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A proposal for boundary delimitation for integrated coastal zone management initiatives

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A B S T R A C T

ICZM relies heavily on the definition of major multidisciplinary characteristics/elements of the coastal area of interest. Usually, only terrestrial boundaries are considered, which tend to respond to a specific sectoral problem and can be determined by administrative limits. In this study, we propose a method for establishing a decision-making tool to inform boundary delimitation for ICZM initiatives that is proactive and widely applicable as opposed to reactive and problem specific. This method integrates environmental, economic and societal characteristics of the marine and terrestrial boundaries of the coastal zone, starting at the boundary of the jurisdictional zone of influence (shoreline units), increasing in detail through the definition of their influential areas from jurisdictional, environmental or socio-economic perspectives (functional areas) and, within them, specifying the finest scale at which relevant indicator data may be obtained (analysis units).

1. Introduction

Coastal areas constitute the basic implementation locus of ICZM. Due to the extreme variability of coastal areas, the highly diverse nature of these systems, and their socio-ecological value, appropriate study units need to be selected from the very beginning to guide associated ICZM initiatives [1,2]. Effective ICZM requires that the problem being addressed can be defined within appropriate geographic boundaries that contain both causes and effects [3]. Although there are some notable studies focused on the delimitation of coastal environments from an integrated management perspective (e.g. [4,5]), there is a noticeable absence of work dedicated to establishing proactive methods for delimiting boundaries for ICZM initiatives. The works that constitute a reference in this field generally relate to a specific problem, such as pollution and/or resource-use conflicts [1,3,6,7], and delimit boundaries based exclusively on the area of influence of that problem. Other studies [2,8–10] relate solely to the administrative divisions of local areas or regions, or are centered in the zones delimited by regulations related to the physiographic and geomorphic characteristics of the coastal area. Homogeneous environmental management units (HEMUs) are large scale territorial units which have been used to define management boundaries in some cases (see for example [1,2,11,12]). The boundaries of HEMUs are generally defined by coastal areas with similar environmental and socio-economic characteristics. These HEMUs are generally composed of local administrative units (LAUs equivalent to municipalities). Where smaller areas within HEMUs must be defined for management purposes, LAUs may not represent the most relevant scale needed to understand the interactions that may lead to problems and conflicts raised during the managerial process. Data availability, ecosystems, and jurisdictional boundaries also need to be taken into account. All of these factors result in the fact that boundary delimitation continues to be a challenge for coastal managers and scientists.

The aim of this work is to propose a more proactive, widely-applicable method for delimiting boundaries of ICZM initiatives based not on a specific problem, but on data availability and the geo-environmental, socio-economic and jurisdictional characteristics of the management area. This method is developed and applied in the context of the coastal zone of the island of Mallorca, Spain (Balearic Islands, northwest Mediterranean Sea). Although presented in the context of an insular environment, the methodology presented below may be applied to any coastal zone. The result of categorizing and defining territorial units using this method is a visual tool that can be used to make informed decisions

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about the area that needs to be taken into consideration for implementing ICZM at any given location.

2. Study area

The Balearic Islands (Fig. 1) constitute the prolongation towards the NE of the *Béticas mountain ranges*. The archipelago is made up of four main islands whose main characteristics are given in Table 1. The socio-economic structure of the Balearic Islands is based on a service economy, the tertiary sector occupies 80% of the economy, while industrial activities occupy 10%, construction sector 8%, and the primary sector 2%. Tourism is the main economic activity of the islands with a contribution of 75% of its 22 billion euros GDP in 2006 [13]. The sector is based on the "sun and beach" tourist model [14–17]. Although growth tendencies of this kind of tourism have diminished recently, during the last years, the Balearic Islands have shown continuous growth from the mid twentieth century due to fundamental factors such as social stability and modernization of the tourist product [15,18]. However, the development of tourism in the Balearic Islands has resulted in a substantial increase in urbanization, resulting in a drastic transformation of the landscape, especially in coastal areas. The implementation of an economic model based on tourism gave rise to a change in the territorial organization around the leisure industry [19], transforming large areas and coastal zones constituted by rural and natural landscapes (e.g. salt marshes and coastal dunes) into urban spaces of primary and secondary residences and tourist sites with associated services. In doing so, it has created multiple conflicts and has increased the demand for improved methodologies for informing decision-making related to coastal management. As insular environments, where space and resources are especially limited and vulnerable to change, the Balearic Islands constitute an important location for ICZM within a clearly defined spatial context.

2.1. Legal framework of Mallorca coastline

Coastal areas of Spain fall under the jurisdiction of the coastal law 22/1988 [20]. The coastal law is compulsory with the objectives of: (a) guaranteeing public use and access, (b) taking appropriate measures to protect and restore coastal areas, with respect taking account for the landscape, environment and historical patrimony, and (c) guaranteeing satisfactory levels of water quality. This legislation was enacted by a Coastal General Directorate under the Spanish Ministry of the Environment. The coastal law differentiates some zones in the coasts (Fig. 2) and proposes limitations in order to guarantee the protection of the terrestrial and marine public domain. These zones are: (1) *servitude of protection*, which covers the first 100 m inland from the coastline and can be extended to an additional 100 m when considered necessary to protect certain characteristics of an area, prohibiting construction, resource exploitation and pollution, among others; (2) *servitude of transition*, which affects a strip 6 m inland from the coastline, with the possibility to extend up to 20 m if deemed necessary; the function of this zone being to ensure the public use of the coastline; (3) *servitude for sea access*, which ensures public access to the sea; and finally (4) *the zone of influence*, with a minimum width of 500 m with respect to the coastline, taking into account the servitudes mentioned previously, which ensure that the density of new construction does not exceed the existing density in the respective municipality.

Under the coastal law framework, coastal management activities in Spain suffer from the division of competencies between the different administrative units at the local (municipalities), regional

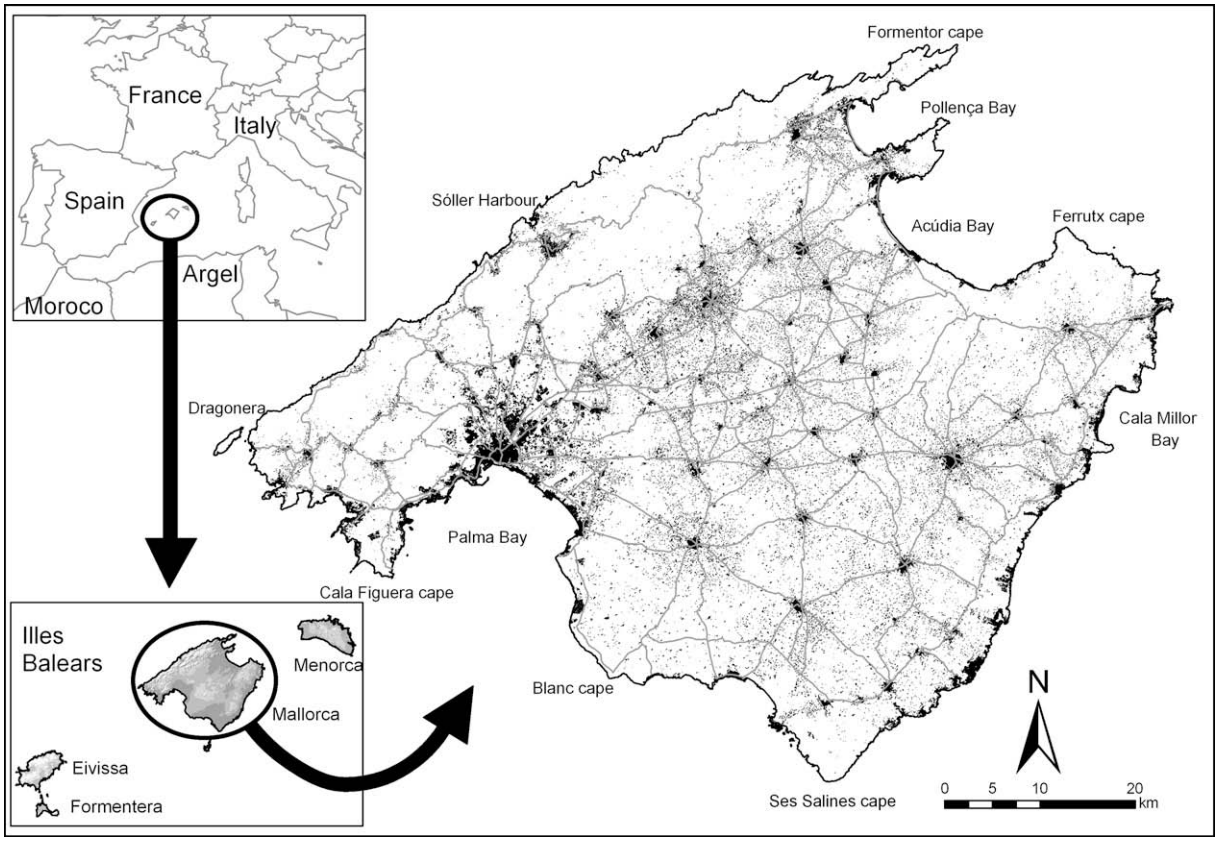

Fig. 1. Location of the study area showing roads and urbanized areas of Mallorca.

Table 1
General characteristics of the Balearic Islands

	Mallorca	Menorca	Eivissa	Formentera
Surface (km^2)	3623.4	694.5	571.8	82.5
Coastline (km)	722.6	349	291.3	104
Population	777,821	86,697	111,076	7506
Municipalities	54	8	5	1
Main city (population)	Palma (285,869)	Maó (24,523)	Eivissa (42,421)	Sant Francesc (2228)

(autonomous regional governments), and national levels (Government of Spain). These entities tend to address different sectoral aspects related to the coastline, often with opposing objectives and strategies [21]. In addition, in the Balearic Islands there is an additional administrative entity at the regional level, the Insular Council, which, in some circumstances has autonomy with respect to the Autonomous Government of the Balearic Islands. Four insular councils exist in the Balearic Islands (Mallorca, Menorca, Eivissa and Formentera). The insular councils are responsible for the elaboration and modifications of the *Insular Territorial Plan*, which establishes the criteria that guide land use changes for each island, and includes other sectoral plans. The proposed actions in those plans must be respected by the inferior jurisdictional level (e.g. municipalities). This multi-tiered, overlapping jurisdictional framework is confusing and often leads to ineffective management, communication, and coordination in the coastal zone. This further necessitates a clear, proactive definition of management boundaries, including the geo-environmental, socio-economic and jurisdictional characteristics within those boundaries to facilitate informed decision-making.

3. Methods for boundary delimitation: definition of territorial units

In this section we define three levels of the analysis which comprise the proposed methodology for developing the decision-making tool to inform boundary delimitation for ICZM initiatives. These levels correspond to decreasing scales of measurement, starting with HEMUs, then with the classification of the boundary of the jurisdictional zone of influence (shoreline units) and increasing in detail through the definition of their influential areas from jurisdictional, environmental or socio-economic perspectives (functional areas) that contain the finest scale at which relevant indicator data may be obtained (analysis units). Fig. 3 shows a visual representation of these different levels of analysis applied to Cala Millor in Mallorca, which are described in detail below.

3.1. Homogeneous environmental management units (HEMUs)

The spatial heterogeneity of the coastal zone can be rationalised by selecting homogeneous environmental management units (HEMUs). These territorial units should then be linked to a strategic territorial plan, and thus, to active management units [22]. Normally HEMUs should define areas with similar land attributes selected as decision criteria for planning and evaluation [23]; then, it becomes necessary when HEMUs are initially delimited that all their associated elements (natural, socio-economic, administrative, …) are spatially coherent. Although HEMUs have been used mainly for biophysical considerations, in order to develop an integrated vision of the coastal zone, the socio-economic dimension needs to be incorporated into the process [9,17]. Due to the fact that tourism is by far the most significant economic activity on the islands, rather than defining HEMUs using biophysical characteristics, we have adopted regional divisions of the tourist zones of the *Tourism Council of the Balearic Islands Government* [24] (Fig. 1), introducing some changes so that the limits of the proposed regions correspond with municipal limits. These changes are deemed necessary for practical purposes since many jurisdictional limits and the availability of indicator data often correspond with municipal boundaries. The tourism zones were determined by the government in accordance with the homogeneity of tourism supply and demand and, at the same time, reflect additional socio-economic (population size and growth, impervious surface), and natural (protected area, coastal geomorphology, landscape, water condition) dimensions of the territory. The zones also correspond with the four main coastal slopes of Mallorca and include all of the coastal municipalities of the island.

3.2. Shoreline units (SUs)

Shoreline units (SU) are the initial boundary category to be defined in the proposed classification. SUs represent the state and organization of coastal areas; they reflect the existing reality (natural areas, transformed areas). The inland boundary of a SU is determined by the jurisdictional *zone of influence* defined by the Spanish coastal law (i.e. 500 m inland). SUs incorporate natural (elevation, coastal geology) and socio-economic (level of tourism, land use) characteristics. Nine categories of SUs have been defined (Fig. 4) on the basis of these criteria in the coastal zone of Mallorca

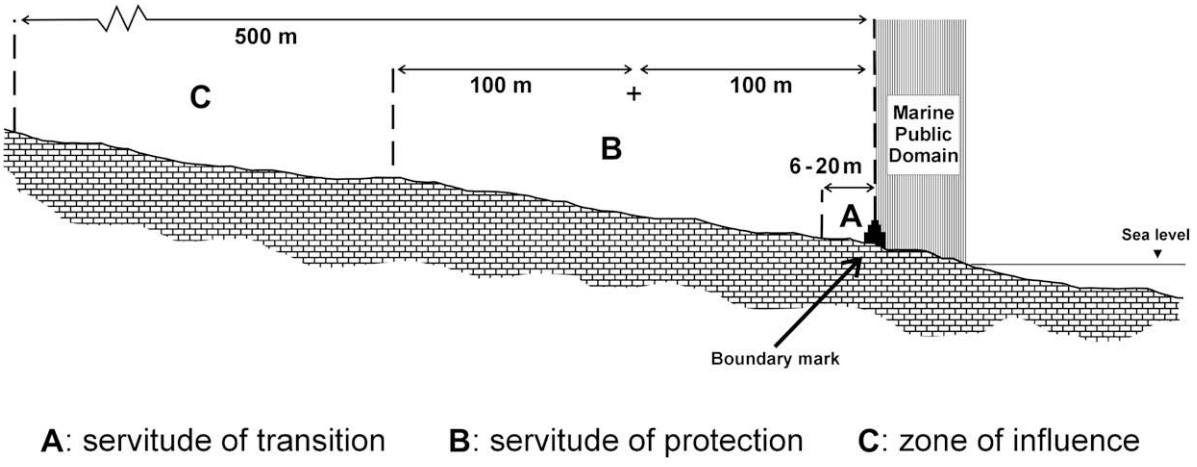

Fig. 2. Distribution of zones within the Spanish coastal law.

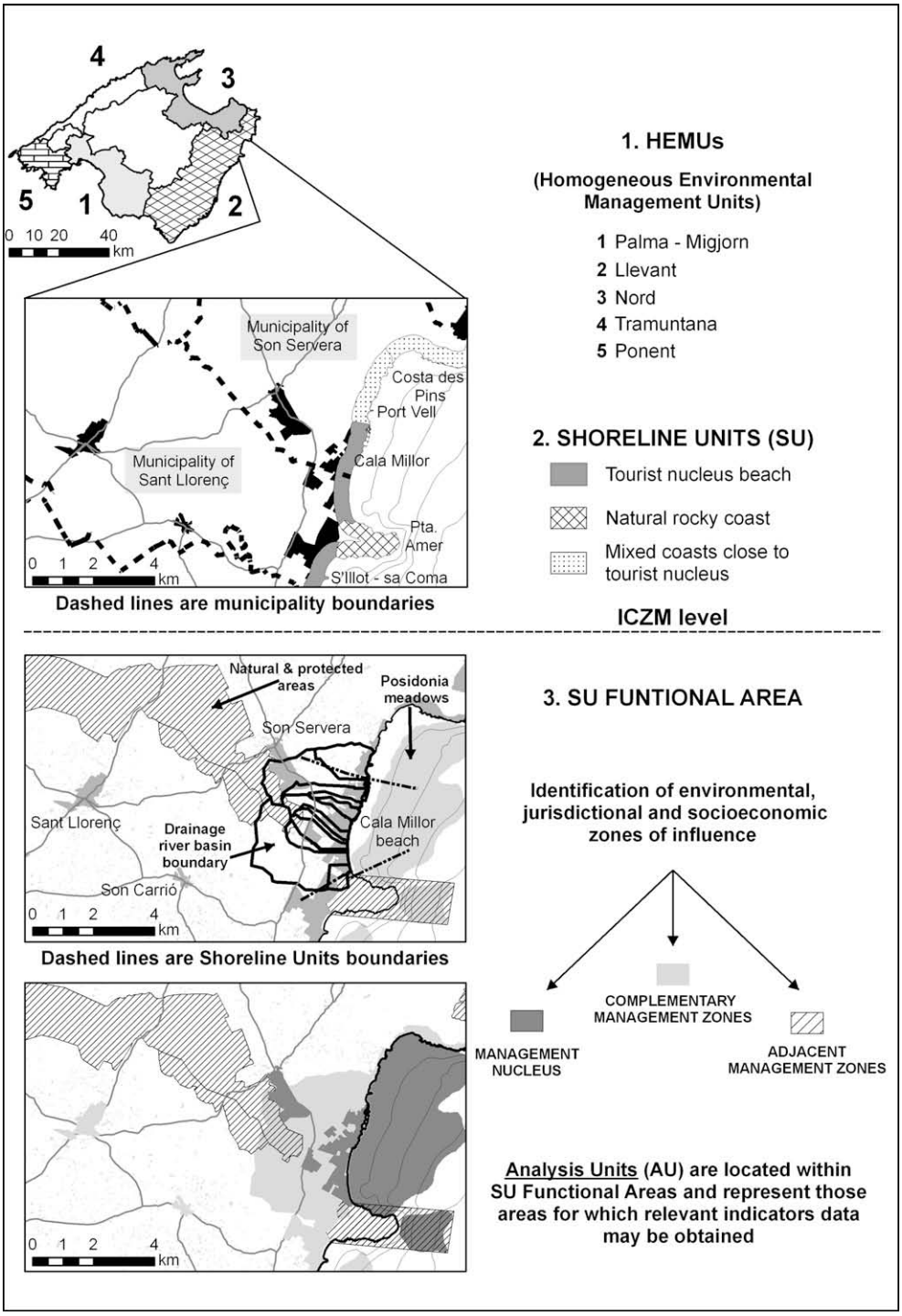

Fig. 3. Application of the boundary delimitation methodology in Cala Millor (Mallorca).

and converted to digital maps using geographic information systems (GIS). Details of the methods used to define these categories are as follows:

- Elevation levels were classified into two groups: flat zones ranging from 0 to 200 m above sea level and mountainous zones higher than 200 m. Zones below 200 m were considered flat as opposed to mountainous because the post-orogenic tabular platforms in the southern and southeastern part of the island have resulted in cliffs that often exceed 100 m. A digital elevation model (DEM) with 50 m cell size was used to generate 1/5000 scale maps.
- Land uses in the coastal zone were classified into three main types: urban, rural and natural (natural protected zones). Digital maps of this concerning information (1/5000 scale) were created using the *Insular Territorial Plan* of Mallorca and *Corine Land Cover* cartography (1/50,000 scale).
- Coastal typologies were defined according to previous coastal classification works [25] based on the nature of the materials that comprise the coastline, their degree of exposure, and ease

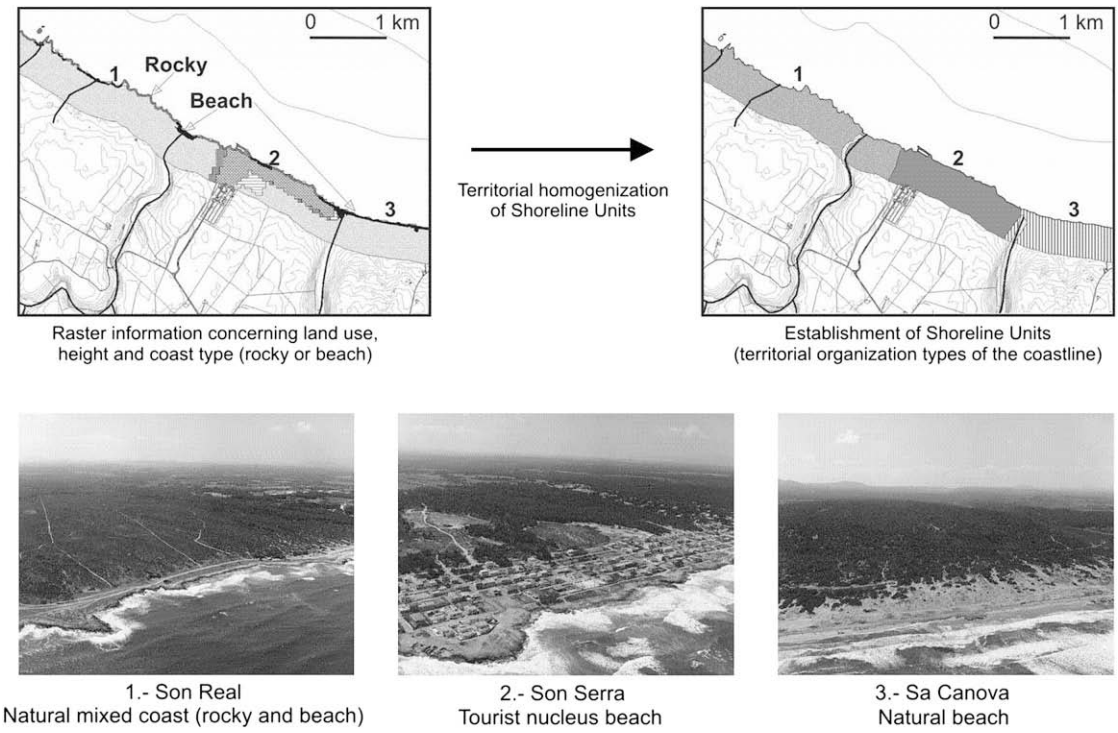

Fig. 4. Example of the methodological process for establishing shoreline units (SUs).

with which the coast may be cleaned. This methodology is based on NOAA [26]. Ten of these coastal types are rocky in nature and seven do not consist of consolidated materials (beaches). In this context and for the sake of simplicity, coastal zones were classified into two types: rocky coasts and beach coasts. Again, this information was recorded digitally (1/5000 scale).

- Finally, tourist sites were digitized on a scale of 1/5000 using the *Arrangement Plan of Touristic Supply* (POOT) of the *Tourism Council of the Government of the Balearic Islands* (1995). The resulting cartography is a polygon layer containing information about whether or not tourism is present in each population center of Mallorca.

The maps for land use and tourist centers were converted to raster data with a cell size of 50 m. Both maps were overlaid with the elevation map (also with a raster cell size of 50 m), resulting in a raster map of Mallorca containing three criteria: elevation, land use, and the presence of coastal tourist nucleus. The 500 m buffer was then applied and finally, the map of coastal typologies was overlaid. The result of overlaying these four information layers within the 500 m buffer zone is a raster map where each cell has a different colour gradation representing the different combinations of each characteristic (see Fig. 5). The resulting SU categories are described in Section 4.

3.3. SU-functional areas and analysis units

SUs are often located within larger territorial areas, expanding landward to a distance greater than 500 m or extending out into the territorial sea, which may be influential from jurisdictional, environmental or socio-economic perspectives. These areas have been defined as functional areas. A SU and its functional areas combined may be defined as a SU-functional area. The boundary of the SU-functional area delimits the spatial area that needs to be taken into consideration for ICZM implementation in that zone. Three different zones can be observed *within a SU-functional area* (Fig. 3):

(a) Management nucleus: This area represents the central focus of the ICZM initiative. It may be an urban zone near the coast with an elevated influence on the natural environment of the SU, a popular beach, a critical habitat such as a dune system or salt marsh, a protected area, or an important area of agricultural production.
(b) Complementary management zone: This area takes into account the drainage basin, which may extend inland beyond 500 m and is considered a critical area for consideration from the environmental perspective.
(c) Adjacent management zone: These areas take into account jurisdictional limits defined by protected areas (as defined by local, national, regional or European law) that extend landwards or seawards from the SU. In some cases where they bridge the drainage basin, they may extend further than the complementary management zone.

The incorporation of the boundaries described above as an additional GIS layer in the database was the final step in the process of creating the boundary delimitation for the ICZM decision-support tool. Section 4 describes the application of this tool in general and then specifically, using the example of Cala Millor, a tourist beach in Mallorca.

Analysis units (AUs) are located within SU-functional areas and represent those areas for which relevant indicator data may be obtained. Availability of data is a crucial reality that affects management and monitoring efforts and is therefore an essential consideration for the analysis of boundary delimitation. In addition to describing tangible activities (e.g. construction, reforestation, occupation of beaches, number of species or organisms, percentage of urbanization, rate of conversion of natural habitats to urbanized land, among others), they can also reflect less tangible aspects that may not emerge using the analysis criteria for the SU-functional area (i.e. energy and water consumption or generation of wastes). Due to the great diversity of indicators (population, urban and economic structure, pollution, operation of resources and land uses,

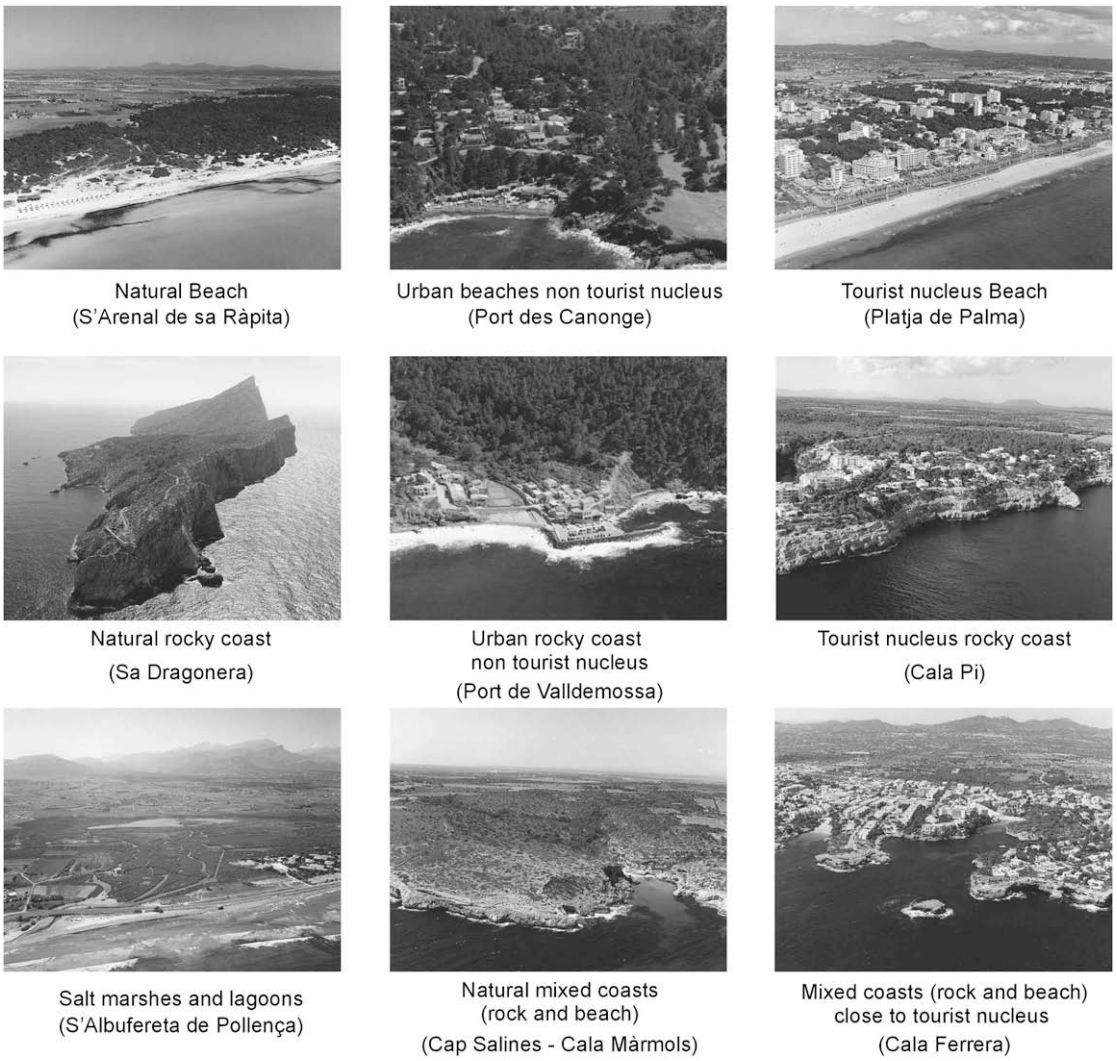

Fig. 5. Sample photographs of shoreline unit categories.

among others) AUs may overlap or be incorporated within other AUs. Each SU-functional area will contain a number of AUs, some of which will be more important than the others depending on the defining characteristics of the area. For example, if the SU-functional area contains an urban beach, data related to the beach surface, crowding and urbanization will be the most relevant. Alternatively, if the SU-functional area is characterized by a natural rocky coast, data on the extent of natural habitats will be more important.

4. Results

Prior to the specific application of Cala Millor, a general, island-wide analysis was done in order to determine the general characteristics of the coastline. Based on the four characteristics used to delimit SUs (elevation, land use, coastal typologies, and tourist sites), nine categories of SUs were determined: (1) natural beach, (2) urban beaches non tourist nucleus, (3) tourist nucleus beach, (4) natural rocky coast, (5) urban rocky coast non tourist nucleus, (6) tourist nucleus rocky coast, (7) salt marshes and lagoons, (8) natural mixed coasts (rock and beach), and (9) natural mixed coasts (rock and beach) close to the tourist nucleus (Fig. 5). These categories resulted in a total of 122 SUs along the coastline of Mallorca (Table 2). The two categories of natural rocky coast (4) and mixed coasts (rock and beach) close to the tourist nucleus (9) were found to dominate the coastal environment of the island in terms of both the total number of SUs and the total length of the coastline they represent. The proportion between artificial coastal zones (urban beaches non tourist nucleus (2), tourist nucleus beach (3), urban rocky coast non tourist nucleus (5), tourist nucleus rocky coast (6) and mixed coasts (rock and beach) close to the tourist nucleus (9)) and natural coastal zones (natural beaches (1), natural rocky coasts (4), salt marshes and lagoons (7) and natural mixed coasts (8)), was 49.1% and 50.9% respectively. Essentially, half of the coastline on Mallorca remains in its natural state.

HEMU-3 (Nord) contained the highest diversity of SUs. Natural beaches were mainly located in low height coasts within large inlets or bays. Urban beaches non tourist nucleus were only located in HEMU-4 (Tramuntana). Tourist nucleus beaches normally correspond with natural beaches that have been transformed into urban areas. Natural rocky coasts were mainly concentrated in HEMU-1 (Palma-Migjorn), HEMU-2 (Llevant), and HEMU-4 (Tramuntana). Urban rocky coasts normally correspond to some urban nucleus of HEMU-4 (Tramuntana) and to the city of Palma. Tourist nucleus rocky coasts were mainly located in HEMU-1 (Palma-Migjorn) and HEMU-2 (Llevant) due to the high presence of cliffed coasts. Concerning salt marshes and lagoons, the best example of this type of SU was located in HEMU-3 (Nord), "*sa*

Table 2
Composition of shoreline units and HEMUs of Mallorca

Shoreline unit (type)	Number of SUs	Length of coastline (km)	% of coastline
Natural beach	7	15.04	2.2
Urban beaches non tourist nucleus	3	2.99	0.4
Tourist nucleus beach	10	70.66	10.3
Natural rocky coast	41	272.81	39.6
Urban rocky coast	7	39.14	5.7
Tourist nucleus rocky coast	22	96.31	14
Salt marshes and lagoons	1	0.73	0.1
Mixed natural coasts (rock and beach)	8	62.38	9.1
Mixed coasts (rock and beach) close to the tourist nucleus	23	128.24	18.6

HEMUs	SU categories	Number of SUs	Length of coastline (km)	% of coastline
Palma-Migjorn	5	15	103.63	15.1
Llevant	7	42	190.10	27.6
Nord	9	29	181.30	26.4
Tramuntana	5	18	85.38	12.4
Ponent	5	18	126.83	18.5

Albufereta" in relative contact with the coastline. Mixed natural coasts (rock and beach) were mainly located in the eastern coast (HEMU-2, Llevant); normally these coasts are cliffed with a high abundance of inlets with various beach sizes. Mixed coasts (rock and beach) close to the tourist nucleus were geomorphologically similar to the above with the presence of urban areas and were mainly located in HEMU-2 (Llevant).

4.1. Example of application of decision-support tool in Cala Millor, Mallorca

Cala Millor began to develop tourism in the early 1960s, nowadays, Cala Millor is one of the most heavily sought after tourist beaches (roughly 6600 users daily [27] and 500,000 visitors annually) in Mallorca with a significant number of large hotels near the coastline. This makes it a meaningful candidate for ICZM given that the level of tourism and the associated construction have resulted in a significant number of environmental and socio-economic impacts. Similar to what occurs in others tourist zones of the Balearic Islands, 74% of active inhabitants of the area work in the service sector which is highly seasonal. In the summer months, the population increases by more than three times that of the rest of the year which places significant pressure on natural resources and the resident population (padrón o censo). In addition, the beach has undergone five renourishments during the last years, involving a sand budget of around 58,159 m^3.

Cala Millor is located in HEMU-2 (Llevant) and bridges two municipalities, Sant Llorenç (south) and Son Servera (north). Using the specified criteria, it may be classified as a tourist nucleus beach (Fig. 3). As mentioned in Section 3, the SU-functional area is comprised of: (a) the management nucleus, (b) the complementary management zone and (c) the adjacent management zone. In the case of Cala Millor, the management nucleus consists of: (a) the tourist beach neigbourhoods of Sant Llorenç and Son Servera, (b) the marine sandbanks associated with the Cala Millor beach, and (c) the offshore *Posidonia oceanica* beds. The complementary management zone is delimited by the old wetland drainage river basin boundary of this zone and extends approximately 3 km inland. Finally, the complementary management zone overlaps with the protected area of Calicant, which delimits the adjacent management zone, and with the nearby protected area of Punta de n'Amer. Based on the criteria and methodology proposed in this paper, these three zones and the resulting SU-functional area define the boundaries of the area that should be taken into consideration in an ICZM initiative for Cala Millor. In the case where data availability of important indicators, defined by AUs, does not correspond directly with the boundaries of the SU-functional area, decisions may need to be made based on the priorities of the initiative (i.e. how important is the data? Is it necessary to develop a methodology for obtaining this data? Is it more important to take into account the jurisdictional or environmental boundaries represented by the AU?). Regardless of whether the mapping exercise results in one clear option for a management boundary, it cannot fail to contribute to improving the ICZM activity by providing clarity, important information, and promoting discussion and coordination among the entities involved in the exercise.

5. Discussion and conclusions

Managing coastal areas while protecting ecosystems and natural resources from coastal developments is an important objective for ICZM [28]. A critical first step towards reaching this goal is to spatially define the area that needs to be managed. ICZM requires integration among a number of different dimensions including territorial space, economic and social sectors, habitats, and legislations. All of these dimensions can be mapped digitally and hence can contribute to the delimitation of boundaries for ICZM initiatives. Clearly, it would be unrealistic to assume that every element of every dimension could be taken into consideration; so cartographic data sets must be created that are based on data availability, logistic reality and those criteria that are considered to be most important and influential from a management perspective. This is the proactive approach that has been taken to create the decision-support tool presented in this paper.

The implementation of ICZM in a small island environment such as Mallorca is challenged by the fact that, if you consider the interconnectivity between communities, especially in relation to tourism and the service sector, the zone of influence of the coastal zone could easily end up being the entire island. Managing an area of such size and complexity would most likely be outside the scope of any ICZM initiative. However, the plurality of urban and rural landscapes distributed throughout the territory and its physiographic variety confer to Mallorca the fact that coastal and inland areas are well differentiated. There is a significant deficiency of resources, data and technology to support ICZM in Mallorca, a concept which only came to the forefront of political discussions in the recent years. The tool presented in this paper represents an important data aggregation exercise that could help with decision-making in future ICZM initiatives. As mentioned in Section 1, there is a significant amount of confusion on the island resulting from "blurred lines" of jurisdiction among the different laws, regulations and implementing entities. This tool at the very least will help create a context within which these various entities can begin to discuss management options and cooperate with each other. For example, the SU-functional area of Cala Millor is included in two municipalities. The exercise of delimiting its boundaries brought to light the important consideration that these two municipalities should coordinate their efforts in order to manage the beach and the adjacent protected areas.

The decision-support tool presented in this paper, including the methods described for its development, may be applied to any coastal environment and has the advantage that it does not rely on the emergence of a specific problem or a particular resource (see for example [1,3–7]). Other countries or islands may consider adjusting the criteria to reflect local or national realities but the basic concept is universally applicable. It is important to tailor this method to the socio-economic and environmental reality of the area. For example, tourism may not be the most important economic sector in all

places. The application of this method in other areas should consider adding cartographic information concerning the most dynamic economic sectors which influence the most substantial transformation of the territory.

As mentioned previously, this approach is subject to the availability of necessary information. It also requires individuals trained to work with digital cartographic data. Where better and more abundant data will obviously improve the effectiveness of the method, limited data should not be a reason for not to act since the method is based on making the best use of available data. In Europe for example, cartographic information from Corine Land Cover (land use) is freely accessible. Coastal typologies (rocky/sandy) can be obtained from previous works or could be elaborated easily by means of a survey through vertical and/or oblique aerial photographs. The digital elevation models (DEMs) to get the height of the coastal area can be constructed in a quick and simple way using the programme ArcGIS® 9.1. In countries where cartographic data are very limited, public resources such as Google Earth may be a good point of departure.

It is important to note that the current work does not enter into depth on how to delimit the marine boundary for ICZM initiatives. The boundary was based on the existence of *Posidonia oceanica* seagrass beds and marine protected areas. This approach is based on available data and on the relative importance of managing these areas in relation to land-based activities. In Mallorca, activities that occur on land have the most profound impact on tourism related economy and on the lives of residents. In an area where the link between tourism and the marine environment is more substantial (i.e. dive destinations in the Caribbean) or where near-shore fishing or aquaculture is a major economic activity, delimitation of the marine boundary may require more in-depth focus.

A major benefit of the proposed approach, besides being a proactive decision-making tool that is relatively easy to apply, is that it may be used to inform decision-making for initiatives similar to ICZM that require an integrated approach. For example, the methodology could be used to support the European Union Directive 2001/42/EC on strategic environmental assessment (SEA) for land use and regional planning. As with ICZM, a limitation of SEAs is often the lack of physically set boundaries delimiting the area within which effects need to be assessed. If, for instance, we have a proposed highway that crosses 12 SU-functional areas in a particular HEMU, we can define a geographical extension for which effects need to be evaluated, and, in this way, several SUs should be considered in the SEA analysis. In this context, the definition of SU-functional areas could be valid as an attempt to establish a preliminary scaling exercise to provide adequate planning tools to improve the environmental assessment and to develop SEA accordingly.

This work is also compatible with the homogenous territorial zoning used by the European Union for comparison between different regions among different countries [29], the *NUTS* (*nomenclature of territorial units for statistics*) [30], and the *LAUs* (*local administrative units*), a system of infraregional zoning. The statistical data offered for the more detailed levels (*LAU* 2) of these territorial units could be used to define AUs, thus creating congruence between our proposed method and the territorial classification work already being done at the European level.

The majority of coastal management decisions in Mallorca and many other places are based on isolated assessments of AUs. This constitutes a sectoral planning approach which does not take into consideration the complexity and interacting processes in the coastal zone. The concept of integration should not be confused with a simple consensus between stakeholders. While this is essential, this consensus must be based on the knowledge of interactions between environmental, jurisdictional and socio-economic elements in the spatial area that is under consideration. This area, in turn, must be defined in accordance with these interactions. Only then can the consensus between stakeholders lead to the types of informed decisions that will allow for the effective implementation of ICZM.

Thirty years ago, ICZM arose as a tool that was able to resolve the problems of degradation of the coastal environments due to human pressure. This degradation has not stopped, and is clearly antithetical in relation to the Mediterranean coasts [31]. ICZM is based not only on implementation, but also on making the correct decisions at the outset. Decision-support tools are sparse and critical, particularly those that are data intensive and visual. The proactive tool presented in this paper represents a step towards improving our capacity to make ICZM decisions at a global scale.

Acknowledgments

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