



**The DIBA: A dynamic assessment tool for beach quality on protected areas**

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## **The DIBA: A dynamic assessment tool for beach quality in protected areas**

### **Abstract**

The Dynamic Index for Beaches in protected areas (DIBA) is introduced as a dynamic method for evaluating the quality of beaches in protected areas. The aim of this dynamic approach is to assess quality on a weekly basis so that different scores may be obtained throughout the bathing season. The index is made up of three sub-indices encompassing the main concerns regarding beaches in protected areas, i.e. the environment, landscape and recreation. These sub-indices consist of nine indicators and four sub-indicators; the five indicators are recorded yearly and the four sub-indicators are recorded weekly. The procedure is tested at four selected beaches on Spain's Mediterranean coast and gives good overall scores although these decrease throughout the bathing season. The DIBA is a useful tool for managers of beaches and protected areas because it can be used to characterize and compare beaches. With minor adjustments, this procedure may be applied to other beaches in protected areas in the Mediterranean basin.

### **Keywords**

DIBA, beach management, beach quality index, coastal protected areas, Mediterranean

### **1. Introduction**

Tourism is one of the largest-growth industries in the world and has one of the highest economic impacts, accounting for one job in eleven and about 30% of the world's services and exports (UNWTO, 2014). According to the WTO (2015), international tourism generated US\$ 1,522 billion in 2014, with only fuel and chemicals generating more.

International tourist arrivals in 2015 were above 1,100 million which is a growth of 4.4%

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3 from 2013. Europe received 51% of those arrivals, which is equivalent to 609 million  
4 people, and the Southern Mediterranean region registered growth of over 5%. A good deal  
5 of this tourism occurs in coastal regions because tourist resorts are mainly located on the  
6 seashore (Velvet, 2013), beaches being fundamental to tourism demands (e.g. Klein, Osleeb  
7 & Viola, 2004; Houston, 2013). The WTO estimates that tourism will increase by 3.5 to  
8 4.5% in Europe, thus placing the continent in the third place in world ranking (WTO,  
9 2015), and most of this growth will be on the Mediterranean coast.

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22 The Mediterranean basin faces a large number of social and ecological risks caused by, for  
23 example, unsustainable water consumption, forest fires and erosion (EEA, 1999). Among  
24 those tendencies, high artificial rates of land cover are particularly important, both from a  
25 quantitative and a qualitative point of view, as they are usually irreversible. GRATET  
26 (2013) analyzed the urban development in a number of tourist destinations and found that  
27 more than 75% of the tourist area is covered by residential, tourist and commercial zones.  
28 Rates of coastal development are very, reaching 100% in some cases (Table 1). Mullins  
29 (1991) analyzed urban development caused by tourism growth, and several other studies  
30 have identified urban spatial patterns dominated by tourism accommodation, urban spaces  
31 specifically built for tourism and urban-tourism sprawl (e.g. Pons, Rullán & Murray, 2014;  
32 Rovira & Anton-Clavé, 2014). In the coming years it is predicted that more coastlines will  
33 become built up (Benoit & Comeau, 2005).

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53 With this in mind, particular attention must be paid to non-built-up areas in coastal tourism  
54 regions because their scarcity makes them a rare commodity (Blay, 2012; Harris, Nel,  
55 Holness & Schoeman, 2015). Most of these sites are in protected natural areas which are

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3 rare and under pressure in high-density urban coastal environments and must therefore be  
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5 specially preserved (Eagles & McCool, 2002). The European Union's Natura 2000, the  
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7 largest network of protected areas in the world, has 4342 sites in the Mediterranean  
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9 biogeographical region; a GIS analysis reveals that 28.93% of those sites are partially or  
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11 totally located less than 1km from the seashore. Since many protected areas are as tourist  
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13 attractions, they are noticeable affected by human activity.  
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20 Beach users' preferences have been studied on numerous occasions (Breton, Clapés,  
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22 Marquès & Priestley, 1996; Tudor & Williams, 2006; Roca & Villares, 2008; Lucrezi,  
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24 Saayman & Merwe, 2016). Desirable attributes frequently mentioned by beach goers  
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26 include scenery, cleanliness, sand and water properties and facilities such as showers or  
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28 shops. Other desirable attributes are related to comfort and include tranquility and policies  
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30 to reduce noise, prohibit smoking and control dogs. Overcrowding rates are often quoted  
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32 because beach-goers' often seek calmness and peace. Unsurprisingly, beaches with more  
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34 commodities are among the most sought-after and are usually among the most crowded.  
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36 Urban and non-urban beaches are noticeably different here in that users of the former attach  
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38 less importance to tranquility than do users of the latter (Roca & Villares, 2008; Rangel-  
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40 Buitrago, Correa, Anfuso, Ergin & Williams, 2013). Nevertheless, People's preferences and  
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42 perceptions can often be exaggerated and must be interpreted carefully because they are  
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44 fluid cultural responses that may vary quickly (Breton et al., 1996).  
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53 Several methods are used to assess beach quality in an objective and systematic way. Since  
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55 1987, the Blue Flag award has been adopted *de facto* as an international certification of  
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57 beach quality, including beaches in protected areas. Its aim is to promote coastal  
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3 sustainability by awarding scores for over thirty criteria grouped into four categories:  
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5 environmental education and information, water quality, environmental management, and  
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7 safety and services (Blue Flag, 2016). Although some of these items appear relevant to  
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9 beach management, the award is regarded as inadequate for assessing beach quality.

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12 Lucrezi, Saayman & Merwe (2015) observes three aspects that bring into question the  
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14 usefulness of the Blue Flag award: (1) the award does not consider important aspects  
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16 relating to ecosystem functions, including geomorphology and floral characteristics; (2)  
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18 some criteria, such as water quality, are considered more important than others and should  
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20 be assessed on a more regular and consistent basis; (3) some management practices appear  
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22 to be inconsistent with beach protection, such as litter removal using heavily machinery.  
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25 Several studies have questioned the validity of the Blue Flag award as a universal and  
26  
27 reliable indicator for beach certification as it focuses more on management rather than  
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29 quality (Ariza, Sardá, Jiménez, Mora & Ávila, 2008; Boevers, 2008; Mir-Gual, Pons,  
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31 Martín-Prieto & Rodríguez-Perea, 2015; Fraguell, Martí, Pintó & Coenders, 2016).  
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39 A number of environmental management systems for beaches have been launched in recent  
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41 years, some with the purpose of redressing procedures that have ceased to function in the  
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43 intended manner (Ariza et al., 2008). Comprehensive indexes tend to consider key  
44  
45 parameters beach quality which, according to Williams and Micallef (2009), are safety,  
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47 facilities, water quality, cleanliness and scenery. The Beach Quality Index (Ariza, Jimenez,  
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49 Sarda, Villares, Pinto, Fraguell, Roca, Marti, Veldemoro, Ballester & Fluvia, 2010) has  
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51 been adopted in Spain, is based on thirteen sub-indices weighted and related by linear  
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53 aggregation, and has been developed to assess overall quality in Mediterranean urban and  
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55 urbanized beaches. Botero et al. (Botero, Pereira, Anfuso, Cervantes, Williams, Pranzini &  
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3 Silva, 2014) developed the Index of Environmental Quality for Tourist Beaches as a tool to  
4 assess sustainability in Colombian beaches; it uses thirty parameters, including coastal  
5 scenery, safety and security, urban development, zoning, and environmental protection,  
6 which are major issues related to environment and recreation on tourist beaches. The Beach  
7 Evaluation Index (Lucrezi et al. 2016) was adopted in South Africa and is made up by three  
8 sub-indices: the Beach Description Index, the Human Dimension Index and the Monetary  
9 Index, which together provide a descriptive matrix of 131 indicators. This tool, which can  
10 be generalized to beaches around the world, was specially designed for sandy beaches and  
11 tested on recreational ones. Other composite indexes focus on economic aspects, such as  
12 the Integrated Beach Index (Cervantes & Espejel, 2008) which has been applied to urban  
13 beaches in California, Mexico and Brazil, whereas others focus on scenery and aesthetic  
14 qualities, such as the well-known procedure proposed by Ergin et al. (Ergin, Karaesmen,  
15 Micallef & Williams, 2004) and applied worldwide (Williams, Micallef, Anfusio, Gallego-  
16 Fernandez, 2012; Rangel-Buitrago et al., 2013; Williams & Khattabi, 2015). All these  
17 procedures provide static information about beaches relating to an undefined time or, in  
18 some cases, to an undefined bathing season.

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43 The present study tests the Dynamic Index for Beaches in Protected Areas (DIBA), a tool  
44 that can assess beach quality in protected areas in a dynamic manner. Due to tourist  
45 pressure on fragile protected areas in highly urbanized coastal environments, it is necessary  
46 to create an index to dynamically measure and compare the quality of beaches throughout  
47 the tourist season and, at the same time, determine their carrying capacity. This index was  
48 applied on a weekly basis during the bathing season to four selected Spanish beaches and is  
49 intended to be generalized to other Mediterranean beaches.

## 2. Methods

The DIBA model consists of three sub-indexes which cover the three main aspects used to assess beaches in protected areas: environment (E), landscape (L) and recreation (R). Each sub-index has a set of indicators, sub-indicators and components which may have a value on their own or may be averaged. All values are normalized to a 0-1 scale, where 0 corresponds to the lowest quality and 1 to the highest. Integration is carried out using a linear combination method which involves adding or multiplying weighted and normalized data. The DIBA is modelled on the index by Ariza et al. (2010) but introduces new items, weighting criteria and adjustments to fit it to beaches in protected areas. The final model of the DIBA is shown in Figure 1.

The final results are shown on a numerical scale ranging from 0 to 1. The scale is adapted to a nominal scale so that restrictive criteria and knowledge can be used to increase understanding of the studied areas (Table 2).

The research was supported by a panel of experts who checked the sub-indices' components and weightings. The panel included geographers, landscapers, protected area managers and NGO members chosen for their involvement in coastal issues.

Crowdedness was assessed by 42 valid questionnaires conducted on beach goers during August 2015. The questionnaire consisted of opened and closed questions and followed a structure similar to that used by Silva (2002).

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6 This procedure provided several measurements a week throughout the bathing season  
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8 (June, July and August) of 2015. This means a long-term and constant series of data (13  
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10 weeks). Measurements were taken simultaneously on the same day of the week (Thursday)  
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12 for all beaches in order to obtain a synoptic picture for the entire period under study. Field  
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14 work was undertaken on Thursday as this day is representative of any week-day; week-ends  
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16 were assumed not to be representative of the week they belonged to but rather were  
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18 classified as being like any week-day in August. This was also the case for users'  
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20 frequentation and overcrowding scores.  
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### 27 *2.1. Environmental sub-index (E)*

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32 This sub-index measures environmental items related to the quality of beaches. It consists  
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34 of two indicators: Water Quality (WTQ), which includes the sub-indicators Microbiological  
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36 Water Quality (MIB) and Mesobiological Water Quality (MEB), and Land Quality (LQ),  
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38 which encompasses the Vegetation Species Richness (VSR) and Landform Diversity (LFD)  
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40 sub-indicators.  
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46 This sub-index does not include environmental indicators considered in other studies (e.g.  
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48 Lucrezi et al., 2016) such as pollutants, cyanobacteria, seaweed or marine predators. This is  
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50 because these are uncommon in beaches on the northern shore of the Mediterranean and  
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52 their appearance is thus considered as accidental.  
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The indicators are integrated in accordance with the following equation which places a good deal of importance on both low WTQ scores and high LQ quality; furthermore, low WTQ scores may neutralize LQ scores. The algorithm is formulated as follows:

$$E = (WTQ*0.50)*(LQ*0.50)$$

$$WTQ = (MIB*0.50)+(MEB*0.50)$$

$$LQ = (VSR*0.60)+(LFD*0.40)$$

### *2.1.1. Water Quality sub-index (WTQ)*

#### *2.1.1.1. Microbiological Water Quality (MIB)*

The microbiological water quality indicator is set in accordance with Directive 2006/7/CE, a European directive on the management of bathing water quality. This act ensures microbiological hygiene by measuring organisms that cause fecal pollution (Table 3).

On most of the northern Mediterranean shore, water quality is good and sewage treatment is proficient, so Directive 2006/7/CE is not violated and high water quality standards are generally assumed (Ariza et al., 2010). Consequently, a positive value for this parameter in the E sub-index does not improve the final score, although low values may neutralize final scores. This sub-index is calculated according to the regulations ISO 7899-1 and ISO 9308-3. Measurements must be taken weekly and the analyses are carried out by government officers because these values are legally regulated. However, some agencies only provide measurements every two weeks.

### 2.1.1.2. Mesobiological Water Quality (MEB)

Mesobiological quality is established by the number and type of jellyfish detected on the seashore (Table 4). Jellyfish are a serious nuisance for beachgoers, even in low numbers and can disrupt people's enjoyment of the beach, as the respondents' questionnaires revealed. Given this, it is surprising that measuring numbers of jellyfish is not a widely used methodology for assessing swimming water quality (Pendleton, Martin, & Webster, 2001; Cervantes & Espejel, 2008; Botero et al, 2014).

The data is acquired by field work in which a 100 m transect is sampled every kilometer along the beach; if the beach measures less than one kilometer, the entire shoreline is sampled. Jellyfish are counted both on the beach and in the sea in a five meter buffer on either side of the water's edge. As in the previous index, a good value does not make a difference to the final score, but a poor one may neutralize it. Consequently, MEB penalizes beaches for the presence of stinging jellies and the abundance of non-stinging ones, but does not reward their absence. Measurements are required weekly.

### 2.1.2. Land quality (LQ)

The Land Quality indicator is made up of two sub-indicators: vegetation species richness (VSR) and landform diversity (LFD).

#### 2.1.2.1. Vegetation species richness (VSR)

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Vegetation species richness takes into account the number of plant species in the vicinity of the beach. Only indigenous plants and those with a non-cosmopolitan distribution are considered as indicator plants (Table 5).

Data is acquired by field work in which the inventory plot is a 100 m buffer area from the external border of the beach with no vegetation heading inland. A point is given to each different species recorded; if the species is included in Annex II of the European Commission's Habitats Directive, Directive 92/43/CE, the species is given an extra point. After 21 plants have been recorded, no further points are given. The final result is multiplied by 0.60 and add to the landform diversity sub-indicator because vegetation is regarded as better environmental indicator than geomorphology (Zonneveld, 1995). This inventory is conducted yearly.

#### 2.1.2.2. Landform diversity (LFD)

Landforms have been shown to be useful for assessing beach quality (Pintó, Martí & Fraguell, 2014) and their diversity is assessed by identifying and inventorying different types. The inventory records two different types: those caused by the deposition of sediment and those cause by erosion (Table 6).

Data is acquired by surveying the beach. The final result is multiplied by 0.40 and added to the VSR sub-indicator. This inventory is undertaken yearly.

## 2.2. *Landscape sub-index (L)*

This sub-index measures the beaches' aesthetic qualities, although some of the aspects considered also take into account environmental qualities. The sub-index consists of four indicators: appearance (APP), artificial land cover (ALC), heritage (HRT) and view shed (VSH). This sub-index includes most of the components used in other well-known procedures for a beach's aesthetic qualities (Ergin et al., 2004; Rangel-Buitrago et al., 2013; Williams, Rangel-Buitrago, Anfuso, Cervantes & Botero, 2016).

The indicators are integrated with the following algorithm, which gives preference to view sheds as these play a key role in landscape appraisal (Linton, 1968):

$$LI = (APP * 0.2) + (ALC * 0.4) + (HRT * 0.2) + (VSH * 0.2)$$

### 2.2.1. *Appearance (APP)*

The appearance indicator assesses a beach's aesthetic qualities and cleanliness by recording water color, levels of litter and oil patches, among other components. Data is acquired by field work using a slightly more restrictive procedure than the one suggested by Coastwatch (<http://coastwatch.org>). Data is gathered from a 100 m transect sampled every kilometer along the beach; if the beach measures less than 1 km, then the whole beach is sampled. Data is collected on land and in the sea in a 5 m buffer on either side of the water's edge. Only items of litter that are larger than 10 cm are considered (Table 7).

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6 The result of this indicator is the most frequent value (i.e. mode) in every survey. The result  
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8 is directly add to the others indicators in the landscape index. Measurements are required  
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10 weekly.  
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### 12 13 14 15 16 17 18 *2.2.2. Artificial land cover (ALC)* 19

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22 Artificial land cover is calculated by weighting for land cover existing in a 500 m buffer  
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24 area from the seashore. The weighting is lowered as the level of natural land cover  
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26 diminishes; consequently, a built environment gives a lower score than an unbuilt  
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28 environment. Final normalization was given by an expert panel (Table 8). Data is acquired  
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30 by GIS analysis and land cover maps at a scale of 1:25.000.  
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36 Scores are calculated according to the percentage for each category and multiplied by the  
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38 normalized value. Results are added up and divided by 100 so they can be adjusted to a 0-1  
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40 scale. It is important to notice that this index shows the degree of artificial land cover but  
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42 does not provide an aesthetic evaluation. This analysis is undertaken yearly.  
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### 50 51 *2.2.3. Heritage (HRT)* 52

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55 Heritage values are determined by recording the historical and cultural features existing in a  
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57 1 km buffer around the beach. Examples of heritage elements are archaeological sites,  
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3 watchtowers, windmills, lighthouses or salt-water lakes. Facilities such as purpose-built  
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5 viewing points or environmental education centers are also included in this group (Table 9).  
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8 Data is obtained by field work; if local heritage inventories exist, these can also be used.  
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12 Each heritage item is multiplied by 0.1 and final scores are added up; up to 10 items can be  
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14 considered. It is important to notice that this index counts the number of heritage items, not  
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16 their meaning or significance. This analysis is undertaken yearly.  
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#### 20 21 22 *2.2.4. Viewshed (VSH)* 23

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26 Viewshed is assessed by weighting land cover in a 25 km radius around the shoreline; both  
27  
28 the inland and offshore areas of the shoreline are assessed to determine the skyline  
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30 viewsheds. Land cover is normalized according to expert criteria and previous works on  
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32 landscape aesthetics (Linton, 1968; Dunn, 1974; Daniel, 2001) (Table 10). Data is acquired  
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34 by GIS analysis, and land cover maps are surveyed at a scale of 1:25.000.  
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41 Scores are calculated on the basis of the percentage for each category and multiplied by the  
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43 normalization value. Results are added up and divided by 100 so they can be adjusted to a  
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45 0-1 scale. This analysis is undertaken yearly.  
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#### 50 51 52 *2.3. Recreation sub-index (R)* 53 54 55 56 57 58 59 60

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3 This sub-index measures social and cultural items related to beaches' recreational capacity.  
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5 The index consists of three indicators: facilities (FAC), frequentation (FRQ) and  
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7 recreational activities (RTA). This sub-index is specially intended for beaches in protected  
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9 natural areas, which are quite different from beaches in urban or semi-urban environments.  
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11 This is the reason why both the meaning and the interpretation of some indicators may  
12  
13 differ slightly from those used in other procedures focused on built-up beaches (Cervantes  
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15 & Espejel, 2008; Ariza et al, 2010). Some common components, such as the presence of  
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17 public telephones or illumination at night (Lucrezi et al., 2016) were left out because they  
18  
19 are not relevant to beaches in protected areas. The indicators are integrated using the  
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21 following algorithm which prioritizes FRQ due to its importance in fragile areas.  
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$$29 \quad RI = (FAC * 0.25) + (FRQ * 0.5) + (RTA * 0.25)$$

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### 36 *2.3.1. Facilities (FAC)*

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41 The facilities indicator records signs, parking lots and other commodities to measure ease  
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43 of access to the beach. Information about protection of the environment is also taken into  
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45 account given its importance to the social function of protected areas (Eagles & McCool,  
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47 2002). Data is acquired by field work (Table 11).  
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52 The sub-index takes into account signposting within 500 m of beach and signposting  
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54 further away from the beach. The parking lot indicator records whether parking lots are  
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56 legal or not. The environmental protection indicator records the beach's level of protection  
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3 and whether beachgoers can acquire environmental information there. The results of all the  
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5 indicators are added up using a linear sum; the maximum score may be 1. This analysis is  
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7 undertaken yearly.  
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### 10 11 12 2.3.2. *Frequentation (FRQ)* 13

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17 Frequentation refers to the amount of visitors to the beach and it is useful for assessing  
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19 overcrowding. This indicator is related to beach usage patterns and carrying capacity, and it  
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21 is of the utmost importance when considering recreational issues. Data is obtained by field  
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23 work and GIS analysis. Scores are based on the number of users per 100 m<sup>2</sup> plots and thus  
24  
25 the amount of sand available to each user; the higher the sand availability the higher the  
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27 score, as such beaches clearly do not suffer from overcrowding (Table 12). Three threshold  
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29 values of sand availability per user are given in accordance with the literature (Yepes,  
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31 1999; Silva, 2002; Ribeiro, Ferreira & Silva, 2011; Zacarias, Williams & Newton, 2011),  
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33 the expert panel's criteria and the responses to questionnaires.  
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41 The number of beachgoers is counted by direct survey, using 1:2.500 orthophotos as a  
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43 reference; this procedure was chosen because it is more accurate than positioning with GPS  
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45 devices. Visitors are always counted on the same day of the week at the same time for all  
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47 beaches; the count follows the seashore and marks the position of each visitor in the  
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49 orthophoto. For better referencing, a 100\*100m grid was placed in the orthophoto, and all  
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51 landmarks, such as paths, lifeguard sites or stabilized dunes were highlighted. This  
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53 methodology, though highly time consuming, brought better results than any other GPS-  
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55 based procedure. Measurements are required weekly.  
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### 2.3.3. *Recreational activities (RTA)*

Recreational activities, either because of their abundance or their type, may degrade the landscape and damage the reputation of beachgoers because protected areas are not considered recreational areas (at least in their entirety). The main recreational activities on the beaches studied include water sports, recreational fishing, shell fishing and buggy racing. Data is acquired by field work (Table 13).

A synoptic survey of the beach is obtained by counting recreational activities at the same time as frequentation. Counting ceases after the score reaches 10 scores. Data is added up linearly and integrated to the R sub-index. Measurements are taken weekly.

## 3. Study area

The fieldwork was conducted on the Catalan coast in north-eastern Spain. Four recreational beaches located in protected areas were selected: Muntanyans, Cala Fonda, Riumar and Trabucador (Fig. 2). The two former beaches belong to the Costa Daurada tourism brand and the two latter to the Terres de l'Ebre, both of which are recognized brands that attract tourists through their sun, sea and sand (Mariné-Roig & Anton Clavé, 2016). The beaches present both similarities (e.g. sandy beaches, Blue Flag awards) and dissimilarities (e.g. some beaches are in a small pocket bays while others are exposed; some are easy to reach

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3 from resorts while others are quite remote.) All of them are in protected areas recognized  
4 by the European Union and other international organizations, and they appear as attractions  
5 in all tourist brochures for the region (Tripadvisor, 2016).  
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### 10 11 12 13 *3.1. Muntanyans*

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17 Muntanyans is a long (3 km) sandy beach with an average width of 25 m located between  
18 the villages of Torredembarra and Creixell, which have developed into coastal resorts since  
19 early the 1990s. The beach separates the sea from an area occupied by low (< 3 m) dunes  
20 partially covered with scattered vegetation; beyond the dunes, there is a marsh area. The  
21 beach, dunes and marsh are included in the European Union's Natura 2000 because of their  
22 importance as a stopover for migrating birds (e.g. *Cygnus olor*), a nesting site for others  
23 (e.g. *Charadrius alexandrinus*), and endangered flora (e.g. *Pancremium maritimum*). A cord  
24 separates the beach from the dunes and the marshes; some paths, hides and information  
25 panels are provided to teach the visitors about its natural environment. Seven paths (about  
26 200 m long) flanked by cords link the beach to campsites beyond the protected area; bars,  
27 showers and lifeguards are provided along the beach.  
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### 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 *3.2. Cala Fonda*

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3 no roads. The beauty and color of the beach, cliffs and forests mean that they are protected  
4 by the Natura 2000 network. The blue sea, the yellow cliffs and green forests together make  
5 a lovely vista that is highly sought after by tourists who like to get off the beaten track. Its  
6 isolation and dramatic landscape makes this beach a popular destination among naturist  
7 beachgoers.  
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### 14 15 16 17 18 3.3. *Riumar* 19

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21 Riumar is a 1 km long and 60 m wide sandy beach that skirts a shallow bay. It is enclosed  
22 by high (> 3 m) sea dunes which are active near the beach and partially fixed by scattered  
23 vegetation towards the interior; at the dunes are over 200 m wide at their widest point. This  
24 beach is on the northern side of the Ebro Delta Natural Park, which is protected by the  
25 Natura 2000 network, the Ramsar convention and the UNESCO's Man and Biosphere  
26 Program. The beach has bars, showers and lifeguards, and is a popular destination with  
27 families due to its abundant sand and shallow water. The landscape is astonishing and the  
28 blue of the sea and sky and the golden dunes combine to make intense contrasts of color.  
29 The beach has been chosen as a setting for commercials and movies on several occasions.  
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### 45 46 3.4. *Trabucador* 47

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49 Trabucador is a long (about 6 km) remote and exposed sandy beach consisting of a 130 m  
50 wide spit on the southern side of the Ebro Delta Natural Park. This beach is remarkably  
51 scenic as the eastern side of the spit faces the open sea while the western side faces a bay  
52 opposite to the mainland coast. The area has some low dunes and scattered vegetation and  
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3 its most remarkable feature are the vistas; water bodies on both sides of the spit and the  
4  
5 mountains on the distant mainland coast create a surreal sensation that is very appreciated  
6  
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8 by visitors who like to get off the beaten track. At the end of the spit, a little peninsula  
9  
10 contains a saltwater lake. Flamingoes (*Phoenicopterus roseus*), turtles and other marine life  
11  
12 are easy to see. In addition to naturalists, the beach attracts domestic tourism and surfers  
13  
14 who usually camp in vans. No specific areas are delimited, though nudism is a common  
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16 practice.  
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#### 22 **4. Results**

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27 The DIBA shows the final scores for each beach for every week in the bathing season  
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29 (Table 14). Final scores vary across the beaches and weeks, but the general trend is as good  
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31 with average values of 0.66. Higher scores are found in the E sub-index, though the MIB  
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33 and MEB sub-indicators may neutralize final scores if those scores are lower. L and R sub-  
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35 indices have the same averages, although R scores are more variable mainly owing to the  
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37 FRQ scores, which tend to lower final scores, and to the RTA scores, which tend to  
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39 increase them.  
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46 Riumar and Trabucador in the Ebro Delta Natural Park performed particularly well,  
47  
48 whereas the overall scores for Muntanyans were the worst of all four beaches. This is  
49  
50 especially true in August because of the higher FRQ rates. Scores for Riumar are slightly  
51  
52 higher than those for Trabucador, and Riumar obtained the maximum score on three  
53  
54 occasions (4<sup>th</sup> week of June and 1<sup>st</sup> and 5<sup>th</sup> week of July).  
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3 This dynamic procedure shows that Riumar and Trabucador have good DIBA scores for  
4 eleven weeks (84.6% of the bathing season), whereas Muntanyans has good scores for three  
5 weeks and Cala Fonda has only one (7.69%).  
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## 10 11 12 13 **5. Discussion**

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17 The main aim of this research was to design and test a procedure to assess the quality of  
18 four Spanish beaches in protected areas. By developing the DIBA, a number of specific  
19 goals were also achieved. The first was to synthesize as many items as possible for  
20 assessing beaches in protected areas. The second was to develop a dynamic procedure for  
21 assessing quality throughout the bathing season. Finally, the last objective was to enable  
22 beaches to be compared.  
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### 34 *5.1. Synthetizing items*

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38 Several items and a number of parameters have been used in other procedures for assessing  
39 beach quality. Ergin et al. (2004) designed a procedure based on 26 parameters, Cervantes  
40 & Espejel (2008) used 47 indicators, Ariza (2010) used a composite index based on 13 sub-  
41 indices, and Lucrezi at al. (2016) demonstrated a matrix based on 131 indicators. The  
42 DIBA was created with three sub-indices consisting of 9 indicators and 4 sub-indicators,  
43 which at first sight may seem a low number. The sub-indices refer to environmental,  
44 landscape and recreational issues encompassed by Williams & Micallef (2009) “big five”.  
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46 Although other procedures use more indicators to assess beaches, it is not clear that they  
47 have greater overall efficacy. According to Lucrezi at al. (2016), some indicators cannot  
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3 always be recorded due to the multi-faceted characters of beaches or the various approaches  
4 that may be taken to certain items. Furthermore, field work for a good deal of parameters is  
5 hampered by a significant lack of information. This is also true when it comes to gathering  
6 field data using non-standard or inappropriate sampling methods. In addition to this, a large  
7 number of indicators is not synonymous with better performance or more in-depth analysis,  
8 as many items may record basic or irrelevant information and make no real improvement to  
9 the index's performance.  
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22 However, the DIBA does include a set of indicators relevant to beaches in protected areas  
23 (i.e. vegetation, landforms) which are left out of other procedures, such as the Blue Flag  
24 assessment (Boevers, 2008).  
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32 Certain indicators used in the literature were not adopted in the present study as they were  
33 considered irrelevant to the beaches studied, for example erosion, marine predators,  
34 security, recreational activities and so on (Botero et al., 2014). These were not applied to  
35 the beaches analyzed in the present study as they would not have produced additional  
36 information regarding beaches in protected areas or the environments in which they are  
37 located.  
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#### 48 *5.2. Dynamic procedure*

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53 By assessing beach quality on a weekly basis throughout the bathing season, the DIBA  
54 takes a dynamic approach to assessing beach quality. This is of the utmost importance  
55 because beach behavior and quality is not the same throughout the bathing season, and  
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3 mean scores might not be representative of reality. By taking weekly records, more reliable  
4 data can be obtained and a deeper understanding of beaches can be achieved. Non-dynamic  
5 methods are useful for procedures that focus on permanent or long-term qualities such as  
6 scenery, economic value or simply general assessment (e.g. Ergin et al., 2004; Cervantes &  
7 Espejel, 2008). But for fragile environments or for rapidly changing situations, a dynamic  
8 procedure provides a more accurate picture of the world. This is also true for procedures  
9 used in management and applied studies (Botero et al., 2014). Similarly, Lucrezi et al.  
10 (2016) points out that repeating the analyses is important to prevent any given situation  
11 from being regarded as representative.  
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27 Different preferences and perceptions are explained by the characteristics of the beaches  
28 and the beach-user profile (Roca & Villares, 2008). Therefore, a dynamic procedure helps  
29 prioritize environmental educational programs that are specifically tailored to visitors to  
30 protected areas.  
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39 The DIBA index consists of six parameters (indicators or sub-indicators) that are recorded  
40 on a yearly basis (e.g., vegetation or viewshed) and which thus provide reliable information  
41 for the whole year. Although they are recorded this way, some parameters (e.g., heritage)  
42 do not need to be taken on a yearly basis because they are not expected no change  
43 noticeably during this period. Five parameters (indicators or sub-indicators) are collected  
44 weekly and some of them are heavily weighted, so substantial differences in the final score  
45 may be found if they are taken on a long-term basis. Finally, it is important to point out that  
46 two parameters (micro and mesobiological water quality) can neutralize E and lower  
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3 noticeably DIBA scores, as happened for Riumar (1<sup>st</sup> and 2<sup>nd</sup> August) and Trabucador (5<sup>th</sup>  
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5 July and 1<sup>st</sup> August).  
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### 10 *5.3. Comparison of beaches*

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15 This research allowed a number of aspects related to beach quality to be compared at four  
16  
17 selected beaches and their global performance on the DIBA index to be determined.  
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22 The beaches' scores on the DIBA decrease over the 13 weeks of the bathing season. Scores  
23  
24 for all the beaches are neutral or good. These overall positive scores are unsurprising  
25  
26 because beaches in protected areas are usually outstanding, particularly when it comes to  
27  
28 aesthetic qualities (Rangel et al., 2013). Consequently, even if a beach in a given set  
29  
30 performs particularly well, this may only be indicated by slight differences in its final score.  
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32 A high correlation may be seen between overcrowding and reduced beach quality because  
33  
34 crowdedness is particularly weighted. Lower scores may be improved via a number of  
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36 actions but as has been noticed on other occasions, human factors are easier to improve  
37  
38 than physical factors (Williams et al., 2016).  
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46 The kind of comparison undertaken in the present study can be beneficial for many reasons.  
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48 The most evident is that, by contrasting different beaches within a same region or  
49  
50 geographical area, managers have more information and are thus better able to plan  
51  
52 activities and assess carrying capacity. By introducing minor items or readjusting  
53  
54 weighting, the index can also be used to assess beaches in different environments. Beaches  
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56 vary widely and flexible procedures are needed to assess them (Botero et al., 2014).  
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3 Consequently, the DIBA can be used as an alternative to other widely used quality  
4 assessment procedures such as the Blue Flag award.  
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## 10 **6. Conclusions**

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13 The aim of this study was to develop a dynamic procedure to assess beach quality in  
14 protected areas. Four beaches on the Spanish Mediterranean coast were chosen for the case  
15 study. The DIBA proved to be a useful tool for evaluating beaches because it collects data  
16 on a weekly and therefore dynamic basis throughout the bathing season. Its composite  
17 index allows good and bad parameters to be identified and the resulting scores to be  
18 explained. The four beaches tested generally obtained good scores, with lower scores  
19 recorded during certain weeks due to overcrowding and poor water quality.  
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34 A number of items important to beach management (e.g., economic indicators) were  
35 deliberately excluded from the DIBA as they were considered to be outside the scope of the  
36 present research. However, in certain cases it may be interesting to complement the DIBA  
37 with economic indicators. One limitation of this study is that it did not record beachgoers'  
38 attitudes to the beaches they visited, although this was because the index was intended to  
39 focus on beach quality rather than on the impressions of tourists.  
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The tool is useful for comparing different beaches, not only during the bathing season but  
throughout the year, and its application over the long-term will provide a better  
understanding both of beaches and protected areas.

## Geolocation information

Mediterranean, Spain, Catalonia

## References

Ariza, E., Jiménez, J.A., Sarda, R., Villares, M., Pinto, J., Fraguell, R., Roca, E., Marti, C., Valdemoro, H., Ballester, R. & Fluvia, M. (2010). Proposal for an integral quality index for urban and urbanized beaches, *Environmental Management*, 45, pp. 998-1013. doi: [10.1007/s00267-010-9472-8](https://doi.org/10.1007/s00267-010-9472-8)

Ariza, E., Sardá, R., Jiménez, J., Mora, J. & Ávila, C. (2008). Beyond the performance assessment measurements for beach management: Application to Spanish Mediterranean beaches, *Coastal Management*, 36(1), pp. 47-66. doi: [10.1080/08920750701682023](https://doi.org/10.1080/08920750701682023)

Benoit, G., & Comeau, A. (2005). *A Sustainable Future for the Mediterranean: The Blue Plan's Environment and Development Outlook*. London: Earthscan.

Blay, J. (2012). Generation and management strategies for areas of natural interest. In *10 Lessons on Tourism*, ed. S. Anton-Clavé. Barcelona: Planeta.

Blue Flag. (2016). Criteria for beaches. *Blue Flag*. <http://www.blueflag.global/criteria/> (accessed March 1, 2017).

Boevers, J. (2008). Assessing the utility of Beach Ecolabels for Use by Local Management, *Coastal Management*, 36, pp. 524-531. doi: [10.1080/08920750802398776](https://doi.org/10.1080/08920750802398776)

Botero, C-M., Pereira, C., Anfuso, G, Cervantes, O., Williams, T, Pranzini, E. & Silva, P.. (2014). Recreational parameters as an assessment tool for beach quality, *Journal of Coastal Research*, 70, pp. 556-562. doi: <http://dx.doi.org/10.2112/SI70-094.1>

Breton, F., Clapés, J. Marquès, À. & Priestley, G.K.. (1996). The recreational use of beaches and consequences for the development of new trends in management: the case of the beaches of the Metropolitan Region of Barcelona (Catalonia. Spain), *Ocean & Coastal Management* 32(3), pp. 153-180. doi: [10.1016/S0964-5691\(96\)00032-4](https://doi.org/10.1016/S0964-5691(96)00032-4)

Cervante, O., & Espejel, I. (2008). Design of an integrated evaluation index for recreational beaches, *Ocean & Coastal Management*, 51, pp. 410-419. doi: [10.1016/j.ocecoaman.2008.01.007](https://doi.org/10.1016/j.ocecoaman.2008.01.007)

Daniel, T.C. (2001). Whither scenic beauty? Visual landscape quality assessment in the 21<sup>st</sup> century, *Landscape and Urban Planning*, 54, pp. 267-281. doi: [10.1016/S0169-2046\(01\)00141-4](https://doi.org/10.1016/S0169-2046(01)00141-4)

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53  
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56  
57  
58  
59  
60

Dunn, M.C. (1974). *Landscape evaluation techniques: An appraisal and review of the literature*. Birmingham: University of Birmingham.

Eagles, P., & McCool, F. (2002). *Tourism in national parks and protected areas: planning and management*. Wallingford: Cabi Publishing.

EEA. (1999). *State and pressures of the marine and coastal Mediterranean environment*. Luxembourg - Office for Official Publications of the European Communities.  
<http://www.eea.europa.eu/publications/ENVSERIES05/#parent-fieldname-title> (accessed March 1, 2017).

Ergin, A., Karaesmen, E. Micallef, A. & Williams, A.T. (2004). A new methodology for evaluating coastal scenery: fuzzy logic systems, *Area*, 36 (4), pp. 367-386. doi: [10.1111/j.0004-0894.2004.00238.x](https://doi.org/10.1111/j.0004-0894.2004.00238.x)

Fraguell R.M., Martí. C., Pintó, J. & Coenders, G. (2016). After over 25 years of accrediting beaches. Has Blue Flag contributed to sustainable management?, *Journal of Sustainable Management*, 24(6), pp. 889-903. doi: [10.1080/09669582.2015.1091465](https://doi.org/10.1080/09669582.2015.1091465).

GRATET. (2013). *Successful destinations. An approach based in the analysis of 16 worldwide beach cities*. Department of Geography. Rovira i Virgili University.  
<http://www.globaltur.org> (accessed March 1, 2017).

Harris, L., Nel, R., Holness, S. & Schoeman, D. (2015). Quantifying cumulative threats to sandy beach ecosystems: A tool to guide ecosystem-based management beyond coastal reserves, *Ocean & Coastal Management*, 110, pp. 12-24. doi: [http://dx.doi.org/10.1016/j.ocecoaman.2015.03.003](https://doi.org/10.1016/j.ocecoaman.2015.03.003)

Houston, J. (2013). The economic value of beaches – a 2013 update, *Shore & Beach*, 81 (1), pp. 3-10.

Klein, Y., Osleeb, J. & Viola, M. (2004). Tourism-Generated Earnings in the Coastal Zone: A Regional Analysis, *Journal of Coastal Research*, 20 (4), pp. 1080-1088. doi: [http://dx.doi.org/10.2112/003-0018.1](https://doi.org/10.2112/003-0018.1)

Linton, D.L. (1968). The assessment of scenery as a natural resource, *Scottish Geographical Magazine*, 84 (3), pp. 219-238. doi: [10.1080/00369226808736099](https://doi.org/10.1080/00369226808736099)

Lucrezi, S., Saayman, M. & Merwe, P. (2016). An assessment tool for sandy beaches: A case study for integrating beach description. Human dimension and economic factors to identify priority management issues, *Ocean & Coastal Management*, 121, pp. 1-22. doi: [http://dx.doi.org/10.1016/j.ocecoaman.2015.12.003](https://doi.org/10.1016/j.ocecoaman.2015.12.003)

Lucrezi, S., Saayman, M., & Merwe, P. (2015). Managing beaches and beachgoers: Lessons from and for the Blue Flag award, *Tourism Management*, 48, pp. 211-230. doi: [http://dx.doi.org/10.1016/j.tourman.2014.11.010](https://doi.org/10.1016/j.tourman.2014.11.010)

1  
2  
3 Mariné-Roig, E. & Anton Clavé, S. (2016). Perceived image specialisation in multiscale  
4 tourism destinations, *Journal of Destination Marketing & Management*, 5, pp. 202-213. doi:  
5 <http://dx.doi.org/10.1016/j.jdmm.2015.12.007i>  
6

7  
8 Mir-Gual, M., Pons, G. X., Martín-Prieto, J.A. & Rodríguez-Perea, A. (2015). A critical  
9 review of the Blue Flag beaches in Spain using environmental variables, *Ocean & Coastal*  
10 *Management*, 105, pp. 106-115. doi: <http://dx.doi.org/10.1016/j.ocecoaman.2015.01.003>  
11

12 Mullins, P. (1991). Tourism urbanization, *International Journal of Urban & Regional*  
13 *Research*, 15 (3), pp. 326-342. doi: [10.1111/j.1468-2427.1991.tb00642.x](http://dx.doi.org/10.1111/j.1468-2427.1991.tb00642.x)  
14

15  
16 Pendleton, L., Martin, N. & Webster, D.G. (2001). Public Perceptions of Environmental  
17 Quality: A Survey Study of Beach Use and Perceptions in Los Angeles County, *Marine*  
18 *Pollution Bulletin*, 42 (11), pp. 1155-1160. doi: [10.1016/S0025-326X\(01\)00131-X](http://dx.doi.org/10.1016/S0025-326X(01)00131-X)  
19

20  
21 Pintó, J., Martí, C. & Fraguell, R.M. (2014). Assessing current conditions of coastal dune  
22 systems of Mediterranean developed shores, *Journal of Coastal Research*, 40 (4), pp. 832-  
23 842. doi: [10.2112/JCOASTRES-D-13-00116.1](http://dx.doi.org/10.2112/JCOASTRES-D-13-00116.1)  
24

25  
26 Pons, A., Rullán, O. & Murray, I. (2014). Tourism capitalism and island urbanization: tourist  
27 accommodation diffusion in the Balearics, 1936-2010, *Island Studies Journal*, 9 (2), pp. 239-  
28 258.  
29

30  
31 Rangel-Buitrago, N., Correa, I.D., Anfuso, G., Ergin, E. & Williams, A.T. (2013). Assessing  
32 and managing scenery of the Caribbean Coast of Colombia, *Tourism Management*, 35, pp.  
33 41-58. doi: [10.1016/j.tourman.2012.05.008](http://dx.doi.org/10.1016/j.tourman.2012.05.008)  
34

35  
36 Ribeiro, M.F., Ferreira, J.C. & Silva, C.P. (2011). The Sustainable Carrying Capacity as a  
37 Tool for Environmental Beach Management, *Journal of Coastal Research*, Special issue, 64,  
38 pp. 1411-1414.  
39

40  
41 Roca, E. & Villares, M. (2008). Public perceptions for evaluating beach quality in urban  
42 and semi-natural environments, *Ocean & Coastal Management*, 51, pp. 314-329.  
43 doi: [10.1016/j.ocecoaman.2007.09.001](http://dx.doi.org/10.1016/j.ocecoaman.2007.09.001)  
44

45  
46 Rovira, M.T. & Anton-Clavé, S. (2014). From destination to town. The urban reformulation  
47 of mature coastal tourist destinations. The case of Costa Daurada central, *Architecture. City*  
48 *and Environment*, 9 (25), pp. 373-392. doi: [10.5821/ace.9.25.3632](http://dx.doi.org/10.5821/ace.9.25.3632)  
49

50  
51 Silva, C.P. (2002). Beach Carrying Capacity Assessment: How important is it?, *Journal of*  
52 *Coastal Research*, Special issue, 36, pp. 190-197.  
53

54  
55 Tudor, D.T. & Williams, A.T. (2006). A rationale for beach selection by the public on the  
56 coast of Wales. UK, *Area*, 38(2), pp. 153-164. doi: [10.1111/j.1475-4762.2006.00684.x](http://dx.doi.org/10.1111/j.1475-4762.2006.00684.x)  
57

58  
59 Tripadvisor. (2016). <https://www.tripadvisor.com> (accessed March 1, 2017).  
60

1  
2  
3 UNEP-UNWTO. (2008). *Making tourism more sustainable: a guide for policy makers*.  
4 United Nations Environment Programme – World Tourism Organization.  
5 [www.unep.fr/shared/publications/pdf/DTIx0592xPA-TourismPolicyEN.pdf](http://www.unep.fr/shared/publications/pdf/DTIx0592xPA-TourismPolicyEN.pdf) (accessed March  
6 1, 2017).  
7

8  
9 UNWTO. (2014). *Tourism highlights. 2015*. [http://www.e-](http://www.e-unwto.org/doi/pdf/10.18111/9789284416899)  
10 [unwto.org/doi/pdf/10.18111/9789284416899](http://www.e-unwto.org/doi/pdf/10.18111/9789284416899) (accessed March 1, 2017).  
11

12 Velvet, N. (2013). *An Introduction to the Geography of Tourism*. Plymouth: Rowman &  
13 Littlefield.  
14

15  
16 Williams. A.T. & Khattabi, A. (2015). Beach scenery at Nador Province. Morocco, *Journal*  
17 *of Coastal Conservation*, 19, pp. 743-755. doi: [10.1007/s11852-015-0393-9](https://doi.org/10.1007/s11852-015-0393-9)  
18

19  
20 Williams, A.T., Micallef, A., Anfuso, G. & Gallego-Fernandez, J.B. (2012). Andalusia. Spain:  
21 An Assessment of Coastal Scenery, *Landscape Research*, 37, pp. 327-349. doi:  
22 [10.1080/01426397.2011.590586](https://doi.org/10.1080/01426397.2011.590586)  
23

24  
25 Williams. A.T. & Micallef, A. (2009). *Beach management. Principles and practices*. London:  
26 Earthscan.  
27

28  
29 Williams. A.T., Rangel-Buitrago, N.G., Anfuso, G., Cervantes, O. & Botero, C.M. (2016).  
30 Litter impacts on scenery and tourism on the Colombian north Caribbean coast, *Tourism*  
31 *Management*, 55, pp. 209-224. doi: <http://dx.doi.org/10.1016/j.tourman.2016.02.008>  
32

33  
34 WTO. (2015). *Annual Report*. Madrid. [http://www2.unwto.org/publication/unwto-annual-](http://www2.unwto.org/publication/unwto-annual-report-2015)  
35 [report-2015](http://www2.unwto.org/publication/unwto-annual-report-2015) (accessed March 1, 2017).  
36

37  
38 Yepes, V. (1999). Las playas de la gestión sostenible del litoral. *Cuadernos de Turismo*, 4,  
39 89-110.

40  
41 Zacarias. D.A., Williams, A.T. & Newton, A. (2011). Recreation carrying capacity  
42 estimations to support beach management at Praia de Faro. Portugal, *Applied Geography*, 31,  
43 pp. 1075-1081. doi:[10.1016/j.apgeog.2011.01.020](https://doi.org/10.1016/j.apgeog.2011.01.020)  
44

45  
46 Zonneveld. I. S. (1995). *Land Ecology. An introduction to Landscape Ecology as a base for*  
47 *Land Evaluation. Land Management and Conservation*. Amsterdam: SPB Academic Publ.  
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Residential, tourist and commercial zones	Built-up area (%)	Built-up coastal index (%)
Antalya-Analya (Turkey)	90.62	80.51
Benidorm-Costa Blanca (Spain)	95.80	74.03
Marbella (Spain)	95.39	97.75
Nice-Côte d'Azur (France)	94.15	98.52
Salou-Costa Daurada (Spain)	93.82	86.45
Rimini (Italy)	79.56	100.00

Table 1. Built-up area and built-up coastal index for the main Mediterranean tourist destinations.

Source: GRATET (2013).

Numerical values	Nominal scale
< 0.50	Deficient
$\geq 0.50$ - < 0.65	Neutral
$\geq 0.65$ - < 0.85	Good
$\geq 0.85$	Very good

Table 2. Correspondence between numerical values and nominal scale.

	Very good	Norm. value	Good	Norm. value	Deficient	Norm. value
<i>Fecal streptococcus</i>	<100	1.0	100-185	0.5	>185	0.0
<i>Escherichia coli</i>	<250	1.0	250-500	0.5	>500	0.0

Table 3. Microbiological water quality assessment. Scores are expressed in colony-forming unit, cfu/100ml. MIB scores are normalized to a 0-1 scale (Norm. value column)

Species	Degree of harm	Very frequent	Norm. value	Less frequent	Norm. value	Absent	Norm. value
<i>Pelagia noctiluca</i>	high	>21	0.0	≤20	0.0	0	1.0
<i>Rhizostoma pulmo</i>	medium	>21	0.0	≤20	0.0	0	1.0
<i>Cotylorhiza tuberculata</i>	low	>21	0.0	≤20	0.5	0	1.0
<i>Aequorea forskalea</i>	low	>21	0.0	≤20	0.5	0	1.0

Table 4. Mesobiological water quality assessment. All four commonest jellyfish in the Mediterranean are listed. Scores are expressed as numbers of individuals. MEB scores are normalized to a 0-1 scale (Norm. value column).

	Low richness	Norm. value	Medium richness	Norm. value	High richness	Norm. value
Number of species	<10	0.1	11-19	0.5	>20	1.0

Table 5. Vegetation species richness assessment. Scores are expressed in numbers of individuals.

VSR scores are normalized to a 0-1 scale (Norm. value column).

	Landform features	Norm. value
Erosion	cliffs $\geq$ 10 m	0.6
	cliffs < 10 m	0.3
	features (stack, sea caves, tafoni, etc.)	0.1 per feature up to 3 features
	good color contrast	0.1
Deposition	dunes $\geq$ 5 m	0.6
	dunes < 5 m	0.3
	features (spit, tombolo, shoal, etc.)	0.1 per feature up to 3 features
	good color contrast	0.1

Table 6. Landform diversity assessment. Values are expressed in number of landforms. LFD

scores are normalized to a 0-1 scale (Norm. value column).

Item	Very good	Norm. value	Good	Norm. value	Deficient	Norm. value
Water color	blue	1.0	blue-greenish	0.5	greenish, brownish, yellowish, greyish	0.0
Water transparency	$\geq 1.5$ m	1.0	1.5-0.5	0.5	$\leq 0.5$	0.0
Algae patches	0	1.0	1	0.0	$>1$	0.0
Dead animals	0	1.0	1-3	0.5	$>3$	0.0
Oil patches	0	1.0	1	0.0	$>1$	0.0
Litter on sand	0-6	1.0	7-14	0.5	$>14$	0.0
Litter floating in water	0-3	1.0	4-7	0.5	$>7$	0.0

Table 7. Appearance assessment. Scores are expressed in units. APP scores are normalized to a 0-1 scale (Norm. value column).

Land cover class	Norm. value
Open water	1.0
Coastal morphology	1.0
Natural vegetation	1.0
Croplands	0.5
Built-up area	0.0

Table 8. Artificial land cover assessment. ALC classes are normalized to a 0-1 scale (Norm. value column).

Item	Norm. value
Heritage item	0.1

Table 9. Heritage assessment. Scores are expressed in units.

Item	Norm. value
Inland water	0.5
Marine water	0.8
Coniferous forest	1.0
Sclerophyllous forest	0.9
Broad-leaved forest	1.0
Shrub and grassland	0.8
Irrigated herbaceous crops	0.8
Non-irrigated herbaceous crops	0.7
Irrigated fruit trees	0.8
Non-irrigated fruit trees	0.7
Road network	0.0
Continuous urban fabric	0.5
Bare land	0.5
Beaches, dunes and sand plains	0.8
Non-continuous urban fabric	0.0
Inland marshes	0.8
Vineyards	0.7
Burnt areas	0.0
Industrial or commercial unit	0.0

Table 10. Viewshed assessment.

	Features	Norm. value	Features	Norm. value	Features	Norm. value
Signposting						
	Signposting exists beyond 500 m at all accesses points to the beach	0.3	Signposting exists in the nearest 500m at any access point to the beach	0.2	No signposting	0.0
Park lot						
	Legal parking lot	0.2	Illegal or unregulated parking lot	0.1	No parking lot	0.0
Environmental information						
	Information about the environment and environment law.	0.3	Information about the environment law, only. Information about the environment, only	0.2	No environmental information	0.0
Commodities						
	Lifeguard service	0.2	Showers, bins, cocktail bar, etc.	0.1	No commodities	0.0

Table 11. Facilities assessment. ACS scores are normalized to a 0-1 scale (Norm. value column).

Item	Very good (m <sup>2</sup> /user)	Norm. value	Good (m <sup>2</sup> /user)	Norm. value	Deficient (m <sup>2</sup> /user)	Norm. value
Sand availability	>10	1.0	5-10	0.5	<4,9	0.0

Table 12. Frequentation assessment. FRQ scores normalized to a 0-1 scale (Norm. value column).

Activity	Number of users doing activity (at all the beach count)	Norm. value	Number (at all the beach count)	Norm. value
Dog walking	<5	0.0	≥ 5	0.2
Buggy racing	<4	0.0	≥ 4	0.4
Water sports	<5	0.0	≥ 5	0.1
Recreational fishing	<5	0.0	≥ 5	0.1
Shell fishing	<5	0.0	≥ 5	0.1
Others	0	0.0	≥1	0.1

Table 13. Recreational activities assessment. RTA scores are shown in brackets.

	E				L				R				DIBA			
	M	CF	R	T	M	CF	R	T	M	CF	R	T	M	CF	R	T
1 <sup>st</sup> week June	0,76	0,70	1,00	0,46	0,59	0,68	0,59	0,74	0,75	0,40	0,83	0,78	0,67	0,62	0,75	0,68
2 <sup>nd</sup> week June	0,76	0,70	0,75	0,35	0,59	0,68	0,61	0,74	1,00	0,40	0,88	0,88	0,73	0,62	0,71	0,67
3 <sup>rd</sup> week June	0,76	0,70	0,75	0,35	0,59	0,68	0,63	0,76	0,50	0,65	0,88	0,88	0,61	0,68	0,72	0,68
4 <sup>th</sup> week June	0,76	0,70	1,00	0,46	0,59	0,68	0,63	0,76	0,50	0,40	0,88	0,90	0,61	0,62	0,79	0,72
1 <sup>st</sup> week July	0,76	0,70	1,00	0,46	0,59	0,68	0,61	0,72	0,50	0,40	0,88	0,90	0,61	0,62	0,78	0,70
2 <sup>nd</sup> week July	0,76	0,70	1,00	0,46	0,59	0,68	0,61	0,72	0,50	0,40	0,98	0,73	0,61	0,62	0,80	0,66
3 <sup>rd</sup> week July	0,76	0,70	0,75	0,46	0,59	0,68	0,61	0,74	0,48	0,40	0,73	0,73	0,60	0,62	0,68	0,67
4 <sup>th</sup> week July	0,76	0,70	0,75	0,46	0,59	0,68	0,63	0,72	0,50	0,40	1,00	0,78	0,61	0,62	0,75	0,67
5 <sup>th</sup> week July	0,76	0,70	1,00	0,23	0,59	0,68	0,57	0,70	0,75	0,40	0,98	0,90	0,67	0,62	0,78	0,63
1 <sup>st</sup> week August	0,57	0,70	0,50	0,35	0,59	0,68	0,63	0,70	0,50	0,40	0,58	0,73	0,56	0,62	0,59	0,62
2 <sup>nd</sup> week August	0,76	0,70	0,50	0,46	0,59	0,68	0,63	0,72	0,50	0,40	0,63	0,73	0,61	0,62	0,60	0,66
3 <sup>rd</sup> week August	0,76	0,70	1,00	0,46	0,59	0,68	0,61	0,76	0,50	0,40	0,58	0,73	0,61	0,62	0,70	0,68
4 <sup>th</sup> week August	0,76	0,70	1,00	0,46	0,59	0,68	0,63	0,70	0,50	0,40	0,60	0,78	0,61	0,62	0,72	0,66

Table 14. Sub-indices and final score for the DIBA index. Beach key: M: Muntanyans; CF: Cala

Fonda; R: Riumar; T: Trabucador

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9 Fig. 1. The DIBA workflow.  
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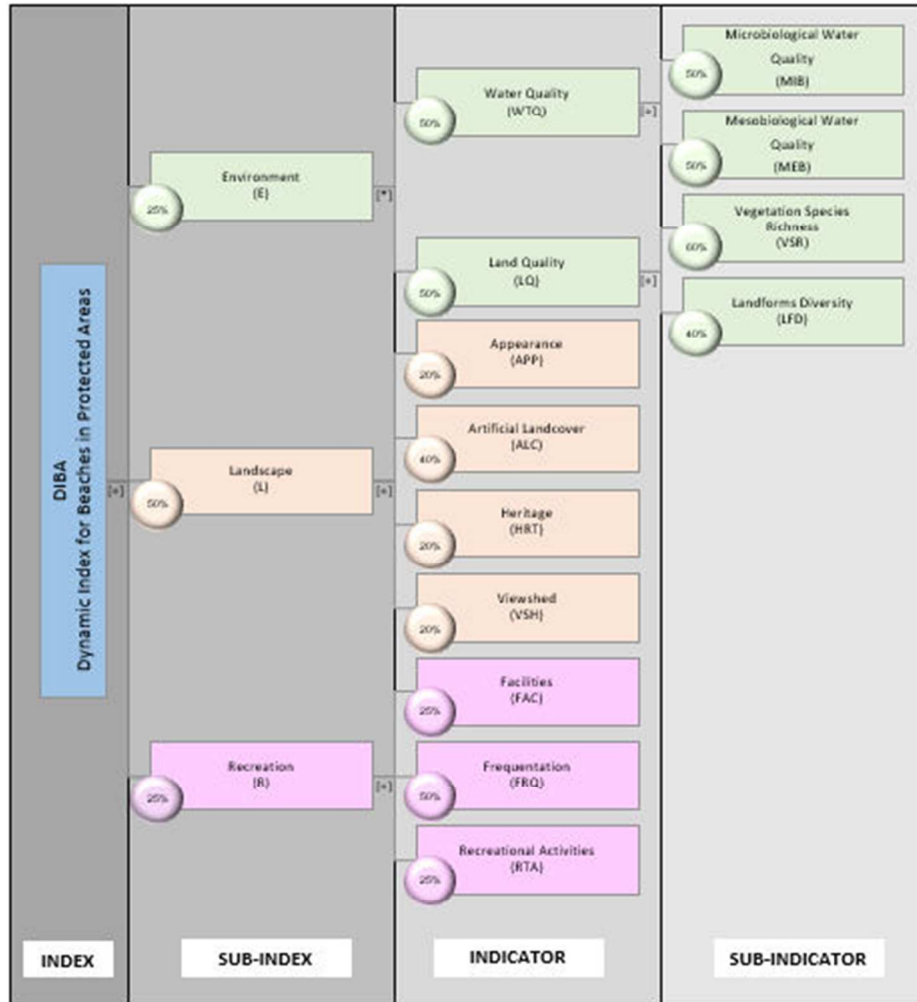


Fig. 1. The DIBA workflow.

163x177mm (72 x 72 DPI)



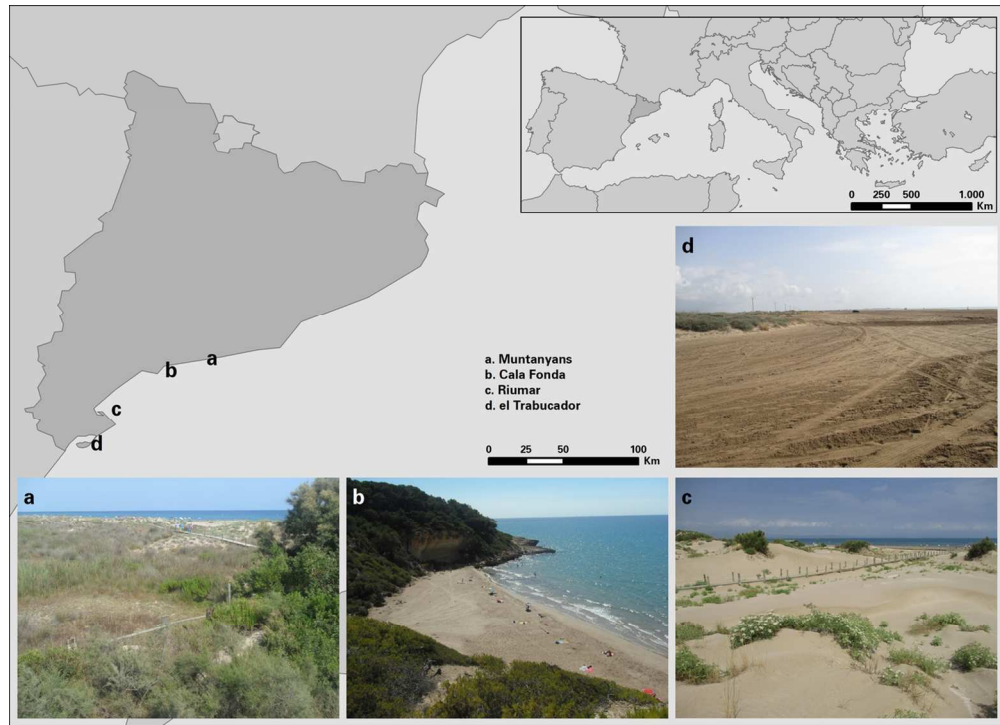


Fig. 2. Overview of the beaches.

120x87mm (300 x 300 DPI)

View Only