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The Sector Analysis as a Coastal Management Tool for Sustainable Tourism Development on the Mediterranean Coast of Morocco

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Abstract: Beaches are ecologically valuable ecosystems and sites that attract many tourists from all over the world, therefore, knowledge of their environmental conditions to establish sound management strategies is of extreme relevance. This study aims to assess and classify 50 beaches through an innovative coastal management approach called "Sector Analysis", which integrates Litter grading, the coastal scenic quality and beach typology in order to classify sites into one of three sectors: Green (high value sites), Red (low value sites) and Yellow (sites with contradictory values). Litter Grade makes it possible to classify a site according to the quantity of litter using four grades from "A" (low) to "D" (high amount). The Coastal Scenic Evaluation System (CSES) allows to classify sites into five classes, ranging from extremely attractive natural sites (Class I) to unattractive degraded and urbanized sites (Class V). This innovative methodology for sustainable coastal area management can be easily applied to any beach in the world. The results on Litter Grade and CSES considered in this paper were obtained from previous studies and used to obtain the Sector Analysis that showed only 8 sites (16%) are in the Green sector, 18 sites (36%) in the Red sector and 24 sites (48%) in the Yellow sector. The significant percentage of sites in the Red sector (one third of the sites studied) clearly indicates the degradation that the Moroccan Mediterranean coast has undergone due to considerable anthropogenic activities and the lack of adequate coastal management programs. In this study, various management interventions were proposed to conserve and improve the aesthetic quality of beaches and reduce the impact and presence of litter in the coastal areas.

Keywords: beaches; coastal destination; anthropogenic activities; scenery; litter

Citation: Er-Ramy, N.; Nachite, D.; Anfuso, G.; Azaaouaj, S. The Sector Analysis as a Coastal Management Tool for Sustainable Tourism Development on the Mediterranean Coast of Morocco. *Sustainability* **2023**, *15*, 12581. https://doi.org/10.3390/su151612581

Academic Editor: Colin Michael Hall

Received: 21 July 2023
Revised: 15 August 2023
Accepted: 17 August 2023
Published: 18 August 2023

1. Introduction

Beaches represent multidimensional natural ecosystems of great ecological value, and a valuable environmental resource of very high economic value with many important ecosystem functions, goods and services [1–3]. These natural ecosystems play a fundamental role in coastal protection and disaster mitigation, nutrient cycling, biodiversity preservation and balance and tourism [4–6]. When choosing a tourist destination, coasts are probably the most attractive tourist places around the world [7–9]. The principal reason to visit coastal areas, particularly beaches, is to enjoy the pleasures of the Sea, Sun and Sand ("3S") tourism, the beauty of coastal landscapes and other tourist activities [10–12]. Currently, various human impacts, especially litter, pose a serious threat to beaches along the coast [13–16]. Whatever the source, i.e., land based or marine, litter has a significant impact on the aesthetic quality of beaches, wildlife, human health and the overall functioning of coastal ecosystems [17–21]. Unfortunately, the impacts caused by marine litter are not yet fully understood [22] and beach deterioration caused by litter is currently an

out-of-control problem [23] threating the national economies of coastal countries based on 3S tourism [24,25].

Tourists are attracted by the cleanliness of the sea and beaches [26,27] and the presence of litter is the main reason for avoiding a beach [10,28]. In this context, five parameters are highly important for tourists when choosing a coastal destination and for assessing the quality of beaches, i.e., the "Big Five": water and sand quality, safety, facilities, absence of litter and scenery [29]. An exceptional landscape is among the most important reasons a visitor considers when deciding to choose a seaside tourist destination [30]. Unfortunately, the exploitation of natural resources, including the landscape and especially its quality, has always been closely linked to the anthropogenic development of the coast [31]. The landscape and the absence of litter have been identified as key aspects of coastal management [29].

As beaches are multidimensional spaces, their management must allow sustainable and optimal use of natural resources in order to integrate ecological, socio-cultural, economic and engineering aspects [32,33]. Sustainable beach management depends on the availability of essential information [34] and requires the appropriate tools to develop sound management strategies and improve management practices. Appropriate management is always necessary to ensure the equitable and sustainable use of marine ecosystems and the proposal of new tools and instruments to help managers exercise these practices is still encouraged [35,36]. Within this framework, several tools employed by managers can be mentioned, including Integrated Coastal Zone Management (ICZM), Marine Spatial Planning (MSP) and the Blue Flag award. Therefore, an adequate and appropriate management strategy, including effective planning and a clear regulatory and legislative framework, is required to maintain beach quality [37]. Beaches are valued for many ecosystem services [38], and their management and governance play a very significant role in maintaining the sustainable flows of these services and the health of the coastal environment [5]. As a geomorphological system, beaches are under high threat from coastal erosion worldwide [39,40]. Coastal erosion has serious impacts on the stability of a beach, including the destruction of tourism development and the deterioration of coastal ecosystems. According to Williams et al. [41], addressing of the causes of beach erosion is of the utmost relevance, i.e., it should be the first and foremost objective of any coastal area management action. As a tool for coastal resource management and adaptation to pressures, ICZM must include measures to mitigate the predicted impacts of coastal erosion in order to effectively plan sustainable beach management tolls.

In this paper, 50 coastal sites along the Moroccan Mediterranean coast were evaluated and classified according to an innovative coastal management approach known as Sector Analysis [8], which integrates three factors extremely important to determine the quality of a beach: beach cleanliness, beach typology and coastal scenery. In a first study, carried out by Er-ramy et al. [42], the coastal scenic quality assessment was successfully carried out on the investigated littoral zone using the Coastal Scenery Evaluation System (CSES, [43]) and, in a second study, beach cleanliness was investigated by means of the Litter Grade [44] as an important variable for beach users and the aesthetic quality of beaches [9]. The main objective of this paper is to study these three interdependent factors as important indicators in the perception of coastal zone management, in maintaining the growth of sustainable coastal tourism and in improving beach quality. Thus, the results of this paper represent a significant improvement in the development of Morocco's coastal area monitoring capacity and significantly contribute to the adoption and implementation of appropriate environmental policies. These results are also beneficial and very important to coastal managers, as they provide accurate and realistic baseline information on the state of the coast and associated coastal landscapes for sound and appropriate management actions. Furthermore, this study is based on an innovative methodology for coastal area management that can be easily and widely applied on different beaches around the world and, therefore, the results obtained are of value to the scientific community interested in strengthening the coastal management aspect.

2. Study Area

Morocco benefits from a privileged geographical location, situated at the north-western tip of the African continent, on the border between Europe and Africa (14 km), bounded by the Mediterranean Sea from Cap Spartel to Saïdia (512 km) and by the Strait of Gibraltar to the north and by the Atlantic Ocean from Cap Spartel to Lagouira (3000 km) to the west. Morocco has a rich and diverse marine environment, a precious coastline, a variety of climates and a significant wealth of natural resources that give it a specific ecological diversity. These enormous assets, which make it a versatile pole of tourist attraction, have contributed to the development of national and international tourism that constitutes an important pillar of the national economy, mainly based on seaside activities [45]. Morocco benefits from an important geological diversity including vast plains and plateaus, coastal areas and high mountains. This geological richness results in a very varied topography, with strong geomorphological dynamics.

To assess the quality of the beaches studied, this paper deals with 50 different sites on Morocco's Mediterranean coast (Figure 1). The coast studied hosts a rich and diverse natural heritage distinguished by a wide morphological variation. The beaches selected consist of sand, pebbles, cobbles and boulders and are representative of the natural and landscape heritage of Morocco's Mediterranean coasts.

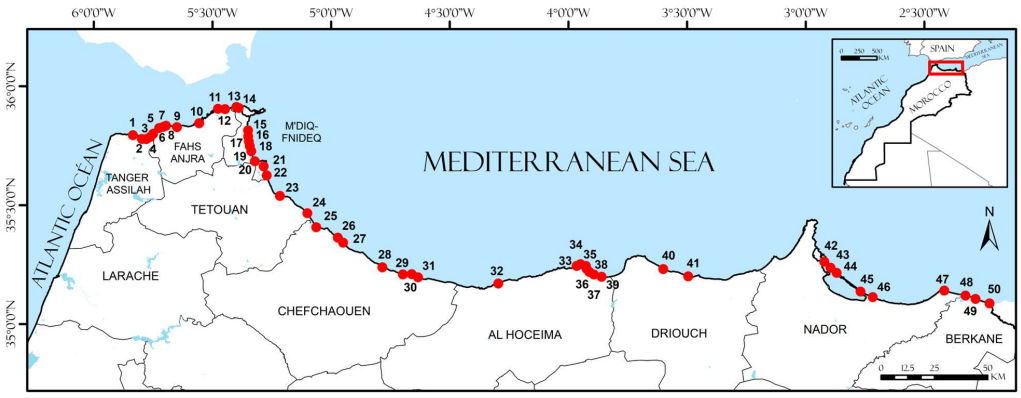

Figure 1. Location map of investigated areas (Morocco).

3. Methods

The Sector Analysis is primarily an economic concept used to assess the performance of a specific sector of activity. In the field of coastal areas, this concept has been used as an innovative approach to sustainable coastal management ideated by C. Botero and presented for the first time by Williams et al. [8], which allows to integrate at the same time beach cleanliness, coastal landscape quality and beach typology into the same analysis (Figure 2). In addition, Sector Analysis is a very important management tool for interpreting sites where the quality of the coastal landscape is affected by litter problems and for interpreting the variation in litter according to beach typology. In the context of coastal management, as an ecosystem of great ecological value, the health of the beach is a prerequisite for any future development and management. The Sector Analysis, as a management tool, can be useful in this respect, providing a wealth of information that can help stakeholders to plan the sustainable management of beaches, which plays an essential role in the achievement of ICZM strategies. For instance, this concept can be used to diagnose the state of health of beaches, identify sites with high tourism potential, strengths and weaknesses in terms of the impacts presented at each site level, in order to propose appropriate and relevant new management measures and actions to improve the quality of coastal areas.

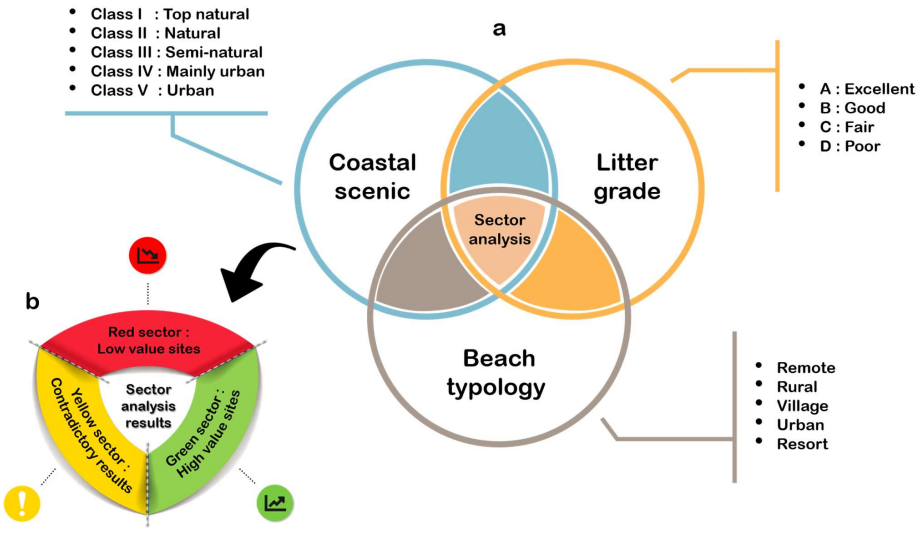

Figure 2. Illustration of the Sector Analysis method used in this study with (**a**) the three essential elements of the Sector Analysis and (**b**) the three sectors as a result of the combination of these elements.

To apply the Sector Analysis approach to the Moroccan Mediterranean beaches, a combination of three methods was used in the study area for data collection and analysis. The EA/NALG technique [44] was used to assess beach cleanliness level by means of the Litter Grade, the Coastal Scenic Evaluation System (CSES) [43] was applied to evaluate coastal scenery and the Bathing Area Registration and Evaluation "BARE" approach [29] was employed to determine beach typology. In addition, the presence of the "Blue Flag" award has been taken into consideration in this study since it is one of the most internationally recognized awards and an indicator of the presence of facilities and beach cleanliness, as well as a symbol of overall beach quality for many tourists [46–49]. In Morocco, the Blue Flag label is under the responsibility of the Mohammed VI Foundation for Environmental Protection. It was first introduced in 2002 as part of the 'Clean Beaches' program. In this context, for a beach to be awarded with the Blue Flag, six categories of criteria are highly required: maintenance, cleanliness, equipment, safety, training, awareness and accessibility. These criteria mainly include the bathing water quality, the state of the beach, the protection of flora and fauna, etc. Coastal municipalities are the ones that obtain the label and are responsible for the complete management of the beach.

Beach typology:

The beaches studied were evaluated and classified into different typologies described in the BARE approach, according to Williams and Micallef [29] (Table A1). The main objective is to determine the management needs of highest priority for each site. This classification separates coastal sites into five categories, considering facilities and equipment, public services, difficulty and means of access, nature of the site and accommodation capacity. The five categories are remote, rural, village, urban and resort.

Litter Grade:

The beaches studied in this paper were evaluated and classified in grades according to their amount of litter [9] following the EA/NALG [44] technique, i.e., the Litter Grade or Beach grading system that has been widely used around the world. According to the EA/NALG classification system, four grades have been identified from "A" (excellent) to "D" (poor), to describe the aesthetic quality of a beach (Table 1). The final grade is the lowest result obtained for one of the selected parameters. For instance, if a beach is classified as "A" for all parameters except for "potentially harmful litter", which is "C", the overall grade is "C".

Table 1. Beach grading system according to litter categories [44].

Category	Type	A (Excellent)	B (Good)	C (Fair)	D (Poor)
Sewage-related debris	General, e.g., condoms, nappies	0	1–5	6–14	15+
	Cotton buds (Q tips)	0–9	10–49	50–99	100+
Gross litter	e.g., trolleys, car parts	0	1–5	6–14	15+
General litter	e.g., cans, sweet wrappers	0–49	50–499	500–999	1000+
Potentially harmful litter	Broken glass	0	1–5	6–24	25+
	Other	0	1–4	5–9	10+
Accumulations	Number	0	1–4	5–9	10+
Oil		Absent	Trace	Nuisance	Objectionable
Feces		0	1–5	6–24	25+

Coastal Scenic Evaluation System (CSES):

The coastal scenery evaluation study was successfully applied along the Moroccan Mediterranean beaches and the sites studied were classified into the five scenic classes [42] using the Coastal Scenic Evaluation System [43]. According to the CSES, landscape assessment is based on 26 parameters, including 18 natural and 8 human aspects (Table A2). Each parameter was weighted by beach users, and then examined by the observer using a five-point rating scale, from 1 (presence/absence, or poor quality) to 5 (excellent quality). An evaluation index (D) has been calculated, classifying each site into one of five classes according to its scenic quality value and degree of human activity. The evaluation index D is calculated from the membership degrees in relation to the attributes (1 to 5), where the membership degrees are the combination between the weighted averages of the attributes of the physical parameters and those of the attributes of the human parameters. The algorithm involving both weighting and fuzzy logic values and incorporating all of the elements above resulted in the evaluation index value according to the following equation:

$$D = \frac{(-2A12) + (-A23) + (A34) + (2A45)}{\text{Total area under curve}} \quad (1)$$

where: A_{12}, A_{23}, A_{34}, and A_{45} are the areas between attributes 1 and 2, 2 and 3, 3 and 4, and 4 and 5, respectively. For more details on the CSES methodology, see Ergin et al. [30,43]. According to CSES, the five classes are defined as follows:

- "Class I: Extremely attractive natural site with a very high landscape value ($D \geq 0.85$);
- Class II: Attractive natural site with high landscape value ($0.85 > D \geq 0.65$);
- Class III: Mainly natural site with little outstanding landscape features ($0.65 > D \geq 0.4$);
- Class IV: Mainly unattractive urban site with a low landscape value ($0.4 > D \geq 0.00$);
- Class V: Very unattractive urban site with intensive development and a low landscape value ($D < 0$)" ([43], p. 380).

To apply the Sector Analysis, after obtaining the results of the three previous factors, a square matrix was developed for each beach type and for all investigated beaches in the study area, integrating Litter Grades ("A" to "D") in the columns and coastal scenic classes (I to V) in the rows. By applying the percentile technique [50] to the dynamic matrix, three different sectors can be obtained. The Green sector, which includes four cells in the upper left quadrant, shows beaches with good grades ("A"-"B") and very high value coastal landscape classes (I-II). The Red sector, which includes four cells in the lower right quadrant, indicates beaches with low Litter Grades ("C"-"D") and low value coastal landscape classes (IV-V). The Yellow sector, which includes the remaining two quadrants and the middle cells, shows beaches with contradictory results, i.e., poor Litter Grades with excellent landscape qualities or the opposite.

4. Results

The distribution and most important characteristics of all the sites studied and the results of the Sector Analysis according to the three sectors (Green, Yellow and Red) are

presented in this section. The sites are highly diversified ranging from class I to V according to landscape quality and from grade "B" to "D" according to the quantity of litter, and show the five typologies of the beaches [9,42]. The results are presented in Table 2 and Figures 3–5. Alongside the study area, the coastal scenery evaluation shows as 9 sites (18%) were classified in class I, 10 sites (20%) in class II, 8 sites (16%) in class III, 16 sites (32%) in class IV and 7 sites (14%) in class V [42]. The results of the Litter Grade evaluation show that none of the sites obtained grade "A" (excellent), 18 sites (36%) scored "B" (good), 28 sites (56%) scored "C" (fair) and 4 sites (8%) scored "D" (poor) [9]. The distribution of sites among scenic quality, beach cleanliness and beach typology shows that class I includes both "B" and "C" grades, divided across rural, remote and village areas (Figure 4). In class II, "B", "C" and "D" scores were observed, in rural, village and resort areas. Class III includes "B" and "C" scores recorded in rural, urban and resort areas. In class IV, "B", "C" and "D" were observed with grade "C" being the most frequent (10 sites), in resort, urban, village and rural areas. In class V, "B", "C" and "D" were observed, all located in urban areas. For more details on site classifications and characteristics see Er-ramy et al. [9,42].

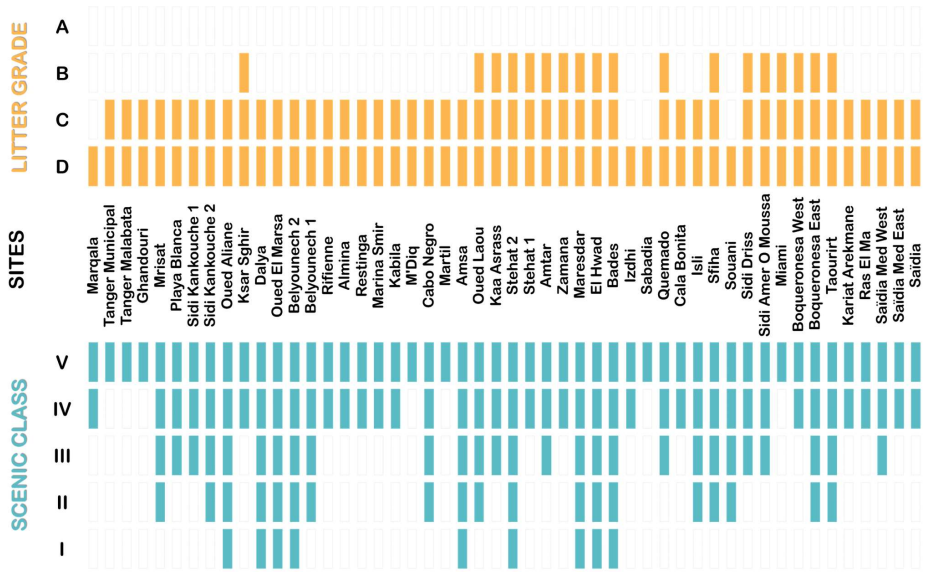

Figure 3. Litter Grade (from grade "A", excellent, to "D", poor) and CSES (from class I, extremely attractive natural sites, to class V, very urbanized and unattractive sites) values used by the Sector Analysis to characterize the Moroccan Mediterranean coast.

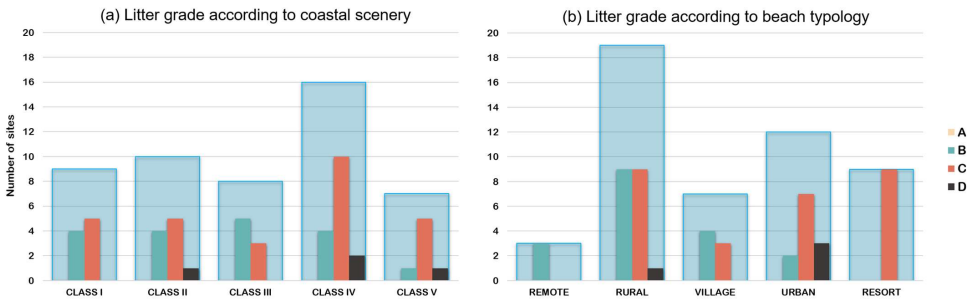

Figure 4. Litter Grade distribution by scenic class (**a**) and beach typology (**b**), i.e., blue rectangles represent the total number of sites and the colored inside bars represent the number of sites for scenic class (**a**) and beach typology (**b**).

Table 2. Results of the Sector Analysis with the main characteristics of the sites studied. Red, yellow and green colors correspond to the three sectors of the Sector Analysis presented in Figure 2b.

N°	SITE	TYPE	LOCATION	D Value	Scenic Class	Litter Grade	Blue Flag	Sector Analysis
1	Marqala	URBAN	TANGER ASILAH	0.39	IV	D		
2	Tangier Municipal	URBAN		−0.32	V	C		
3	Tangier Malabata	URBAN		−0.21	V	C		
4	Ghandouri	URBAN		−0.35	V	C		
5	Mrisat	RURAL		0.81	II	C		
6	Playa Blanca	RURAL	FAHS ANJRA	0.43	III	C		
7	Sidi Kankouche 1	RURAL		0.55	III	C		
8	Sidi Kankouche 2	RURAL		0.77	II	C		
9	Oued Aliane	RURAL		1.00	I	C		
10	Ksar Sghir	VILLAGE		0.14	IV	B		
11	Dalya	RURAL		0.96	I	C	X	
12	Oued El Marsa	RURAL		0.92	I	C		
13	Belyounech 2	VILLAGE	M'DIQ FNIDEQ	1.12	I	C		
14	Belyounech 1	VILLAGE		0.78	II	C		
15	Rifienne	RESORT		0.36	IV	C	X	
16	Almina	RESORT		0.32	IV	C	X	
17	Restinga	RESORT		0.31	IV	C		
18	Marina Smir	RESORT		0.13	IV	C	X	
19	Kabila	RESORT		0.31	IV	C		
20	M'Diq	URBAN		−0.29	V	C	X	
21	Cabo Negro	RESORT		0.76	II	C		
22	Martil	URBAN		−0.27	V	C		
23	Amsa	RURAL	TETOUAN	0.90	I	C		
24	Oued Laou	VILLAGE		0.71	II	B	X	
25	Kaa Asrass	RURAL	CHEFCHAOUEN	0.45	III	B		
26	Stehat 2	REMOTE		0.93	I	B		
27	Stehat 1	VILLAGE		0.34	IV	B		
28	Amtar	RURAL		0.46	III	B		
29	Jebha (Zamana)	VILLAGE		0.12	IV	B		
30	Jebha (Maresdar)	REMOTE		0.98	I	B		
31	Jebha (El Hwad)	REMOTE		0.88	I	B		
32	Bades	RURAL	AL HOCEIMA	1.06	I	B		
33	Izdhi	URBAN		0.23	IV	D		
34	Sabadia	URBAN		−0.31	V	D		
35	Quemado	URBAN		0.42	III	B		
36	Cala Bonita	URBAN		0.21	IV	C		
37	Isli	RURAL		0.71	II	C		
38	Sfiha	RURAL		0.82	II	B		
39	Souani	RURAL		0.79	II	D		
40	Sidi Driss	RURAL	DRIOUCH	0.60	III	B		
41	Sidi Amer O Moussa	RURAL		0.64	III	B		
42	Miami	URBAN	NADOR	−0.50	V	B		
43	Boqueronesa West	RURAL		0.26	IV	B		
44	Boqueronesa East	RURAL		0.68	II	B		
45	Taourirt	RURAL		0.69	II	B		
46	Kariat Arekmane	RESORT		0.20	IV	C	X	
47	Ras El Ma	VILLAGE		0.16	IV	C		
48	Saïdia Med West	RESORT	BERKANE	0.50	III	C	X	
49	Saïdia Med East	RESORT		0.31	IV	C		
50	Saïdia	URBAN		0.09	IV	C	X	

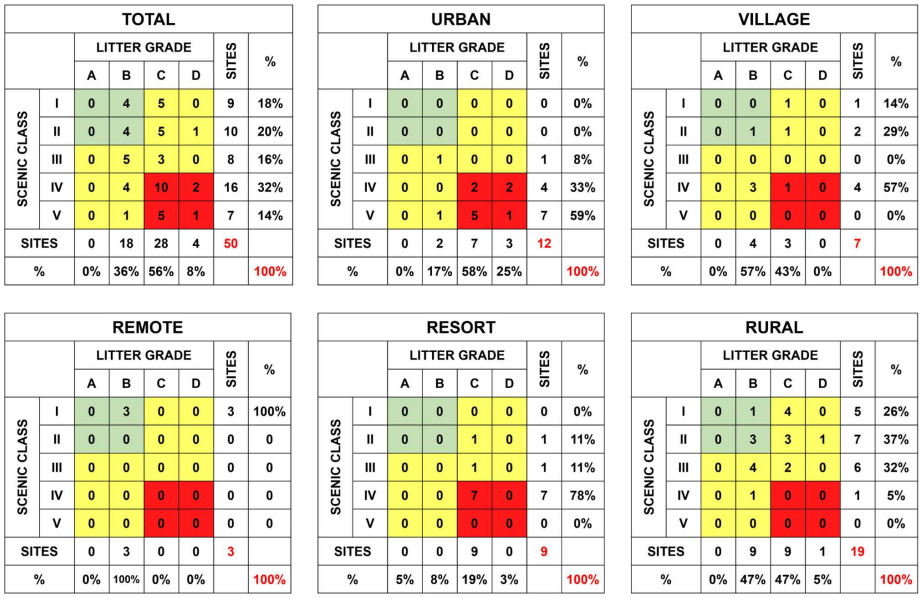

Figure 5. Sector Analysis approach: a combination of litter, coastal scenery and beach typology. Red, yellow and green colors correspond to the three sectors of the Sector Analysis presented in Figure 2b.

4.1. Distribution of the Sites According to the Sector Analysis

The analysis of the combination of beach typology, coastal scenic quality and beach cleanliness based on the Sector Analysis shows as 18 sites are located in the Red sector, i.e., 36% of the study area, representing 77.8% of the seaside resort typology and 83.3% of the urban beach typology. In contrast, only eight sites are located in the Green sector, i.e., 16% of the study area, representing 100% of remote sites, 21.1% of rural sites, 12.3% of village sites and 0% of urban and resorts sites. The remaining 24 sites, i.e., 48% of sites studied, are located in the Yellow sector. At this level, 11 sites are located in the upper right quadrant, i.e., 22% of the study area, which represents almost a quarter of the sites studied (Figure 5). These sites are extremely attractive and have great landscape value and are very highly rated for the quality of coastal landscapes (class I and II), but reveal very poor litter management. In fact, the considerable percentage of sites within the Red sector (36%) and the low proportion (16%) of sites within the Green sector should be a wake-up call to managers to take urgent and appropriate management measures and actions to protect coastal landscapes.

Under the Sector Analysis, all sites have been classified in one of the five categories described in the "BARE" approach and according to the CSES obtained landscape quality and Litter Grade (Figures 3 and 4). The results of such assessments are presented in the following lines:

- Remote: In total, three sites were classified as remote areas. Within this category, all sites belong to Litter Grade "B" and scenic class I and correspond to the Green sector. None of the three sites has been awarded with the Blue Flag label. Maresdar beach, in the western part of the littoral zone, is an example of remote site with an extremely attractive scenic quality associated with low litter quantities (Figure 6a).
- Village: Within this category, seven sites were classified and divided between four sites with a Litter Grade "B" and three sites with "C". For the scenic classes, the sites included classes I, II and IV. Only one site belonged to the Green sector, i.e., in the western coast "Oued Laou" (scenic class II, Litter Grade "B", Figure 6b), which has also been awarded with the Blue Flag label. A single site is located in the Red sector (scenic class IV, Litter Grade "C"). The remaining sites are in the Yellow sector, showing contradictory values, e.g., class IV and grade "B" or class I and grade "C".
- Rural: A total of 19 sites were classified in this category, divided between 9 sites for each "B" and "C" grades and 1 site for grade "D". In terms of scenic value, the sites

were divided between classes I to IV. Concerning the Sector Analysis, only 4 sites were located in the Green sector, none in the Red sector and 15 sites were concentrated in the Yellow sector. Only one site has been awarded with the Blue Flag label. The "Bades" site in the middle part of the littoral is a prime example of rural typology, a mythical site contains elements that form an exceptional historical landscape of class I and a grade quality of "B" due to tourist activity (Figure 6c).

- Urban: A total of 12 sites were classified within this category, the results were very different and divided among scenic classes III, IV and V and Litter Grades "B", "C" and "D". None of the sites belonged to the Green sector, on the other hand, 10 out of 12 were in the Red sector, showing a high degree of deterioration in their aesthetic quality. The other sites are located in the Yellow sector, with a "B" Litter Grade, such as "Quemado", a very popular site located in the coast of Al Hoceima with class III scenic quality (Figure 6d). In general, they are seaside sites with daily beach clean-ups activities. Two sites presented the Blue Flag label.
- Resort: Nine sites were classified in this category, all showing Litter Grade "C", divided between scenic classes II and III with one site each and class IV with seven sites. Such seven sites are all located in the Red sector, while the two remaining sites are located in the Yellow sector, such as Rifienne site on the western coast, an excellent seaside resort with important natural resources (Figure 6e). As is the case for urban sites, none of the sites are located in the Green sector. The Blue Flag label was awarded to five seaside resorts, being the most common category showing this award.

Figure 6. Examples of the main beach features for each beach typology: (**a**) remote, "Maresdar"; (**b**) village, "Oued Laou"; (**c**) rural, "Bades"; (**d**) urban, "Quemado" and (**e**) resort, "Rifienne".

4.2. Blue Flag Label

In this paper, it was highlighted that the Blue Flag, with the exception of the mentioned remote sites, is found on all types of beaches, especially in seaside resorts. In relation to Litter Grade scores, "C" grade is observed in eight sites and "B" in one site. This result is contradictory because, theoretically, the Blue Flag beaches should be very clean. This can be explained by the high number of maximum daily visitors—Blue Flag beaches are very popular, which can reach 80,000 visitors during the summer period. For scenic classes, the Blue Flag label is observed in all classes, especially in class IV with five sites and only one site for each one of the other classes. This can be explained by the fact that high-quality natural sites are often located in remote or protected areas that are characterized by a difficult and complex accessibility where the presence of services and facilities is often limited, opposite to the resort and urban areas; this way, natural sites are not able to fulfill the requirements demanded by the Blue Flag label.

5. Discussion

The Sector Analysis method has proved to be very useful for beach management. In this context, from the combination of coastal landscape classes with Litter Grades, it is possible to distinguish three scenarios:

- **Green sector:**

The Green sector indicates natural sites that are extremely attractive, with low quantities of litter and very high landscape values. In this case, preservation and precautionary measures must be taken to limit any future extension of human activities and coastal exploitation while preserving the natural landscape and appropriate management strategies must be adopted to prevent the accumulation of litter on beaches. In addition, these management measures should aim to protect natural resources and the beauty of the coast through legal protection measures including the creation of protected areas, such as parks, wild areas, protected areas with sustainable use of natural resources, heritage coasts, protected landscapes/seascapes and spaces of exceptional natural beauty.

- **Red sector:**

The Red sector indicates degraded, unattractive sites of very low value with inadequate, ineffective or even non-existent management in some cases. In fact, at this level, management efforts should focus on managing human parameters since the natural characteristics of degraded sites are difficult to manage. Although some of the human parameters that influence landscape quality remain difficult to manage and their improvement is very costly, such as urbanization and public facilities, litter can be improved and thus contribute to improving the quality of coastal landscapes. In the current state, and in order to protect the coast from human pressures, the application of coastal laws is strongly requested by limiting the current development of new constructions and all types of unnecessary anthropic infrastructures. Under these circumstances, this approach can be considered the best simple solution to halt the future deterioration of coastal areas. In addition to this, management strategies based on ecological restoration, rehabilitation, maintenance and beach cleaning operations are strongly recommended.

- **Yellow sector:**

The Yellow sector indicates sites with contradictory results between Litter Grades and coastal landscape quality, in which case further research and more in-depth analysis are strongly required to define the appropriate management measures. That said, for sites located in the upper right quadrant, which refers to sites with high scenic quality and low litter scores, management measures have to be focused on clean-up operations, awareness programs for beach user to address the presence of litter and, consequently, to move the sites back into the Green sector to which they belong in the first place. For sites located in the lower left quadrant, usually showing low scenic quality, management requires an in-depth analysis, case-by-case, of natural and human parameters. Interventions in certain

parameters, such as sewage, noise, dunes, type of access, facilities, etc., can improve the landscape quality and, consequently, bring the sites back into the Green sector.

In the Sector Analysis, the management and the analysis of class III sites is very important [8]. These are located in a transition zone between natural sites (class I and II) and degraded sites (class IV and V), between the Green and the Red sector. In terms of coastal management, class III sites require particular attention and several studies have shown that some of these sites only need to improve one parameter to move up to class II [51,52]. At this level, litter is one of the most important human parameters that characterizes class III sites. For this reason, beach managers and municipalities must make considerable efforts to improve them.

In order to demonstrate in a practical and quantitative way the negative impact of litter on coastal scenic quality, management measures or interventions aimed at reducing the presence of litter on beaches, in particular through regular programs and operations of beaches cleaning and maintenance, have been proposed (Table 3). The adoption of those management measures will contribute to the litter parameter score becoming 4 or 5 (in this study, score 4 was adopted) (Parameter 20, Table A2) and the Litter Grade will improve to at least "Good" or "B" (Table 1). As a result, class II beaches can be upgraded to class I (e.g., Taourirt, Souani, Mrisat). Similarly, class III beaches can be upgraded to class II (e.g., Sidi Driss, Sidi Amer O Moussa), also by moving from the Yellow to the Green sector. Thus, in places, class IV sites can be upgraded to class III (e.g., Stehat 1) by remaining in the same sector. Other sites in lower classes (IV, V), such as Tangier Malabata, Ras El Ma, Martil and Sabadia, can benefit from this intervention to significantly improve their D-value and move from the Red to the Yellow sector by improving their Litter Grade, even if this improvement does not allow them to move up to a higher class, but will bring them to its limit. These sites, as with all the sites in the Red sector, are impacted by a number of anthropogenic factors and, in addition to improving the litter score, require intervention at the level of other parameters.

For this reason, other interventions in addition to litter were proposed to improve the quality of coastal landscapes, particularly in terms of parameters such as sewage (score after intervention will be 5), vegetation debris (4), access type (4), skyline (4) and utilities (4) (Table A2). Results show that, through a series of proposed interventions (Table 3), sites can improve from class II to class I (e.g., Souani, Sidi Kankouche 2), from class III to class II (e.g., Sidi Amer O Moussa, Sidi Kankouche 1), from class IV to class III (e.g., Marqala, Almina) and from class V to class IV (e.g., Martil).

Along the Moroccan Mediterranean coast, litter has already been considered as the principal factor in the deterioration of coastal landscape quality and the entire marine environment (Figure 7a–d). It also has a negative impact on the ability of beaches to reach a higher class in the beach classification and, unfortunately, many beaches of great scenic and tourist value are highly threatened [9,42,53,54]. Beach litter has a detrimental impact on beach tourism, which is very vulnerable to the presence of such types of pollution [55–57] as beach users do not appreciate polluted beaches [10,26]. On the other hand, human activities of bathers, whether intentional or not, are an important source of litter [27,58,59] and are partly responsible for the deterioration of the coastal landscape quality. In addition to hydrodynamic and climatic conditions [60,61], the abundance of man-made litter observed directly on beaches depends on a number of aspects such as the daily number of visitors, the density of the local population, the difficulty of access to the beach, the frequency of substrate cleaning and the typology of beaches mentioned in this paper, etc. However, beach litter management is not simple enough and clean-up operations, while being the simple possible solution, are not enough to solve the problem [51]. Effective management requires optimal cooperation of all actors to try to solve the beach litter problem upstream. Litter management requires time, money and human resources to maintain the attractiveness of a coastal destination while improving beach quality [62].

Table 3. Coastal management measures under the Sector Analysis to improve the quality of the beaches studied by using only one intervention. Red, yellow and green colors correspond to the three sectors of the Sector Analysis presented in Figure 2b.

Sites	Parameter	Score	Modes of Intervention	D	New D	Scenic Class	New Scenic Class	Sector	New Sector
Taourirt	Litter	3	Implementation of regular litter clean-up programs and operations	0.69	0.87	II	I		
Mrisat		3		0.81	0.94	II	I		
Souani		3		0.79	0.93	II	I		
Sidi Amer O M.		3		0.64	0.76	III	II		
Sidi Driss		3		0.60	0.72	III	II		
Amtar		3		0.46	0.57	III	III		
Kaa Asrass		3		0.45	0.56	III	III		
Stehat 1		3		0.34	0.45	IV	III		
Ksar Sghir		3		0.14	0.26	IV	IV		
Izdhi		3		0.23	0.34	IV	IV		
Ras El Ma		3		0.16	0.27	IV	IV		
Tangier Malabata		3		−0.21	−0.09	V	V		
Martil		2		−0.27	−0.02	V	V		
Marqala	Litter (L) + Sewage (S)	L (4) S (1)	Reduction or even elimination of direct waste water discharges, in addition to intervention above	0.39	0.54	IV	III		
Martil		L (2) S (1)		−0.27	0.15	V	IV		
Sabadia		L (3) S (1)		−0.31	−0.05	V	V		
Miami		L (3) S (1)		−0.50	−0.30	V	V		
Oued Aliane	Vegetation debris	3	Periodic beach cleaning and maintenance operations	1.00	1.04	I	I	More than one intervention mode is often required to improve the present situation	
Amsa		2		0.90	1.01	I	I		
Souani		2		0.79	0.90	II	I		
Sidi Amer O M.		2		0.64	0.73	III	II		
Marqala		3		0.39	0.43	IV	III		
Almina	Access type	2	Change the parking location to be far away from the beach and use this location for a buffer zone	0.32	0.48	IV	III		
Quemado		2		0.42	0.58	IV	IV		
Sidi Kankouche 2	Skyline	3	Removal of unappreciated items such as tires, fishing boats on beach sands	0.77	0.89	II	I		
Sidi Kankouche 1		3		0.55	0.66	III	II		
Playa Blanca		3		0.43	0.55	III	III		
Martil		1		−0.27	−0.06	V	V		
Oued Aliane	Utilities	1	Elimination and reduction of unnecessary beach facilities and infrastructure	1.00	1.10	I	I		
Belyounech 1		1		0.78	0.89	II	I		
Sidi Kankouche 1		1		0.55	0.66	III	II		
Rifienne		1		0.36	0.47	IV	III		

The presence of vegetation debris along the Moroccan Mediterranean beaches is also of great importance from the managerial perspective, seriously affecting the aesthetic quality of coastal landscapes, especially in villages and rural areas where clean-up operations are seasonal or virtually absent (Figure 7c,d). Vegetation debris, despite being small in size and of natural origin, has a negative impact on coastal scenery and is not much appreciated by beach users [8,63,64], especially when their quantities become significant. Despite along the Mediterranean beaches the natural accumulation of vegetation debris is usually low (except after strong storms that can bring large quantities of *Posidonia oceanica* leaves or heavy rains that can favor the deposition of large quantities and voluminous vegetation debris transported by rivers) [65–67] around the world and especially in many tropical beaches, vegetation debris may constitute a major problem with relevant aesthetic and safety aspects and have been considered a significant threat to tourist beaches [27]. In terms of management, regular beach cleaning and maintenance operations are necessary and can be seen as a simple solution to tackle the impact of vegetation debris on beach landscape quality.

Figure 7. Examples of litter dumping by beach users damaging the beauty of beaches (**a**,**b**), accumulation of litter and vegetation debris affecting the scenery (**c**,**d**) and some litter management efforts at the beaches studied (**e**,**f**).

The management of coastal areas by Morocco municipalities remains weak, unclear, poor and, in some cases, almost absent. For example, the considerable number of sites with a relevant presence of litter clearly shows that current waste management actions are ineffective and/or inadequate because clean-up actions are not carried out to acceptable standards. According to the study by Jambeck et al. [68], Morocco was ranked 18th in the list of most plastic waste produced around the world according to 2010 estimates, with 0.31 million tons mismanaged per year. Recently, the World Bank (2022) [69] estimated that each kilometer of Moroccan coastline generates around 6.3 kg of mismanaged plastic waste every day, which ends up in the Mediterranean Sea. Municipalities, as part of their management responsibility, must implement a sound management plan, striving to put in place effective waste management programs and facilities to prevent waste and, why not, to develop recycling operations. In fact, litter-monitoring programs are essential and highly demanded to develop effective management strategies that can protect the ecological, aesthetic and economic value of beaches [70].

Morocco has a set of laws of capital importance, constituting largely adequate legal and institutional tools for the preservation and sustainable and appropriate management of the coastline [54]. Such legal arsenal adopted by Morocco aims to protect the coastline against all forms of pollution and degradation, to strike a balance between the imperatives of economic development and the need to preserve and protect the coastline, without forgetting the integration of the environmental dimension into all sectoral policies that concern this natural space [71]. Concerning litter, a global perspective is needed to identify practical solutions that often go beyond the provincial or even national framework to address the complex challenge of beach litter management. Thus, municipalities need a clear and robust management framework to solve litter problems [63].

In addition, awareness-raising programs to educate people to avoid littering beaches and to direct their behavior towards the coastal environment are in high demand [72,73]. The costs of such awareness programs are much less expensive than beach clean-up and maintenance programs. These awareness programs tend to reach a large number of people

in many parts of the country in order to overcome their lack of environmental awareness and stimulate their sense of environmental responsibility. Further, management and public awareness efforts have been deployed on a number of the beaches studied to introduce bins of different colors with labels describing the type of waste in order to sort the different categories (paper, plastic, glass, etc.) (Figure 7e,f). Unfortunately, these bins are misused by beach users and/or are not emptied with a sufficient frequency.

Last but not least, a severe problem in Morocco is that the participation and involvement of the local population in the preservation of the coastline is not clearly defined. Moreover, a relevant gap exists between law creation and their application by municipalities and, therefore, the management of Morocco's coastal areas requires a coherent national and territorial policy, cross-sectoral coordination, consultation among public, private and societal actors and a participative and integrated approach involving the various actors concerned (decision-makers, researchers, managers, politicians, civil society, local populations, etc.).

6. Conclusions

Sustainable beach management requires reliable scientific knowledge and appropriate tools to develop new sound management strategies and improve current practices. In this context, and in order to adopt appropriate coastal management for Morocco's Mediterranean coastal areas, fifty beaches were assessed and classified using the Sector Analysis, an innovative approach to coastal management that integrates three important factors: beach cleanliness, coastal scenery and beach typology. The Sector Analysis aims to classify the sites into three main sectors, Green, Yellow and Red, in order to propose sound management measures for the sites in each sector. The Green sector includes natural sites of high value (CSES classes I and II, Litter Grade "A" and "B"), the Red sector includes degraded sites of very low value (CSES classes IV and V, Litter Grade "C" and "D") and the Yellow sector includes sites with contradictory results between scenery and litter. In fact, this innovative methodology can be used on any beach in the world to manage coastal areas in a sustainable way.

The results of the Sector Analysis show that only 8 sites (16%) are in the Green sector, 18 sites (36%) in the Red sector and 24 sites (48%) in the Yellow sector. Within the Yellow sector, 11 sites, i.e., almost a quarter of the sites studied (22%), are in the upper right quadrant for litter problems, even though they have a high value in terms of landscape quality. The low percentage of sites within the Green sector (16%) along with the considerable percentage of sites within the Red sector (36%), which represents a third of the study area, show the degree of deterioration experienced by the Moroccan coastline due to the absence or mismanagement of coastal areas. For this reason, considerable efforts must be made by Moroccan national and local authorities and stakeholders to implement urgent and appropriate management measures through effective and sustainable strategies, programs and plans based on relevant decision-making and reliable scientific data.

To make the results of this article useful, a series of interventions were proposed to improve the quality of the beaches studied, including the implementation of regular litter clean-up programs and beach maintenance operations, elimination of direct sewage discharges, removal of unnecessary beach facilities and infrastructures, establishment of buffer zones between the beach and human infrastructures, etc. These management measures constitute real orientations and guidelines for a judicious and adequate management of the beaches investigated. The results obtained constitute basic information necessary for the adoption of management decisions, to develop and strengthen the potential of Morocco's tourist offer as a privileged tourist destination at the Mediterranean and African scale in order to stimulate its competitiveness and attractiveness in an ecotourism perspective.

Author Contributions: Conceptualization, N.E.-R., D.N. and G.A.; methodology, N.E.-R., D.N. and G.A.; software, N.E.-R.; validation, G.A. and D.N.; investigation, N.E.-R., D.N. and S.A.; data curation, N.E.-R., D.N., G.A. and S.A.; writing—original draft preparation, N.E.-R., D.N., G.A. and S.A.; writing—review and editing, N.E.-R., D.N., G.A. and S.A.; supervision, G.A. and D.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data are contained within the article.

Acknowledgments: This work is a contribution to the PAI Andalusia Research Group RNM-373 (Spain) and the PROPLAYAS Network.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Beach typologies and their main characteristics [29].

Beach Typology	Characteristics
Remote	A coastal site defined mainly by its difficulty of access, which can be achieved in two ways, either by boat or on foot (>300 m walk). It has no public transport or public services, and the amount of temporary summer tourist accommodation is practically nil or very small.
Rural	A coastal site located outside urban areas, difficult to reach by public transport, with practically no public service facilities (maybe a small shop, wild parking and rarely toilets). There is no permanent community center, although there are a limited number of temporary housing units (0 to 10).
Village	A coastal site located outside the major urban centers, characterized by a small permanent population representing a well-organized but small service structure (schools, religious centers, shops, etc.). The beaches are accessible by public and private transport.
Urban	A coastal site located in an immediately urban environment, marked by large populations and well-structured public services (schools, roads, hotels, banks, shopping center). The beaches are found in or around the urban area, and for the most part are free and open to the public.
Resort	A coastal site that is mainly defined by its recreational vocation, located on a beach next to an accommodation complex (hotels/camping) where a considerable number of beach users reside. A wide variety of public facilities and services are usually present. The management is provided by the complex and the beach often has private access.

Table A2. Checklist of 26 parameters considered by the CSES method [43].

N°	Physical Parameters		Rating				
			1	2	3	4	5
1	Cliff	Height (H)	Absent (<5 m)	$5 \leq H < 30$ m	$30 \leq H < 60$ m	$60 \leq H < 90$ m	$H \geq 90$ m
2		Slope	<45°	45–60°	60–75°	75–85°	Circa vertical
3		Features	Absent	1	2	3	Many > 3
4	Beach face	Type	Absent	Mud	Cobble/boulder	Pebble/gravel	Sand
5		Width (W)	Absent	W < 5 or W > 100 m	$5 \leq W < 25$ m	$25 \leq W < 50$ m	$50 \leq W \leq 100$ m
6		Color	Absent	Dark	Dark tan	Light tan/bleached	White/gold
7	Rocky shore	Slope	Absent	<5°	5–10°	10–20°	>20°
8		Extent	Absent	<5 m	5–10 m	10–20 m	>20 m
9		Roughness	Absent	Distinctly jagged	Deeply pitted and/or irregular	Shallow pitted	Smooth

Table A2. *Cont.*

N°	Physical Parameters	Rating				
		1	**2**	**3**	**4**	**5**
10	Dunes	Absent	Remnants	Fore-dune	Secondary ridge	Several
11	Valley	Absent	Dry	Stream (<1 m)	Stream (1–4 m)	>4 m
12	Skyline landforms	Not visible	Flat	Undulating	Highly undulating	Mountainous
13	Tides	Macro (>4 m)		Meso (2–4 m)		Micro (<2 m)
14	Coastal landscape features	None	1	2	3	>3
15	Vistas	Open on one side	Open on two sides		Open on three sides	Open on four sides
16	Water color and clarity	Muddy brown/grey	Milky blue/green; opaque	Green/grey blue	Clear blue/dark blue	Very clear turquoise
17	Vegetation cover	Bare (<10% vegetation only)	Scrub/Garigue/grass (marram/ferns, etc.)	Wetland/meadow	Coppices, maquis (±mature trees)	Variety of mature trees/natural cover
18	Vegetation debris	Continuous > 50 cm high	Full strand line	Single accumulation	Few scattered items	None
	Human parameters					
19	Disturbance factor	Intolerable	Tolerable		Little	None
20	Litter	Continuous accumulations	Full strand line	Single accumulation	Few scattered items	Virtually absent
21	Sewage (discharge evidence)	Sewage Evidence		Some evidence (1–3 items)		No evidence of sewage
22	Non-built environment	None		Hedgerow/ terracing/monoculture		Mixed cultivation ± trees/natural
23	Built environment	Heavy industry	Heavy tourism and/or urban	Light tourism and/or urban and/or sensitive industry	Sensitive tourism and/or urban	Historic and/or none
24	Access type	No buffer zone/heavy traffic	Buffer zone/light traffic		Parking lot visible from coastal area	Parking lot not visible from coastal area
25	Skyline	Very unattractive	Unattractive	Sensitively designed	Very sensitively designed	Natural/historic features
26	Utilities	>3	3	2	1	None

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