishment) or engineering works had been carried out in response to tourist requirements (the central government has the main authority in this area). In the case of beach safety scores, the lack of clear regulation on resources and beach safety practices in Spain has meant that municipalities can establish beach safety and rescue services based on their own criteria. Very demanding standards have been established, for example, for Barcelona's beaches, due to high use. Malgrat de Mar and other municipalities of the Costa Brava do not provide their beaches with the same level of resources. Protection of the coast is the other exception. In the area of study, damage occurs repeatedly to promenades and back beach facilities (Jiménez *et al.* 2002, Ariza *et al.* in press-b). The lack of local management capacity for applying corrective management measures in the DPMT, and the lack of coordination between central and municipal authorities in terms of beach management issues, means that the establishment of definitive corrective measures for beaches where human facilities are not properly protected by sand is complex (and so uncommon). A sediment management policy is needed that will allow planned proactive management in conflictive areas.

6.2. FINAL CONSIDERATIONS

The application of the BQI, sub-indices and partial indices to beaches constitutes a first attempt to evaluate the integral quality of beaches on the Catalan coast. Although different parts of the BQI may be improved, especially in relation to the aggregation process, it has been demonstrated to be capable of robust monitoring of the most important beach processes in two different types of beaches. Ranking analysis has shown that in the studied area, those types do not differ so much in global quality. The BQI may be considered in local, regional and national strategies on ICZM so that processes and risk affecting beaches and their surroundings may be more deeply understood.

According to the criteria included in the BQI, two of the most important potential threats for beach management frameworks deal with urbanization and severe pollution episodes (Annex 4). Although the effects that these situations have on beach quality have been demonstrated (Ariza *et al.* in preparation), the real effects are likely to be greater in terms of impact. Indirect effects were not estimated due to the difficulty in quantifying them, but they certainly exist and would diminish quality. Therefore, prevention must be also a priority of management. Measures should be defined as soon as possible and they should be based on the coordinated action of different actors with responsibilities for the coast (not just local managers). Integration of proactive beach management into the ICZM strategy is also necessary in order to protect beaches from these two potential dangers.

In Spain, in order to develop a strategy for coastal areas by means of which beaches could be proactively managed in a coastal management framework, a change in the perspective on beaches is needed. The *Shores Act* 22/88 enabled a substantial improvement in the quality of important beach processes. Its most important contributions were that it took account of the conservation of the natural heritage and the legal coverage of public ownership of natural areas, acknowledged natural processes that go further than the intertidal area, established restrictions on the protection area, and guaranteed the conservation of the public area. It did not trigger, though, the implementation of beach ecosystem management, and so other management tools are necessary in order to integrate the highly complicated body of regulations concerning beach management issues in Spain. They should include a set of indices that monitor beach processes and local characteristics, a concrete protocol for coordination among departments, ministries and different authorities, and a beach environmental programme with objectives, responsibilities, time schedules and resources. As it has been already commented, *El Plan Director para el Desarrollo Sostenible de la Costa* (PDSC) may be very important for avoiding those shortcomings. In this line, the BQI/EMSBs may allow a very precise and complete monitoring of beach factors and application of ecosystem management practices in the Costa Brava.

Nonetheless, some possibilities for improvement of the index have been considered. Adaptation to new directives and the gathering of more field data have been already considered (Ariza *et al.* in preparation). Other research related to integral beach quality measurement should be directed at defining the blocking of certain function indicator and BQI scores for very low values of the most important partial indices. In a few cases, the effect of one partial index triggers function and BQI scores lower than 0.5. In the current structure of the BQI, absolutely saturated beaches would score above 0.55 in the six considered cases. In the case of the IBS, for example, a zero score would underlie values above 0.60 for all beaches.

Finally, although the opinion of users has already been taken into account in the development of the index, analysing the relationship between user opinions and BQI scores would undoubtedly prove interesting. In some issues, such as environmental quality, parking conditions, and beach crowding, it may help in revising current methods and the effectiveness of the BQI.

Chapter VII
Conclusions

Beach management processes were analysed using the Costa Brava (Northwestern Mediterranean coast) as an example. An extensive questionnaire was distributed to most of the beach managers in the area, significant issues were addressed, and the application of Environmental Management Systems for beaches (EMSBs) analysed. As an important conclusion of this thesis, we strongly recommend the use of such EMSBs to better manage beach ecosystems. Beach management needs to move beyond a dependence on the performance standards widely in use at present. The main specific conclusions of this research are summarised below.

Performance standards and performance rating systems still drive most beach management processes. However, no single performance assessment measurement covers all criteria considered relevant to beach management. Most of the criteria used in performance standards/rating systems are associated with the recreational function of beaches and few of them with two other important beach functions, namely, the natural function and the protective function. Commonly used performance assessment measurements do not consider proactive and dynamic planning, and for this reason, beach management goals are limited and static.

In recent years, EMSBs have been implemented by local authorities (in Spain in 2005, 189 beaches were awarded ISO 14001 certification) which permits to implement "proactive" and environmental management principles in beaches. EMSBs however, need to include other beach management tools so as to monitor different processes, take account of environmentally significant aspects, and emphasise continuous improvement strategies.

The analysis of current beach management processes in the Maresme and Costa Brava regions yielded the conclusion that it is basically service-oriented. The recreational function is the main beach function considered by managers and the main concerns of beach managers were quality-related aspects (water, sand, and services), cleaning and sediment management. The natural function was not considered to be as relevant. Cumulative investment in beaches was not related to the resident population or to coastline dimensions, but to tourism, with a strong relationship detected between average investment and the accommodation coefficient.

The loss of the protective function of many beaches has determined that beach erosion and sediment management are major concerns in the region. Although reactive measures are applied periodically, no global solution has been defined for improving coordination between authorities and reducing the time lag in responding to problems. Other detected problems are the frequency of beach closures and beach "overuse". The apparent generalisation of these problems should indicate that current beach management strategies need to be modified and proactive measures implemented.

Waste and litter management and the environmental quality of beaches were two of the most important issues in beach management, according to users and managers. Values for kilos of waste/user were comprised in the interval 0.054-0.066 with their composition varying as a function of the beach type (urban vs. urbanised beaches) and time, probably due to user profiles and the length of stay on beaches.

The magnitude of the issue can be identified considering that during summer, waste and litter from beaches is at least 3.24% of the total waste produced in the municipality of Lloret de Mar. Their management can be improved substantially by implementing measures such as recycling programmes, educational campaigns, improved mechanical cleaning practices, and better application of litter assessment methods. Under actual conditions, small-size litter on beaches tends to accumulate towards the peak of the season due to the low efficiency of mechanical cleaning.

Beach use in the area was very intense and suffered marked daily fluctuations in the peak season. Of the nine beaches analysed for La Selva Marítima, three occasionally surpassed the value of 5 m^2/user (Mar Menuda, Lloret, and Canyelles South).

Although the resident population and the number of second homes and associated tourism activities have increased sharply over the period (1982-2000), it seems that the maximum number of beach users at the peak of the day did not increase. Three possible explanations were considered: 1) total beach user numbers in 2000 were much higher than in 1982 but the length of stay was much shorter; 2) the offer of other amenities redistributes the activities of tourists; and 3) the beach experience is partially being substituted by the swimming pool experience.

A composite index (the BQI) was derived and applied to six beaches in the study area. The BQI has the structure of a hierarchical scoreboard and it specifically includes function analysis (which considers the recreational, natural and protective beach functions). The opinion of users and experts was used in the aggregation process to derive partial coefficients. The most influential partial indicators were Water Microbiological Quality index, Water-Sand Pollution index, Physical Quality Index and Protection Index. On the other hand, the indicators with the lowest weight in the global score were Crowding index, Service and Facilities index, Quality of Surrounding Area index, Activities index, Access and Parking index, Comfort index and Natural Conditions index. The BQI is particularly sensitive to pollution events and intense urban development processes in the surrounding area.

Almost all the function sub-index and BQI scores were high for all the analysed beaches. The strongest aspects were generally related to user short-term demand: water quality, environmental (aesthetic) quality, services and facilities, activities, comfort and the absence of water-sand pollution. The weakest aspects were related to the consequences of human “over-use” of the area: beach use, quality of the environment and nature, and the protection of infrastructures. Beach quality partial indices should preferably be used separately, with aggregated scores only used in combination with scores for individual indices and the ranking analysis.

The BQI may be used at different EMSB stages. They will play an important role in the initial diagnosis, to establish environmentally significant aspects, and for operational control. Its use within an EMSB will serve to cover the needs of establishing a framework for proactive management and to have effective monitoring tools. Thus, the BQI alone cannot deal with issues such as managerial matters or mid-term planning whereas EMSBs without an adequate set of indices, may not detect legal problems, promote steady improvement, or reduce/prevent environmental impacts.

Future research into beach management

Other priorities for further research can be established on the basis of the results obtained in this thesis. Although most of the beaches of the region have lost their natural charm, the study of ecological processes for relatively unspoilt Mediterranean beaches is necessary. This thesis has not dealt with the functioning of natural beach processes. Natural values have been considered in the context of some beach communities, such as dune systems, but many beach ecological processes in the area, such as those related to the interstitial community, remain unknown. Recent studies have demonstrated the effects of tourism on upper beach meiofauna, but more research is needed so that bioindicators can be established.

An analysis of the effect of beaches on the economy of coastal municipalities of the area has not been extensively made. The economic analysis of beaches is another interesting line of research and may help in the definition of beach management guidelines.The multiplicative effect produced on income, revenues and employment by tourism activities related to beaches needs to be more precisely established and results considered in beach management decisions. Values should be compared with investment in beach management by local councils and regional and state authorities, through a social cost-benefit analysis that provides a valuation of aspects not included in market values.

A third possible line of research is the valuation of the natural, social and cultural resources of beaches. In this thesis, the natural, recreational and protective functions of beaches were considered, but a detailed analysis of all beach ecosystem services was not carried out. The study developed in this project constitutes a necessary first step towards the global valuation of beach resources on the Costa Brava.

As a final comment, the application of the BQI to other areas may be also produce interesting results. Besides assessing the integral quality of other type of beaches, it would help in further analysing the robustness of the index.

Chapter VIII
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ANNEX

ANNEX I. CEDEX AND CANTABRIA INDICES: STRUCTURE AND METRICS

1.-CEDEX INDEX (metrics)

$$ICP = \frac{4ICAG+3ICAR+2ICFA+3ICG+2ICE+ICCS+ICAC}{16}$$

ICP= Beach Quality (Índice de Calidad de Playas)

ICAG= Microbiological and Chemical Quality of Water (Índice de Calidad Ambiental de las Aguas).- Assessed by analysing faecal coliforms and streptococci and classifying results according to criteria based on directive 76/160/CE**.**

ICAR= Sand Quality (Índice de Calidad Ambiental de las Arenas)**.-** Assessed by analysing microbiological quality, heavy metals and organic matter of sand.

ICFA= Physical Quality of Water (Índice de Calidad Físico de las Aguas).- Assessed by analysing temperature, turbidity and wave regime of beach waters.

ICG= Geomorphologic Quality (Índice de Calidad Geomorfológico).- Assessed by analysing beach width, beach form, sediment dynamics, slope, step on the shore, irregularities in the submerged zone, grain size, sand colour and grain form.

ICE= Aesthetic Quality (Índice de Calidad Estética).- Assessed by analysing litter left by users, litter of sea origin and gathering of shells on the swash area.

ICS= Service Quality (Índice de Calidad de los Servicios).- Assessed by analysing the existence of leisure and service facilities (showers, WC, telephone, accesses), cleanliness and environmental control services and facilities (bins, waste segregation, sanitary control of water and sand), safety and rescue services and information services.

ICAC= Activity Quality (Índice de Calidad)**.-** Assessed by analysing potential annoyances, such as sports played on the sand, animals, nautical motorbikes, motorboats, windsurf and fishing.

2.-CANTABRIA INDEX (metrics)

$$ICP = f_a * f_s * f_o \, (H+V+S+I+C)$$

ICP = Beach Quality Index (Índice de Calidad de Playas)

f_a = Bacteriological Water Quality.- Assessed by analysing accomplishment of guidelines and imperative criteria of directive 76/160/CE.

f_s = Organoleptic factors.- Assessed by analysing the presence of oil and foam on water.

f_o = Chemical sediment quality (calculated only for industrial beaches).- Assessed by analysing heavy metal concentration.

H= Hygiene (not applicable to natural beaches).- Assessed by analysing cleanliness service, presence of bins, presence of drinking water, showers and WC.
V= Safety and rescue services (not applicable to natural beaches).- Assessed by analysing existence of lifeguard services.

S= Signposting (no applicable to natural beaches).- Assessed by analysing presence of sea state flag, dangerous areas, signposting of different use areas and signposting of services.

I= Information (not applicable to natural beaches).- Assessed by analysing information on water quality, sand quality, beach characteristics and beach norms.

C= Characteristics of the environment (not applicable to natural beaches).- In non-natural beaches, assessed by analysing access, parking, public transportation, and facilities in beach areas. In natural beaches, assessed by evaluating landscape, considering rare species, intensity of human impacts and aesthetic quality.

ANNEX II. QUESTIONNAIRES FOR LOCAL MANAGERS AND BEACH EXPERTS

1-QUESTIONNAIRE ON MUNICIPAL COUNCIL BEACH MANAGEMENT PRACTICES

Municipality:
Date:
Position of person responding the questionnaire:

Organizational issues

1. Which of the beaches included in your municipality are managed by municipal council? And by other local entities, such as residential estate managers, campsite managers, etc.?

2. Which municipal council departments are in charge of beach management? How is work distributed?

3. Has the municipal council a beach management plan for the bathing season? (If possible, attach a copy of the document) Date

4. Have any of the beaches in your municipality experienced a pollution event affecting sediment? If so, indicate the cause if it has been determined.

5. Have microbiological, chemical and physical and chemical analyses of sediments been conducted by a competent authority? If, please indicate average data for the last year the tests were conducted.

6. Have any of the beaches in your municipality experienced an emergency situation that led to closure of the beach in the last 5 years? When? What was the cause?

7. What is the approximate budget for maintenance, cleaning and conservation of the beaches in your municipality?

Frequentation and beach use

8. Has an excessive density of users during the bathing season been detected in any of the beaches in your municipality? When and for how long? What percentage use reduction would you recommend?

9. Do you think that it would be interesting to have a tool that enabled more or less continuous control and monitoring of the state and use of beaches in your municipality? Do you think that it would improve or facilitate beach management?

Management of sediment

10. Have you had problems related to sediment loss or sediment pollution on your beaches?

11. Do any of the beaches in tour municipality have chronic erosion problems?

12. Have the beaches of your municipality had problems related to sediments due to storm events?

13. Have the beaches in your municipality had problems related to sediments due to the construction of a maritime infrastructure in the vicinity? If the answer is yes, describe the infrastructure.

14. In order to correct problems related to sediment, have engineering works been carried out on the beaches in your municipality? If the answer is yes, describe the engineering works.

15. Have sediment management works been performed by a competent authority on beaches that needed them? Have alternative management works been performed by a local authority?

    - Creation of beaches ☐
    - Beach nourishment ☐
    - Redistribution of sediments ☐

16. When were these works performed?

17. Are those operations regular or sporadic? If periodic, in which season are they performed?

18. If periodic, what are the criteria used to carry them out? Do they respond to any concrete phenomenon? Is there any protocol with instructions?

19. Indicate kind of sediments (marine or terrestrial) and approximate budget:

20. Is there any natural community in the vicinity that is potentially affected by works to redistribute sediments?

21. Do any of the beaches in your municipality have a belt of dunes, whether stable or in regression?

<u>General concerns</u>

22. What is the main beach management problem or concern in relation to beaches in your municipality?

23. Comments and suggestions:

2-QUESTIONNAIRE ON BEACH QUALITY ASSESSMENT FOR EXPERTS

Date:
Position of person responding the questionnaire:

1.- Coefficients: What is the weighting (in percentage) that you assign to the 8 factors included in the assessment of the recreational function of beaches and for the 3 factors included in the natural function? Please complete below for the three types of beaches. Distribute 100 points among the different blocks of each function.

Factors	**Urban beaches**	**Urbanised beaches**	**Seminatural or natural beaches**
Recreational Function			
1.- Beach crowding			
2.-Environmental quality of water and sand			
3.- Services and facilities			
4.- Activities			
5.- Access and parking			
6.- Quality of surrounding areas			
7.-Comfort of beach space			
8.-Beach safety			
	$\Sigma_{1\ a\ 8} = 100$	$\Sigma_{1\ a\ 8} = 100$	$\Sigma_{1\ a\ 8} = 100$
Natural Function			
1.-Vegetation of beach community			
2.- Pollution of water and sand			
3.-Changes in the elements and physical condition of beaches			
	$\Sigma_{1\ a\ 3} = 100$	$\Sigma_{1\ a\ 3} = 100$	$\Sigma_{1\ a\ 3} = 100$
Protective Function			

Type of beaches

Urban beaches: Beaches located in a highly urbanised setting.

Urbanised beaches: Beaches located in a moderately urbanised setting, with some natural areas.

Seminatural or natural beaches: Beaches with an important natural component, with some urbanised areas.

Comments:

--.

2.-Function weightings: If we assume that beaches may carry out three functions (recreational, natural and protective), what importance (in percentage) do you assign to each in the three type of selected beaches?.

Functions	**Urban beaches**	**Urbanised beaches**	**Seminatural or natural beaches**
Recreational			
Natural			
Protective			

Comments:

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Thank you.

ANNEX III. BEACH SAFETY CRITERIA ESTABLISHED BY *LA DIPUTACIÓ DE BARCELONA*

PROGRAMA D'HIGIENE I SEGURETAT A LES PLATGES
(DIPUTACIÓ DE BARCELONA-ÀREA SALUT PÚBLICA I CONSUM)

1.-Estándares del Plan de Seguridad

Se considera que una playa de 1.000 m y aproximadamente 30-50 m de anchura debe tener los estándares mínimos siguientes:

MATERIAL DE INFRAESTRUCTURA							
1 Lugar de socorro	2 Palos de bandera	1 Torre de vigilancia	1-2 Sillas de vigilancia (depende de la distribución de la torre y el lugar de socorro)				
MATERIAL DE TRANSPORTE							
1 Embarcación tipo I por lugar de socorro	1 Embarcación tipo II cada 4 km*	1 Vehículo cada 4-6 km*	1 Bicicleta o moto cada km (depende del terreno)				
* En función de las características de las playas							
MATERIAL DE COMUNICACIÓN							
1 Emisora portátil por silla/torre/embarcación	1 Emisora fija por lugar de socorro						
MATERIAL DE SALVAMENTO							
4 Chalecos	4 Boyas torpedo	4 flotadores	4 cabos de 100	1 juego de Prismático por silla/torre/embarcación 2 por lugar de socorro			
MATERIAL SANITARIO							
1 juego Resucitador manual	1 Equipo reanimación respiratoria	2 Botiquines	1 Litera reconocimiento	2 Literas portátiles	1 Litera cuchara	1 juego Collar cervical	1 juego Férulas inchables

2.-Recursos materiales propuestos

Embarcación tipo I: Embarcación semirígida de 4-5 m de eslora, equipada con un motor fueraborda (25-30 CV) que se utilizará para tareas cercanas a la playa (permite la entrada a la arena en casos de emergencia).

Los recursos humanos en esta embarcación, 2 personas (un "titulín" o patrón y un socorrista acuático).

Embarcación tipo II: Embarcación semirígida de 7-8 m de eslora, equipada con dos motores fueraborda (70-90 CV) o un motor diesel infraborda, que por su gran navegabilidad en condiciones adversas se utilizará para tareas de salvamento marítimo y rescate.

Los recursos humanos en esta embarcación serán de un patrón (PER) y dos socorristas acuáticos. Podrá llevar hasta 8 personas.

Torre de vigilancia: Estas torres son puntos fijos elevados de observación. Estarán ubicadas en segunda línea de mar.

Los recursos humanos necesarios son socorristas acuáticos o básicos, que realizan la vigilancia de la zona de influencia de la playa y son los encargados de pasar aviso al lugar de socorro y al resto del operativo.

Silla de vigilancia: elemento de vigilancia, de unos 2 m de altura, situado en primera línea de mar (siempre habrá un socorrista acuático). Son puntos de intervención rápida (en caso de rescate). Sirve para hacer recomendaciones a los usuarios.

Lugar de socorro: Estará situada en la playa a distancias equitativas del resto de infraestructuras del servicio (torres de vigilancia, sillas...).

Sus funciones básicas son: ser un punto de asistencia sanitaria de la playa, ser el centro operativo de un dispositivo equilibrado y, también, ser un punto de vigilancia estática en los casos cercanos a la zona de baño.

Contará con unos 4 socorristas, aunque este número variará en función del tipo de playa.

3.-Actuaciones y estándares mínimos de señalización:

a) Señalización de todos los servicios que ofrece cada playa.
b) Palos de bandera que informen del estado del mar.
c) Sistema de aviso de emergencia en cada playa (1 por playa).
d) Balizamiento de las zonas de baño vigiladas (línea de 200 m) y canales de entrada y salida de embarcaciones (1 por caseta de socorro).

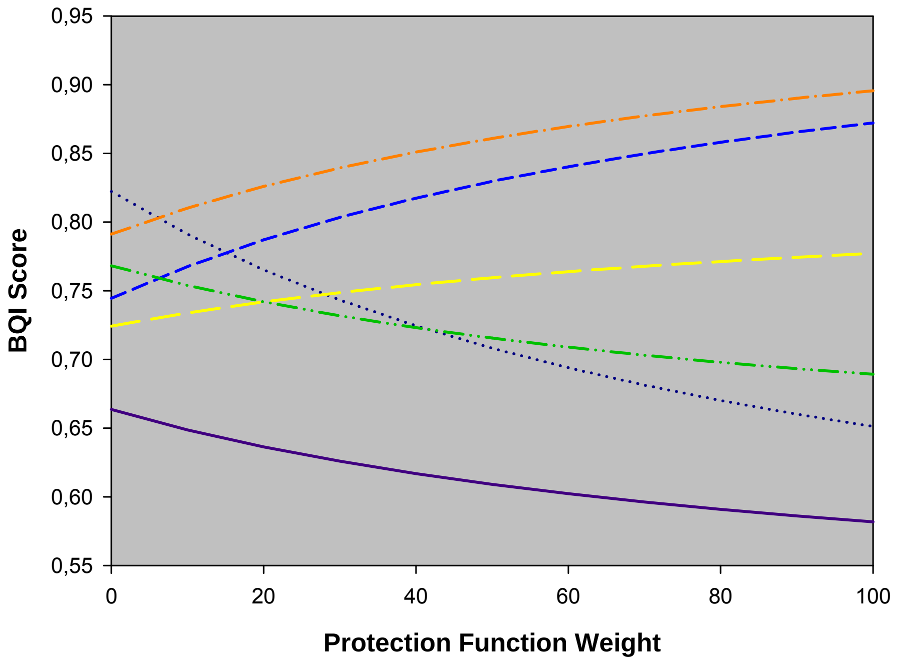
ANNEX IV. SENSITIVITY AND UNCERTAINTY ANALYSIS

The following factors were identified as the main sources of subjectivity in the BQI: the intensity of function indicators, the weights assigned to partial indices, the partial indices included, and the composition of partial indices and scoring. In order to measure the effect of this subjectivity on the BQI and on the different parts of the Index, we developed a series of uncertainty and sensitivity analyses. The partial indices that have the greatest effect are α, IWSP, IPQ and IPP. α is more important on urban beaches than on urbanised beaches. On urban beaches, the lower α scores (all other conditions remain the same) produce very low RFI and BQI scores. IWSP also has a strong influence on the final score, but the BQI score is only below 0.5 when the IWSP value is 0 in Malgrat. IPQ does not produce BQI scores of less than 0; IPP may produce BQI scores of less than 0.5 at Malgrat Nord and Lloret Centre. The partial indices that have the least effect on the final score of the studied beaches are IC, ISerF, IS, IAct, IAcPar, IComf and IN.

The variation of BQI depending on the weight assigned to functions (in percentage) is shown in Figure A41. In the first graph, the increase in the weighting of the protective function (the scores for partial indices are measured in the current situation) and the proportional decrease in the natural and recreational function produce two different patterns: BQI scores decrease for the most exposed beaches (Malgrat, S'Abanell and Lloret) but do not fall below 0.55 for any beach; BQI scores increase for the most sheltered beaches (Sta. Cristina, Canyelles and Tossa-Mar Menuda) when the weighting of the protective function is increased. The BQI scores increase for all beaches when the weight of the natural function is increased; the scores for Malgrat and S'Abanell are never lower than 0.5 and the variation of BQI scores is approximately 0.1. The BQI scores decrease for all beaches except in S'Abanell, when the weighting of the recreational function is increased. The greatest decreases are recorded in Sta. Cristina and Canyelles (0.1-0.2).

The next figure A42 shows the variation in RF and BQI scores depending on the type of weighting applied. Although experts and beach users assign different degrees of importance to particular partial indices, the overall RFI and BQI scores do not change significantly. The results obtained when all sub-indices are given the same weight are very similar to those obtained from the expert and beach user opinions.

Variation of BQI vs variation of Protection Function weight



Variation of BQI vs variation of Natural Function weight

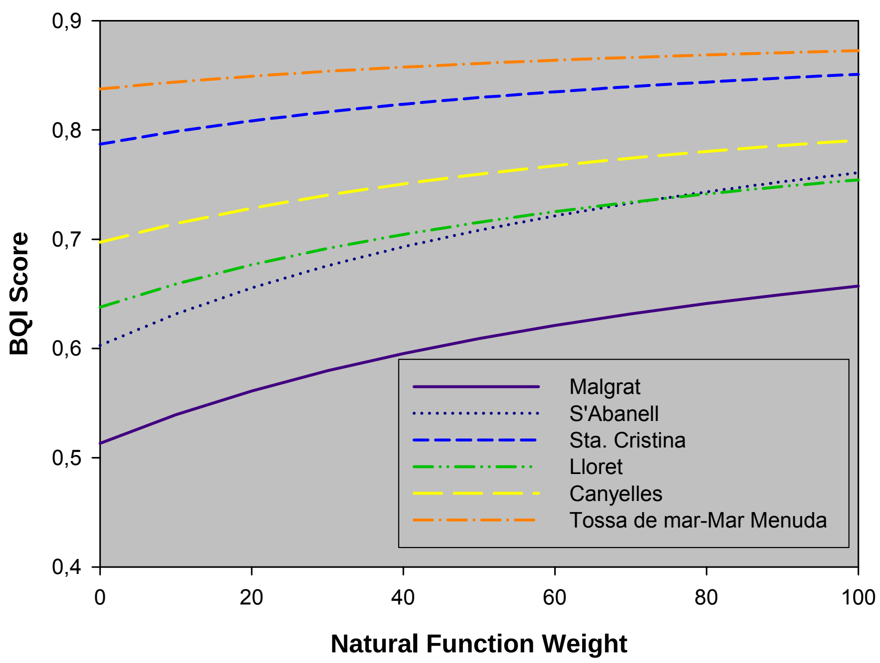


Figure A41. Variation of BQI related to a) increased weighting of the protection function and decreased weighting of the natural and recreational functions; b) increased weighting of natural function and decreased weighting of the recreational and protective functions; c) increased weighting of the recreational function and decreased weighting of the protection and natural functions.

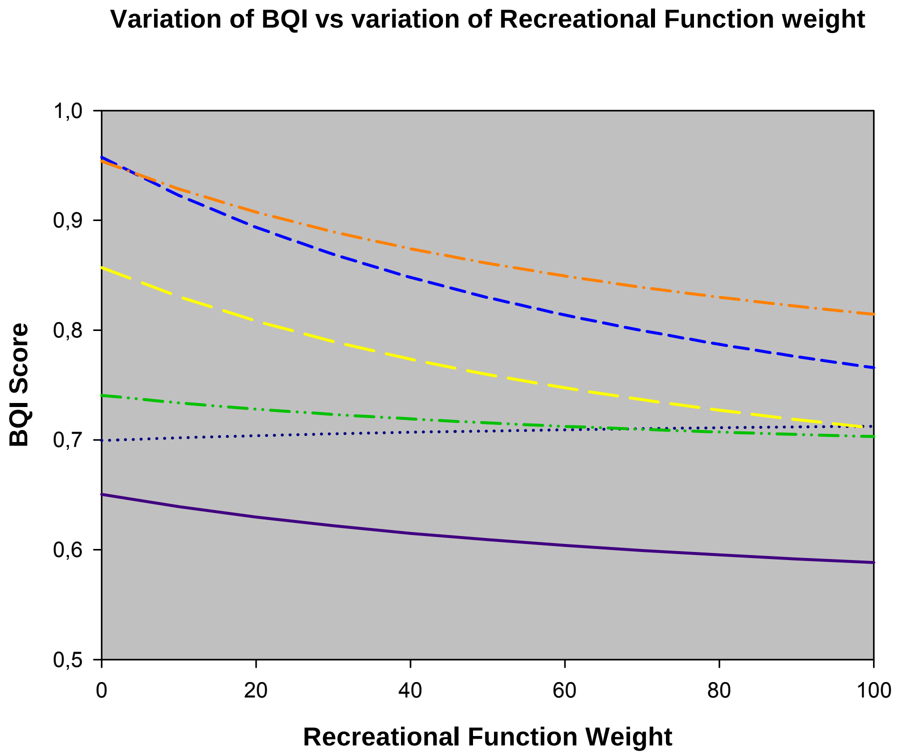
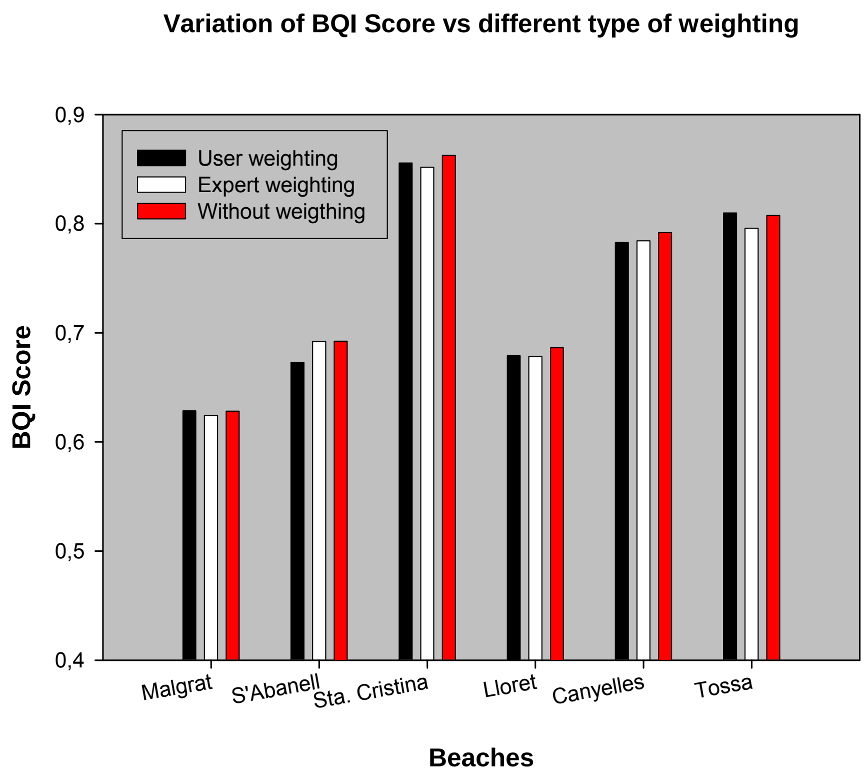


Figure A41 (Continued). Variation of BQI related to a) increased weighting of the protection function and decreased weighting of the natural and recreational functions; b) increased weighting of natural function and decreased weighting of the recreational and protective functions; c) increased weighting of the recreational function and decreased weighting of the protection and natural functions.



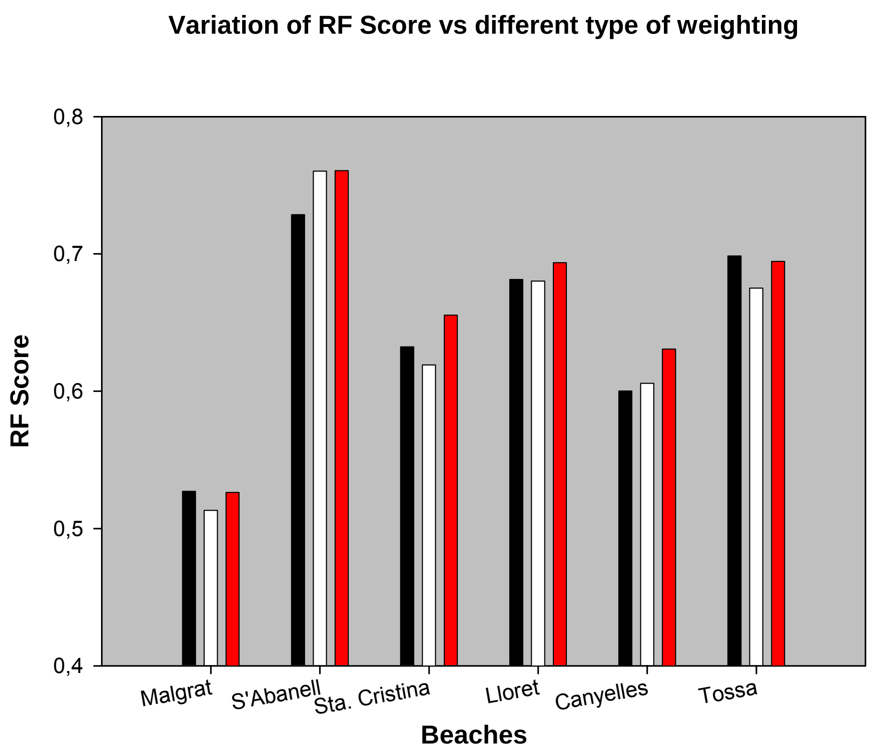


Figure A42. Variation of RF and BQI scores related to different weighting methods: user-defined, expert-defined and without differentiated weighting.

We developed a sensitivity analysis in order to monitor the way in which the functional sub-indices and the BQI scores would be affected by different hypothetical events. We defined four situations and studied the new scores obtained for the sub-indices and the BQI:

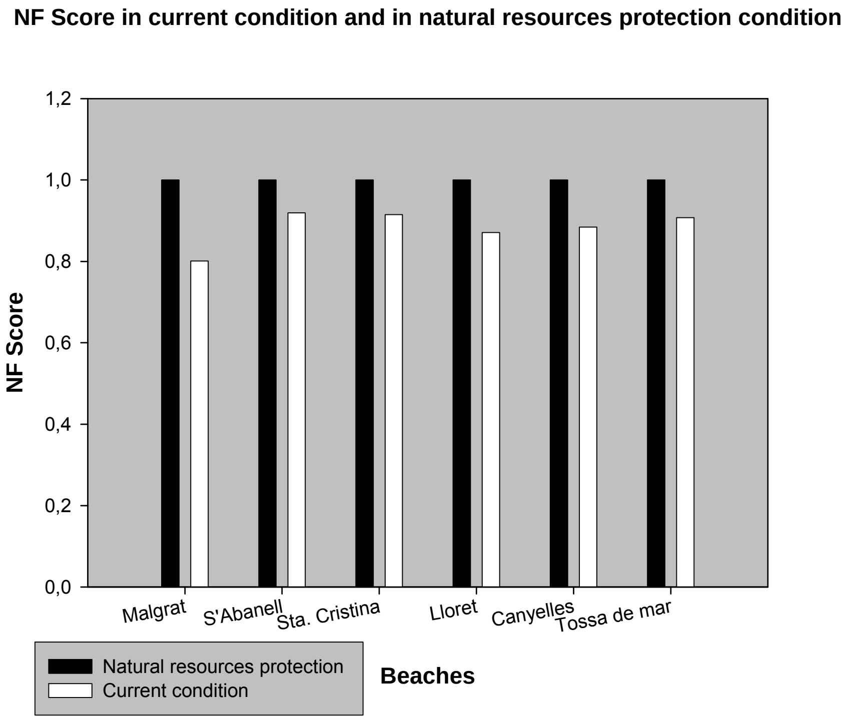
a) The protection of natural resources, in which the following conditions are assumed: perfect IC, IEQ, IAct, IN and IWSP scores.

b) A Marine Pollution event, which would produce the lowest IEQ and IWSP scores.

c) The restriction of beach use and facilities would trigger a perfect IC and the lowest scores for ISerF, IAct and IAcPark.

d) Intense urban development in the surrounding area, in which five conditions are assumed: the lowest IC score, low sand environmental quality in IEQ (score 0.2), low IAct (0.4), the lowest IS score and low IN (0.2).

The results obtained for each situation are shown in Figure A43., Figure A44., Figure A45. and A46. The lowest BQI scores were obtained for the situations related to marine pollution and intense construction conditions. The protection of natural resources situation produced a slight increase in the NFI and the BQI scores increased slightly as a result. The marine pollution conditions situation led to a moderate decrease in the RFI and a dramatic decrease in the NFI. The BQI scores were notably lower for the Canyelles and Lloret Centre beaches. The reduction of use and amenities situation produced RFI scores that are very similar to current values. The overall quality was affected to a greater extent in urban beaches. The BQI scores were very similar to the current values, but there was a slight reduction in quality of the urban beaches. In conditions of intense construction in the surrounding area the value of the RFI fell dramatically. The NFI was very similar to the current value but a slight decrease was observed for some beaches. There was also a moderate decrease in BQI scores.



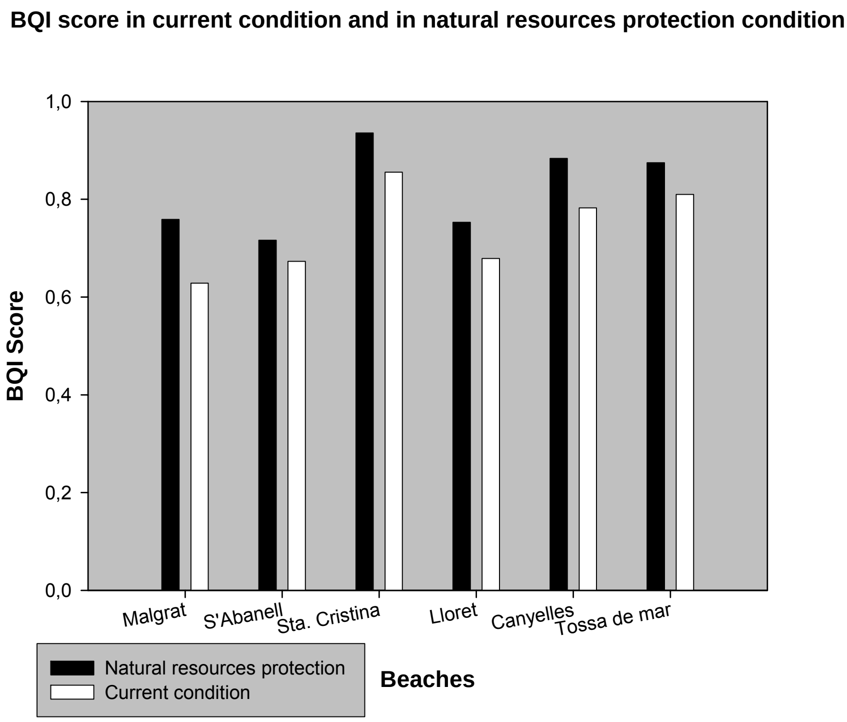
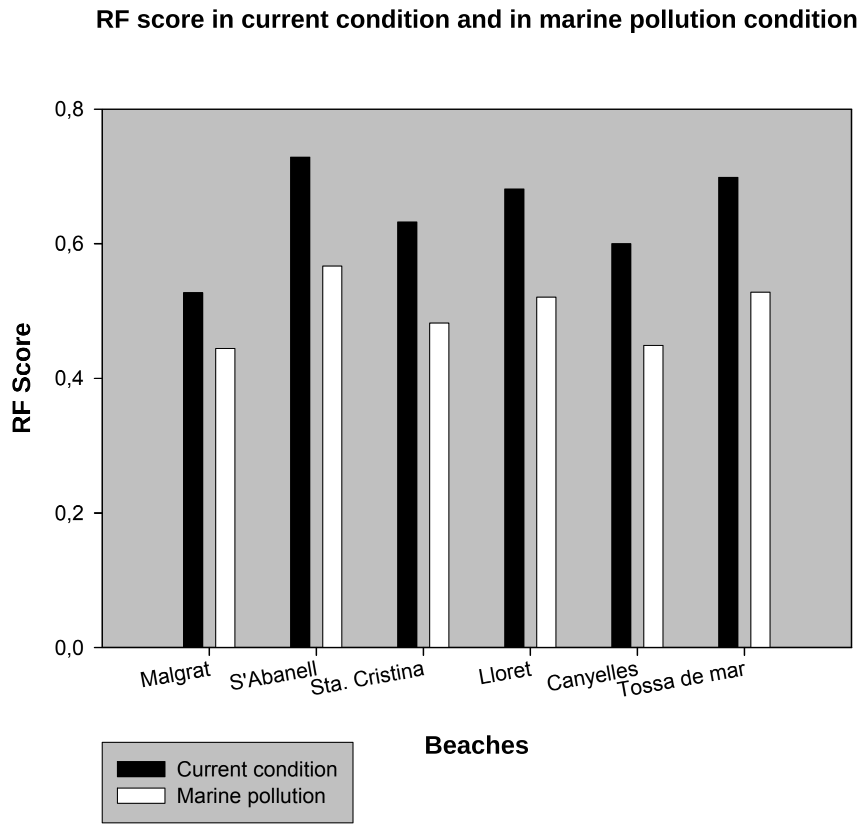


Figure A43. Natural Function score and BQI score in current condition and natural resources protection condition.



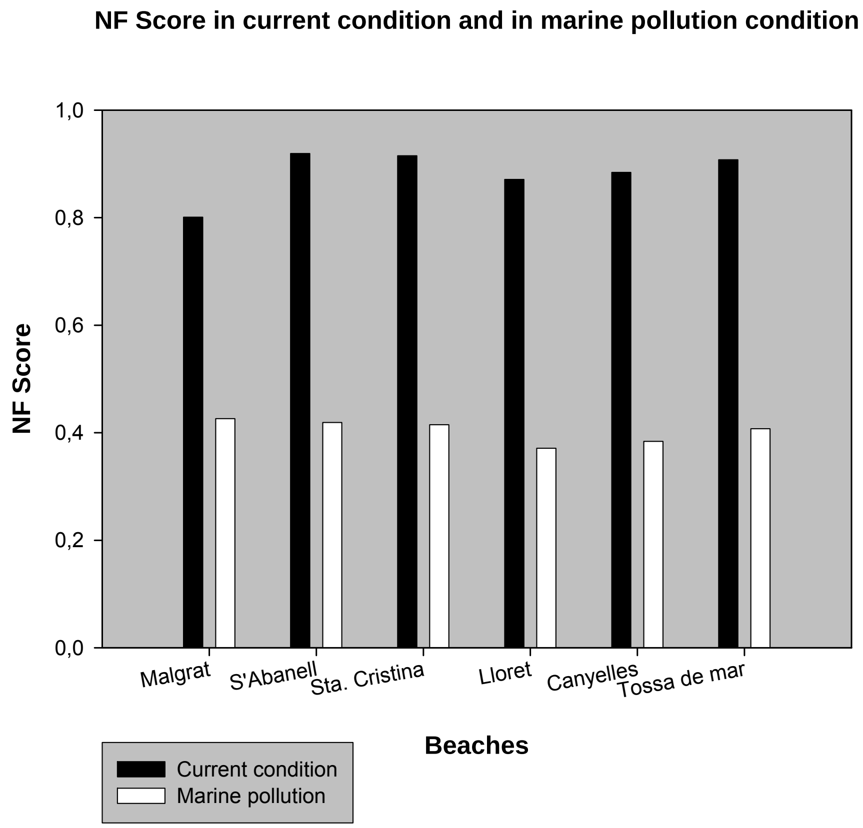


Figure A44. Recreational and Natural Function scores and BQI score in current condition and marine pollution condition.

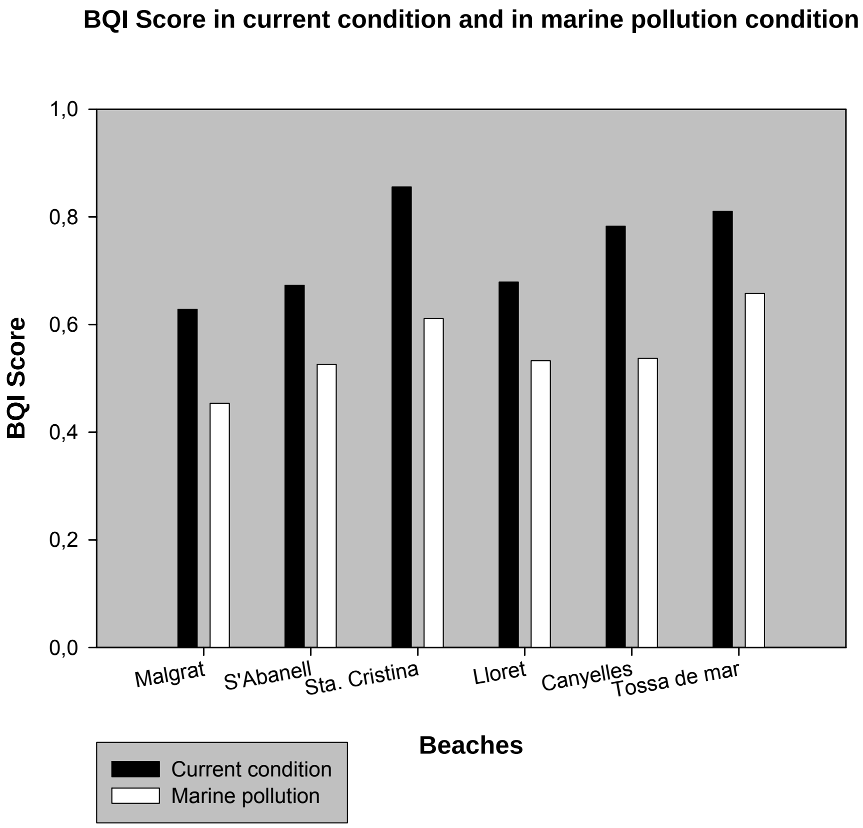
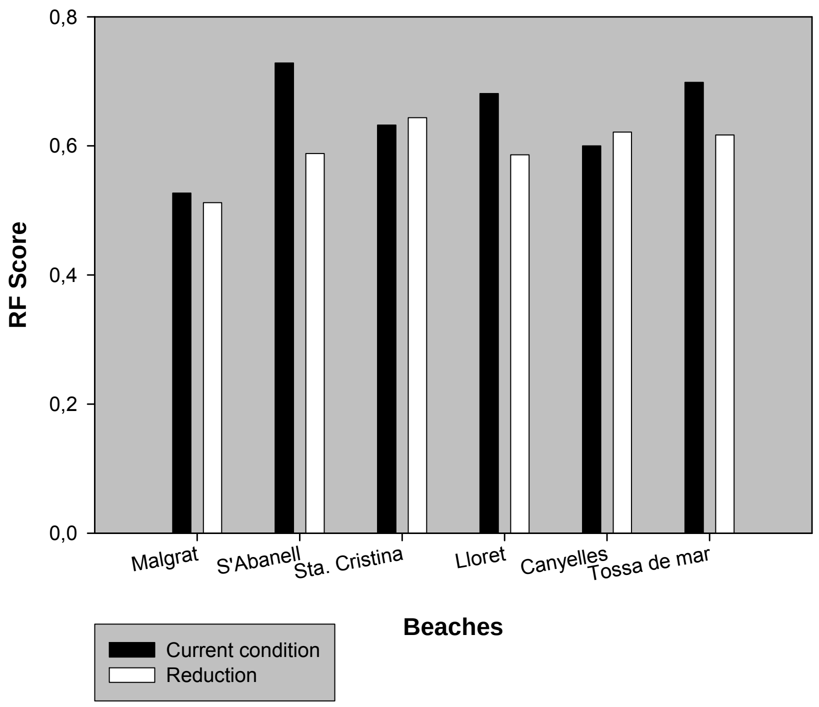


Figure A44 (Continued). Recreational and Natural Function scores and BQI score in current condition and marine pollution condition.

RF Score in current condition and in reduction of use and facilities condition



BQI Score in current condition and in reduction of use and facilities condition

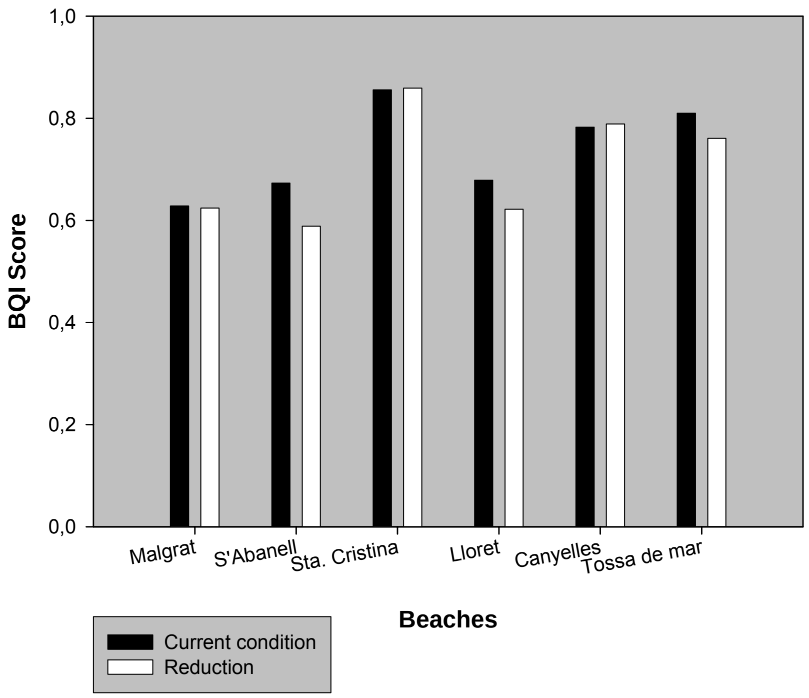
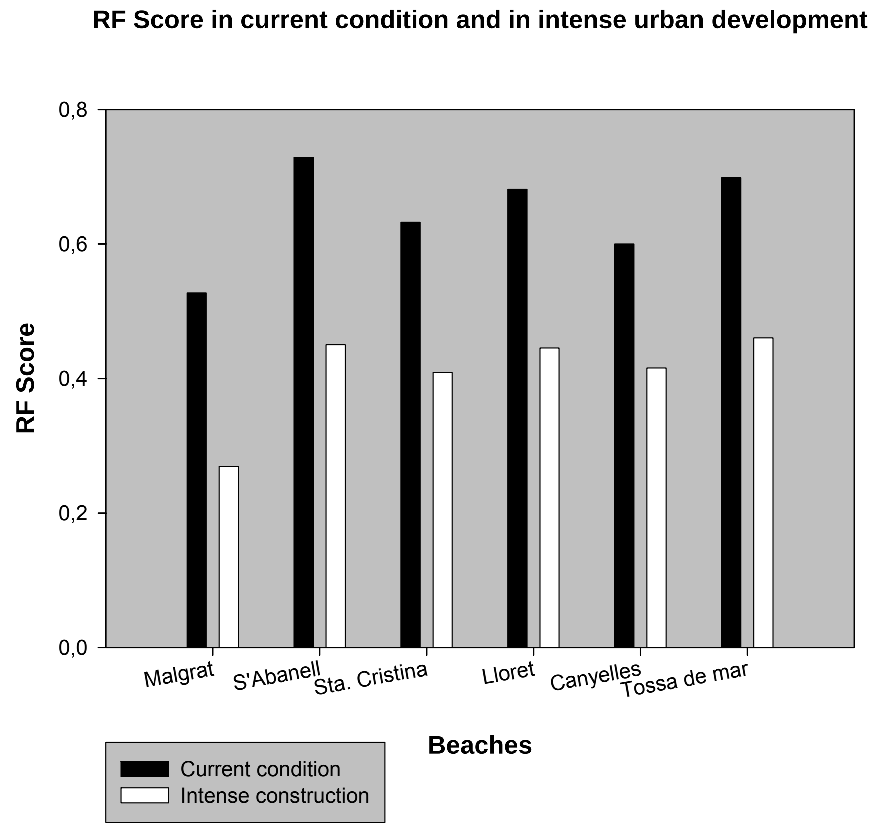


Figure A45. Recreational Function and BQI scores in current condition and reduction of use and facilities condition.



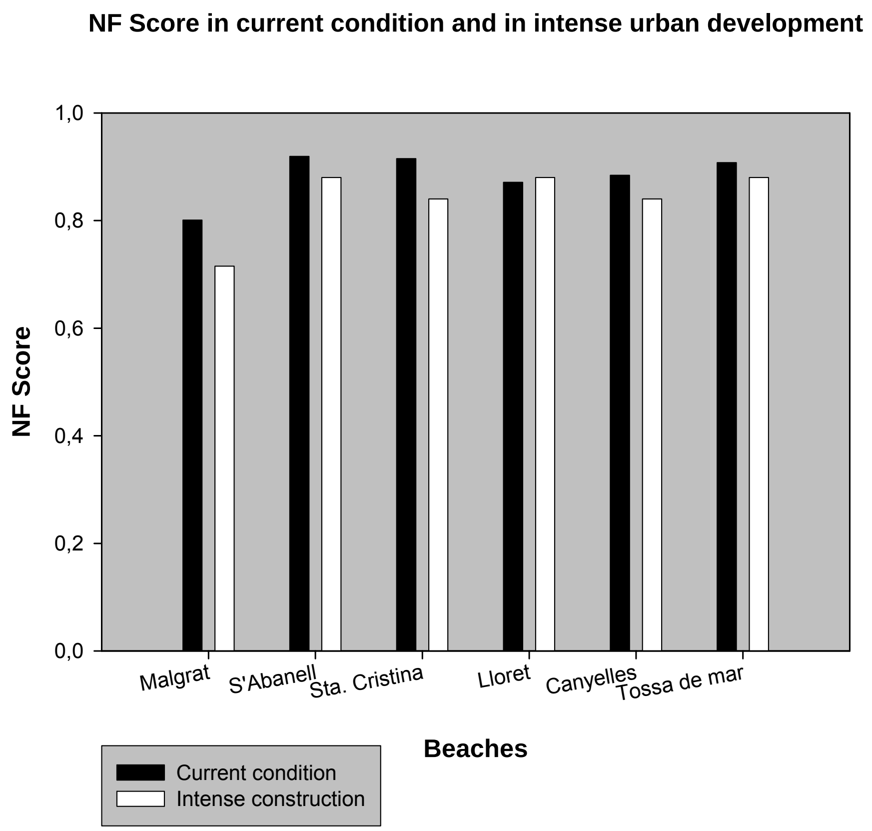


Figure A46. Recreational and Natural Function scores and BQI scores in current condition and intense urban development.

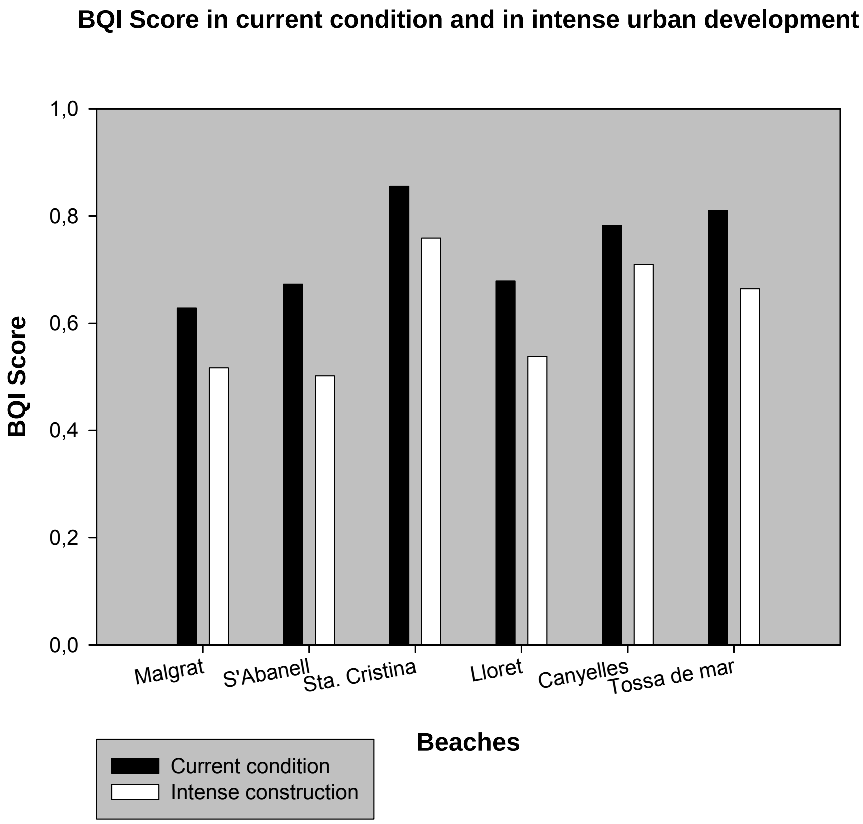


Figure A46 (Continued). Recreational and Natural Function scores and BQI scores in current condition and intense urban development.