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Improving a decree law about coastal zone management in a small island developing state: The case of Cuba

Celene Milanés Batista[a,*], Cristina I. Pereira[b], Camilo M. Botero[c]

[a] Civil and Environmental Department, Universidad de la Costa, Calle 58#55-66, Barranquilla, Atlántico 080002, Colombia
[b] Department of Earth Sciences, Universidad EAFIT, Colombia
[c] School of Law, Universidad Sergio Arboleda, Santa Marta, Colombia

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ABSTRACT

Cuba is one of the few countries from the Small Island Developing States in the Caribbean region having solid coastal legislation: Decree Law 212 (DL-212) entitled "Coastal Zone Management". However, that legal framework presents some deficiencies that need to be improved, wherefore an analysis of the major features of DL-212 and the identification of its main issues were conducted in the present study; some ways of implementing the DL-212 in the country were assessed as well. Regarding the Land-Sea Interaction, this work proposes a set of four variables linking geomorphological and human criteria with the aim of improving coastal zone characterization and boundary delimitation. The set of four variables falls into six types of Coastal Geomorphic-typological Units, which are also sub-classified according to the physical aspects and level of territorial urbanization of the Units. Standard nomenclature about boundaries, territorial planning in relation to land-sea interaction is provided in the present research, as well as nine guidelines and eleven recommendations for institutions responsible for physical use planning to implement, in order to obtain a better understanding and implementation of DL-212. The study makes a great contribution to decision-making processes regarding Land-Use Planning, Integrated Coastal Zone Management, and Marine Spatial Planning for future implementation in other Small Island Developing States.

1. Introduction

Even though 40 Latin-American countries have coastal zones [1], as of 2010 no more than eleven countries had implemented coastal legislation or policies [2]. In this context, Cuba has an outstanding advantage since a Coastal Law, entitled Decree Law 212 "*Coastal Zone Management*" (DL-212), was established in August 2000 [3]. This Law provides protection to ecosystems along and offshore of Cuba's coastline [4]. DL-212 is a type of legal framework designed to avoid and mitigate impacts to lands and waters arising from construction and other activities [5–7].

One of the main purposes of DL-212 was to implement strict zoning with the purpose of preventing damage to coastal areas caused by a variety of activities, such as: tourism, treatment for waste products, fishing, construction, among others [4,7]. An advantage of that legal framework is the setting up of delimitation criteria to control the sustainable use of "coastal zones" and "zones of protection" [8]. In fact, Article 4 of DL-212 establishes the limits of a coastal zone, and its corresponding zone of protection, taking into account five types of coasts, classified according to their physical-natural geomorphology, as well as a non-identified type to account for natural or anthropic causes.

The classification performed in Cuba places the country in a better position than other regarding Coastal Laws, such as Spain and Colombia, which do not have any evidence of ways to classify coasts in their respective legislations [9,10] and coastal policies [11–13]. The classifications of "coastal zone" and "protection zone" following DL-212 have a long list of forbidden activities, including, in particular, construction of new houses and hotels, waste disposal and sand extraction. In spite of the implications for tourism and private owners regarding the elimination of beachfront properties, the enforcement of such protection is paramount to preserve "vulnerable wetlands, dunes, and water bodies" [7]. Coastal zone boundaries and their protection zones depend on the type of coastline and are generally off-limits to permanent structures. They are also subject to a limited exemption of water or coastal-dependent structures and activities, such as docks, piers, or "marinas". DL-212 also provides protection to small islands or Cays.

Although DL-212 remains in force in Cuba, most of the current land-use plans do not delimit the coastal zone during their initial planning

* Corresponding author.
E-mail address: cmilanes1@cuc.edu.co (C.M. Batista).

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Table 1
Methodological analysis of each variable proposed.

Variables	Kind of information	Analysis
1. Geo-morphological Units	• Fieldwork to check coastal landforms in Cuba. • Relevant geographical studies in Cuba [5,21,22].	• Integration of coastal and landform classification according to their geological-marine composition [3,23–25].
2. Transformations	• Reintroduction of previous studies [26,27].	• Evaluation of urban growth changes and modifications in the coastline according to different Cuban Plans for Land-Use Planning at different territorial levels [28–31].
3. Infrastructure	• Types of functional and socio-economic zones, for *e.g.* industrial zones, service zones, transportation and traffic zones, ports, airports, fishing, touristic and mining zones [32]. • Evaluation of extensions of functional zones and links with coastal ecosystems according to the Cuban General Plan of the corresponding territories.	• Definition of levels of urban growth and illegal constructive actions according to DL 212.
4. Settlements	• Characterization of two types of Cuban settlements: *urban* and *rural concentrated* [33]. • Census about Population and Housing [34].	• Exercises of territorial zoning on cartographic maps, analyzing the different zones located at marine and terrestrial spaces in Cuba. • Evaluation of extension in hectares, population and density at random settlements.

stages. Moreover, the coastal zone is occasionally weakly delimitated, causing visitors and residents to misunderstand the real boundaries [14]. On the other hand, implementing that legal instrument has been difficult in most coastal municipalities, due to the limited information provided about the specific characteristics of the types of coasts. Consequently, criteria such as coastal dynamics at sea and land, changes occurring in the geomorphological units as a result of anthropic activity and interactions between land and sea are aspects not reckoned by DL-212 when setting up the boundaries.

The Ministry of Science, Technology and Environment (CITMA) deemed implementing DL-212 a high priority. For instance, just two years after the Cuban Decree Law was approved, the Physical Planning Institute led a far-reaching investigation about the most important territorial problems present in coastal areas, the origin of those problems, and necessary management structures. Nowadays, it is important to emphasize the legislative improvement of that Decree, since two new Chapters are under consideration for inclusion, one about tax regulations when using coastal spaces and resources for different activities, and another one about linking land-use planning programs and IZCM programs [6].

The authorities responsible for proposing the corresponding policies and strategies for coastal zone recovery also get their appointment according to DL-212. That Decree constitutes a very important document for regulating spontaneous urban growth in coastal zones. In spite of the early concern shown through that Decree about Integrated Coastal Zone Management (ICZM), its principles and basic concept do not appear explicitly in the Decree's body. However, the Cuban scientific community has played a decisive role in implementing DL-212 [15].

Within this context, some of the factors that have prevented the full implementation of DL-212 are discussed in this paper with the aim of proposing a set of new variables for coastal zone characterization. Clearer and more comprehensive criteria about future delimitation of coastal zones, taking into account land-sea interaction, are also given in order to help stakeholders implement that Decree. This research work is based on the hypothesis that anthropic activities and their corresponding impacts represent important criteria for coastal characterization and boundary establishment because of their vital role in modifying coastal geomorphological units.

2. Methods

Since an integrated approach is required to understand and apply DL-212, it is necessary to provide background to the complexity of combining natural and anthropogenic aspects. Therefore, the most important variables taken into account to improve DL-212 were analyzed first in the present study, and some recommendations were set forth to apply the designed set of variables after analyzing the Decree's context.

The selection of the optimum variables for coastal zone characterization and its subsequent delimitation was carried out through a State-of-the-Art revision. Two Delphi panels, integrated by national and international specialists in Land-Use Planning and Integrated Coastal Zone Management, evaluated the selected variables. The process to select the Delphi panels was carried out following the methodological guidelines of the Delphi method [16,17]. A set of four variables and their corresponding sub-variables was submitted for consideration by other specialists at two International Workshops, where additional Cuban and Canadian experts approved their validation in Cuba [5,18]. This framework was also developed though a broad consultative process, based on a primary survey applying and non-structured interviews to professionals working in the Institute of Physical Planning at Havana and provincial institutions of the and the Ministry of Science, Technology, and Environment. The objective of the interviews was to inquire about the main issues for applying and implementing DL-212.

A conceptual and cartographic approach was used to define the ranges of each variable proposed for coastal zone characterization in the six different types of Coastal Geomorphic-typological Units. The cartographic estimations were based on the following sources of information: a) Cartographic Institute of Hydrography and Geodesy, b) Head of the Institute of Physical Planning in Cuba [19], and c) Provincial Center of Hydraulic Resources [20]. Table 1 summarizes the analytical process used for each kind of information, where appropriate criteria for the Cuban context are defined.

The four variables were combined to design the Coastal Geomorphic-typological Units. Additionally, the factors influencing the different geographical features of the zones were taken into account to describe the type of coast following relevant authors on this issue [23,35,36]. The different levels of anthropic process were analyzed using the Cuban Land-Use Plans and the method for delimiting and demarcating coastal zones proposed for Cuban coastal boundaries [5,37].

3. Results and analysis

3.1. The weakness of Decree law-212

Decree Law-212 describes some of the geomorphological units defined therein; however, as observed in Table 2 and Appendix 1, only *Low Terrace* and *Beach* have a full description of their land boundaries. Similarly, ocean depths from 100 to 200 m and the territorial insular platform are taken into account for the establishment of marine coastal boundaries [3].

Table 2
Types of Coasts described in DL-212 (Adapted from GORC, 2000).

Geomorphological Units	Characteristics	Boundaries for Coastal Zones in Land	Boundaries for Zones of Protection in Land
1. Low Terrace	• Presence of carbonated rocks, including storm berm composed of loose materials, such as pebble, gravel, and sand resulting from storms, and normally covered by vegetation.	• From the external edge of storm berm. • In case of no storm berm: ✓ 20 m measured from the beginning of the stripe of natural consolidated vegetation nearest to the sea. ✓ Top of the cliff should it be present at the second terrace level.	• Minimum width of 20 m
2. Cliff Coast	• Not provided	• 20 m towards land, measured from the top of the cliff.	• Minimum width of 20 m
3. Beach	• Loose materials of different thickness present in emerged and submerged areas, where processes of erosion and accumulation occur due to natural or anthropic alterations. • Coasts presenting changes in their profile dynamics; presence of submarine bars, berms and dunes.	• From the external edge of the dune nearest to the sea. • In case of no dune: ✓ 40 m towards land measured from the beginning of the stripe of natural consolidated vegetation nearest to the sea. ✓ If presence of a cliff in less than 40 m towards land, boundary is measured from the beginning of the stripe of natural vegetation nearest to the sea and from the top of the cliff.	• Minimum width of 40 m
4. Low Mangrove Coast	• Presence of mangrove swamps in areas associated to marshland, estuaries, coastal lagoons and, in general, low land influenced by the flow and ebb of tides, waves, or by sea – water filtration.	• Maximum external edge of the mangrove. • In case of marshland vegetation, the boundary is measured from the external edge of such vegetation.	• Minimum width of 40 m
5. River Mouths	• Not provided	• 300 m in straight line towards land measured from the longitudinal river mouth. • 60 m inland measured from both riverbanks.	• Minimum width of 20 m.
6. Non – identified Coasts due to Natural or Anthropic Causes	• Not provided	• 20 m measured from the greatest historical tidal flood, or maximum equinoctial high tide.	• Minimum width of 40 m.

Landward boundaries according to Decree Law 212 depend on the coastline's configuration, geology and vegetation, among other aspects [38]. Biotic and arbitrary criteria are also used by DL-212 to set up coastal boundaries. Coastal uses and boundaries are restricted by the Decree to terrestrial distances from a minimum of 20–40 m, and up to 300 m′ tops, meaning that coastal uses are not allowed within these distances from the water line.

The top distance is only provided for the cases of River Mouths (see Appendix 1). In the different geomorphological units analyzed in DL-212, distances are measured to the same longitude in each identical type of unit. For example, in the case of Rivers, the variables Type (intermittent or not) and Flow (strong or weak) are not taken into account. For Beaches, 40 m in addition to the protected coastline are taken into account when establishing the protection zone, but aspects such as the physical-natural origin of the beach (biogenic or terrigenous), type of granulometry, level of urbanization, and urban density (natural, urban, rural beach, etc.) are not taken into consideration for in-land coastal boundaries. Different specialists on the subject [39–41] have highlighted all the aforementioned issues.

The geomorphological and anthropic aspects are not completely connected when classifying and delimiting coastal units. The geographical and eco-systemic approaches are the main ones taken into account for establishing in-land “coastal zones” boundaries, while arbitrary criteria and some geographic features are followed for the boundaries of “zones of protection” and limits in the ocean [14,38,39]. Arbitrary criteria are defined by coastal policies or legislation, sometimes ignoring both the physical and administrative heterogeneity of coastal zones and hindering the implementation of ICZM and ecosystem-based management approaches [42].

Furthermore, DL-212 does not consider some geomorphological units present in coastal territories, such as lagoons, wetlands, swamps, coastal plateau, among others, for establishing boundaries. Nevertheless, to that end, the Decree takes the historical memory of previous natural phenomena into consideration, specifically anthropized or artificial coasts and cliff coasts. Administrative boundaries, or those related to the physical – geographical characteristics of the different hydrographic basins are not considered within the DL-212. Something similar occurs with respect to the social perception, identity, roots, and sense of belonging of local individuals; these are not taken into account. The same happens with key extreme-accuracy variables, such as those related to current scenarios about climate change and coastal zone vulnerabilities, and the great number, or concentration of beachfront houses. The level of urban development is conditioned by all the aforementioned factors [37,43]. Therefore, it is possible to assert that DL-212's current criteria for coastal boundaries delimitation are not entirely effective for territorial planning purposes.

3.2. Set of four variables and corresponding sub-variables

The set of four variables proposed in this research work seeks to become a relevant decision-making tool to implement DL-212, as well as to land-use planning and ICZM programs. Fig. 1 shows interaction among the proposed variables and sub-variables for integrated coastal zones characterization and boundary delimitation. A description of each variable is provided below for better understanding.

3.2.1. Geomorphological Units

These have three sub-variables: the first one refers to the generic types of coasts present in Cuba; the second one specifies landforms according to their geological-marine composition and origin [24,25]; the third sub-variable describes the coast according to the variables influencing the different geographical features of the zone [35,36].

3.2.2. Transformations

This variable refers to the different anthropogenic changes and subsequent modifications occurring in the coastline throughout time. The legal frameworks of the study area determine the processes of urban growth and illegal actions according to Decree Law 212 [3]. The percentage of anthropic levels present in the built areas of the polygon was taken into account to analyze coastal transformations; ex. High

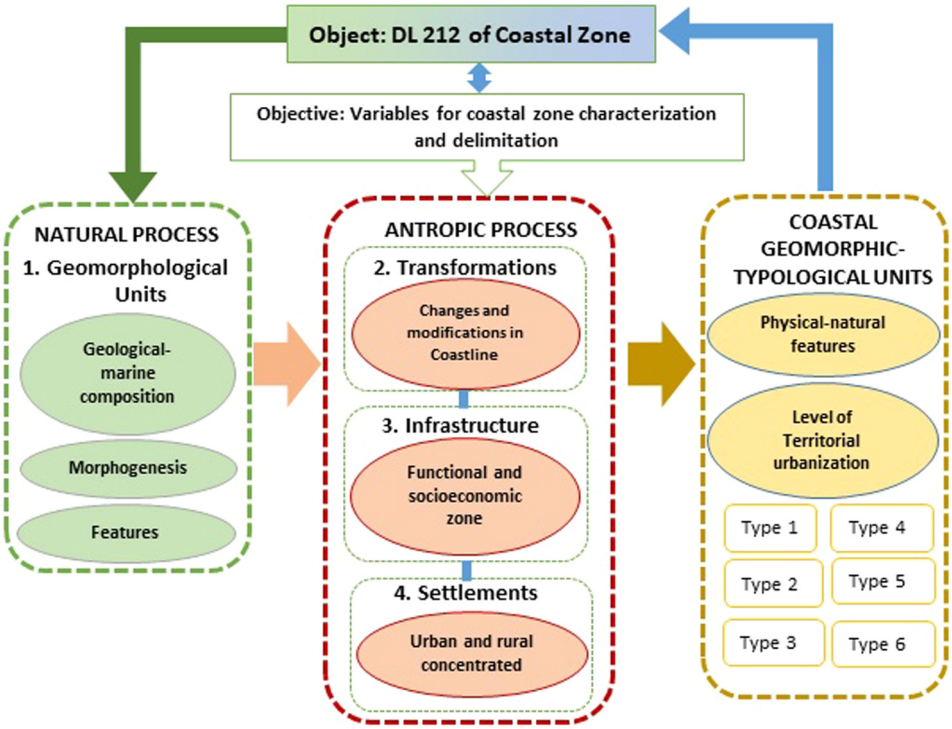

Fig. 1. Conceptual diagram of the set of variables for coastal zone characterization and delimitation.

- > 50–100%; Medium - > 10–50%, and Low - > 0–10%. The Percentage of anthropic levels is the core of the polygon where there is population and buildings whose fractioning is effectively represented by blocks. This system also includes all the non-urban territories that are used for agricultural and mining purposes.

3.2.3. Infrastructure

The territorial zoning on cartographic maps was done by analyzing the different zones located in marine and terrestrial spaces, as well as their extension and ties to coastal ecosystems. For *example,* cases completely linked together point to the absolute presence of fragile ecosystems within the functional zone of analysis. Visual links between the functional zone and the first coastline were catalogued from strong to weak ranges. Waterfronts refers to buildings and infrastructures built between dune cord and the coast [44]. When the position of the assessed functional zone is at the waterfront, it means a strong link; when the zone's extension goes farther, the link tends to weaken. At the same time, each linear infrastructure dividing the coastal unit (e.g. roads, pipes, railways) and, in some way, separating it from the coastline, was also analyzed herein, resulting in three different ranges: Total - *when the Division or Fragmentation is* > 50% *or complete*; Partial - *when the Fragmentation is* ≤ 50%; and Null - *when there is no linear infrastructure*.

3.2.4. Settlements

Areas measured in hectares, population, density and ties to coastal resources were evaluated for each type of settlement to classify them as Urban or Rural-Disperse and Rural-Concentrated [33]. The number of inhabitants present in the polygon of the unit was analyzed following a specific methodology [32]. According to the methodology proposed by those authors, settlements can be classified as: Rural-Disperse (*population: 0–1000 inhabitants*), Rural-Concentrated (= > 1000–2000) and Urban (> 2000). The classification according to links may fluctuate from High to Null. A high link indicates a total, or almost total, community interaction and human dependency on coastal resources.

3.3. Coastal geomorphic-typological units

A feedback process on the four aforementioned variables led to the characterization of the different types of coasts according to their physical-natural features, level of territorial urbanization, and interaction between land and sea. The geomorphic-typological characterization of coastal units was performed using the following six different categories: Type 1: *Low-lying seacoast*, or *Flat coastal plain*; Type 2: *Hard rocky* or *Cliff-lined coast*; Type 3: Beach; Type 4: *Low-lying mangrove coast*; Type 5: *Coastal lagoon*, and Type 6: *River mouth*. Each category was then sub-classified as A, B, C, D, E or F. Sub-classifications A to C correspond to the worst case scenario, whereas D to F, as the case may be, correspond to natural or the best-preserved coasts, and only for beaches are there two extra types for artificial beaches (G and H). The proposal of classifying the Coastal Geomorphic-typological Units by taking into account their geomorphology and anthropic levels, are shown in Table 3, and exemplified in Appendix 2.

Type 1, *Low-lying seacoast*, also known as *Flat coastal plain* or recent coastal deposits refers to areas with a predominantly flat morphology or a low height in relation to the sea level, which have a marine or fluvial-marine origin [25]. That type of coast is occasionally tied to the mainland by hills and mountainous zones and is made up of rocks and loose materials, such as pebble, gravel and sand, and may be covered with vegetation or not. This type of coast may also be composed of a fringing fossil coastal reef, covered mainly with porous stones.

Type 2: A *Hard-rocky* or *Cliff-lined coast* is morphologically characterized by the presence of an escarpment, where the ocean and the continental topography contrast [23]. Storm-wave action in the zone of the prevailing westerlies may provide a recognizable standard [36,45]. The wave's height and the intensive use of coastal space play an important role [3,35].

Type 3: A *Beach* constitutes a relevant ecosystem, although on some

Table 3
Classification of Coastal Geomorphic-typological Units.

	Geomorphology			Anthropic level			Sub-Type
Types	**Units**	**Morphogenesis**	**Features**	**Transformation (landscape)**	**Settlement (population density)**	**Infrastructure (construction density)**	
1	Coastal Plain:	Marine or fluvial sediments	No consolidated vegetation	High	Urban	Total	A
	Flat morphology	Composition: rocks and loose materials (pebble, gravel and sand) with vegetation or not	Transplanted or natural vegetation	Medium	Rural- Concentrated	Partial	B
	Low height		Transplanted or natural vegetation	Medium	Rural- Dispersed	Partial	C
	Fringing fossil coastal reef		Transplanted or natural vegetation	Medium	Rural- Concentrated	Partial	D
			Natural consolidated vegetation	Low	Rural- Dispersed	Null	E
2	Rocky Coast:	Storm-wave action of prevailing westerlies	High cliff-lined	High	Urban	Total	A
	Escarpment contrasting the ocean and the continental topography	High waves		Medium	Rural-Concentrated	Partial	B
	Not exceeded by tidal waves			Low	Rural-Dispersed	Null	C
			Cliff-lined of fixed or variable heights	High	Urban	Total	D
				Medium	Rural-Concentrated	Partial	E
				Low	Rural-Dispersed	Null	F
3	Beaches	Fine to medium or thick sized grains of sand, slime, clay and other similar materials	Dunes with non-native vegetation	High	Urban	Total	A
		Biogenic or terrestrial origin	Dunes with native and non-native vegetation	Medium	Rural- Concentrated	Partial	B
		Mixed with different grain sizes of sand, gravel, pebble, stones or blocks	Coastal dunes with, or without consolidated vegetation	Low	Rural- Dispersed	Null	C
		Biogenic or terrestrial origin	Dunes with non-native vegetation	High	Urban	Total	D
		Foreign grain material, driven by non-natural forces	Dunes with or without consolidated vegetation	Medium	Rural- Concentrated	Partial	E
			Artificial beach	Low	Rural-Dispersed	Null	F
				High	Urban	Total	G
				High	Rural-Dispersed	Partial	H
4	Mangrove Coast:	Influenced by ebb tides	Mangrove patches	High	Urban	Total	A
	Lowland bordering the coast			Medium	Rural-Concentrated	Partial	B
				Low	Rural-Dispersed	Null	C
5	Coastal Lagoon:	Differentiated by types of limiting bar	Limiting bar of non-consolidated marine sand	High	Urban	Total	A
	Permanent saltwater bodies (water mirrors)			Medium	Rural-Concentrated	Partial	B
	Communication with rivers through channels or underground water			Low	Rural-Dispersed	Null	C
			Limiting bar of consolidated marine sand	High	Urban	Total	D
				Medium	Rural- Concentrated	Partial	E
				Low	Rural-Dispersed	Null	F
6	River Mouth	Recent or ancient flow course	Permanent	High	Urban	Total	A
		Meanders		Medium	Rural-Concentrated	Partial	B
		Strait lines		Low	Rural-Dispersed	Null	C
		Small tributaries crossing floodplains	Intermittent	High	Urban	Total	D
				Medium	Rural-Concentrated	Partial	E
				Low	Rural-Dispersed	Null	F

occasions, it may present deterioration or be at risk because of the great number of users and infrastructures [23].

Type 4: *Low-lying mangrove coasts* are present in large areas or in the form of mangrove patches located at lowlands bordering the coast. This last type of coast is influenced by ebb tides and differentiated by the level of anthropic activity.

Type 5: *Coastal lagoon* is a new geomorphological unit also analyzed in this research work because of the great number of lagoons in Cuba; there are more than 35, most of them located in the south-eastern region of the country [46,47]. A Coastal lagoon refers to saltwater bodies permanently accumulated in hollow areas. In some cases, the presence of constant water mirror is the result of them communicating with rivers through channels or underground water. In other cases, there is periodic or permanent exchange with the sea through beaches or shoreline strands nearby [48]. This unit is differentiated according to the level of anthropic activity and type of limiting sea bar [49,50].

Type 6: *River mouths* are classified as permanent or intermittent, and of wide or narrow water flow [25]. This classification also differentiates flow courses as recent or ancient (*paleocauces*), including broad meanders, straight lines, and small floodplains-crossing tributaries [5,25]. This differentiation is established due to two relevant factors: (1) type of river – *permanent* or *intermittent*- and (2) anthropic level of mouth banks.

4. Discussion

4.1. The challenges of applying geomorphic-typologies in cuban coastal zones

Land and sea interaction is not actively recognized in DL-212 for the establishment of coastal boundaries, while delimitation on land is widely analyzed for territorial planning. Despite the great efforts made by the Cuban Government for over two decades, implementing coastal boundaries has failed in the 15 Cuban provinces due to the lack of a budget, insufficient political will and difficulties in controlling actions at coastal zones. Applying the set of variables proposed herein to set up coastal boundaries in Cuba represents a challenge in the current context of DL 212. For that reason, Table 4 suggests the following nine guidelines.

The essential components of a holistic and integrated system approach result from the previous descriptions; leading, therefore, to the question about the best way to organize DL-212 for it to provide adequate information to the corresponding specialists and institutions to effectively support coastal management and the implementation of that legal framework.

4.2. Recommendations for Improving DL-212

A framework about environmental policies for land and sea in Cuba was recently analyzed. According to the Five Policy Attributes promoting sustainability, DL-212 scored less than 60%. After analyzing the levels of ecological organization, as well as adherence to the precautionary and adaptive approaches, DL-212 scored 0 points [51]. The results of that study clearly show that the current Cuban legal framework needs to be improved with the information needed to bridge the knowledge gap progressively detected by the scientific community.

One example where DL-212 needs improving corresponds to the necessity of specifying the adequate procedure and institutions accountable for approving, managing, and checking the establishment of coastal boundaries. CITMA must not be the only institution legally responsible for that task, but also the different headquarters of the Institute of Physical Planning throughout the country. It is also necessary to increase the leading role of all those local institutions when putting the legal norms into practice.

Although DL-212 is currently being reviewed and improved to fulfill all normative needs [5,14,15], it is imperative to reaffirm the necessity of including specific aspects, not taken into account up to now, with the purpose of avoiding further publishing complementary regulations. Some examples are given in Table 5.

DL-212 has been used by the National Institute of Physical Planning in a few touristic hubs of the country, such as Varadero, in Matanzas province, and in the Holguín province. Other provinces have implemented that legal framework through their corresponding offices using a Geographic Information System, but coastal boundaries must be established more accurately [14]. Therefore, it is necessary to verify the preliminary delimitation undertaken at such offices, carrying out fieldwork at the corresponding coastal zones. Fieldwork is extremely useful when establishing coastal boundaries to guarantee higher accuracy levels as inaccurate data can be corroborated on cartographic maps using global position equipment. It is also necessary to update the Land-Use Plans of each coastal municipality of the country.

5. Conclusions

At touristic coastal areas, setbacks derived from Decree-Law No. 212 “Coastal Zone Management” constitute a significant reference for

Table 4
Guidelines for applying DL-212 in Cuba using Coastal Geomorphic-typological Units.

Number	Guidelines
1	Identifying threats to natural vegetation and infrastructures tied to the coasts (*example:* construction of sea roads, deforestation, desertification, bridges).
2	Identifying and updating new coastal activities and anthropic actions in coastal zones (*example:* agricultural activities, settlements, mining activities, domestic wastes, and sewage waters, habitat and mangrove destruction, among others).
3	Determining coastal management institutions capable of leading solutions to the problem, as well as developing and putting action plans into practice. (e.g. Institute of Physical Planning).
4	Adding the geomorphological classification of units proposed in this study to DL-212, making special emphasis on Coastal Lagoons. Information available through official national institutions and open sources data servers (e.g. Google Earth) has been used for the physical–natural characteristics and anthropic level of the Cuban coasts provided in that classification. At the same time, the proposal of Coastal Geomorphic-typological Units brings about the possibility of using uniform nomenclature for coastal characterization, including geomorphological, anthropic, and vulnerability criteria for the establishment of coastal boundaries.
5	Organizing a local multidisciplinary group made up of geographers, urbanists, and other specialists, such as experts in Geographic Information Systems with the aim of managing large databases and drawing new maps of the Cuban coasts following the proposed classifications.
6	Integrating and coordinating processes led by the Institute of Physical Planning with other important national institutions, such as the Ministry for Science, Technology and Environment (CITMA), universities, enterprises, among others, to guarantee a better implementation of boundaries in accordance to DL-212.
7	Taking into consideration new land-use plans, including sea-level rising scenarios of due to climate change for future coastal delimitation, from 2050 to 2100.
8	Delimitating coastal areas at risk according to DL-212, forbidding the presence of new micro-locations and the development of environmental licensing processes inside their limits.
9	Identifying possible funding sources for physical and visible delimitation pursuant of DL-212.

Table 5
Recommendations for Improving DL-212 in Cuba.

Number	Recommendations
1	Article 23 refers to coastal signs, but that legal framework has not been put into practice in 95% of the national territory, denoting the necessity of physically signposting the Cuban coastal zones.
2	Article 26 is concerned with cays or peninsulas, where the established distances for coastal zones and corresponding protection zones are not properly observed. This article also needs a review to identify the numerous cays where building is forbidden because of their geomorphological aspects or extreme fragility.
3	Something similar must be done with Article 4, where the differences to establish coastal boundaries in the geomorphological units of rivers and beaches must be stated according to the physical–geographic and economic characteristics of each ecosystem, taking also into account their morphology, granulometry, degree of human transformation, and natural-origin risks [15,27].
4	There is a lack of morpho-dynamic criteria regarding the marine boundaries established in DL 212 for depths from 100 to 200 m, wherefore other important criteria must be added, i.e., the presence of marine pasture, fishing, presence of wreckage, or other submerged elements of the subaquatic landscape and cultural patrimony, among others. In this way, delimitation would favor Marine Spatial Planning processes and become a generic classification and reference model for *Small Island Developing States* [52,53], as well as for other coastal territories, where the continental shelf is excessively extended [54].
5	Furthermore, in the Third Section of Chapter 1, Article 6.1 of DL 212, all components regarding coastal zones are mentioned without any reference to the highly important component of Human Settlements.
6	The principles of Integrated Coastal Zone Management must be explicitly included and integrated with the norms.
7	Chapter II is called Responsible Authorities. Therefore, the Council of Ministers, as the highest executive and administrative authority in Cuba, must be included in this Chapter and given the task of approving all Programs regarding Zones Under Regimen of Integrated Coastal Management -ZURICM- [6,55], bestowing special emphasis on the zones outside the political-administrative divisions, in order to facilitate local solutions to the possible conflicts originated from coastal uses. Additionally, as the procedure about ZURICM is currently at a standstill in the country, its effectiveness can be legally promoted if the suggestion given herein is implemented.
8	Local governments must have more participation in the processes of approving Programs about Coastal Zones Integrated Management and controlling coastal activities taking into account the stated citizens´ participation in those processes.
9	The scientific results derived from the Macro-project on climate change scenarios for 2050 and 2100 [56], as well as from the studies about Hazard, Vulnerability and Risk [57–64] carried out throughout the country, need to be taken into account to reinforce the current legal requirements for coastal zones, the areas with greatest possibilities of suffering impacts from sea-level rising or coastal aquifers.
10	Chapter IV (Management of Coastal Zone and its Protection Zone) should be complemented with technical aspects to link ICZM Programs to Land-Use Planning. Those tools were linked and validated in the southeastern region of Cuba when the novel integrated method was implemented for the delimitation and demarcation of coastal zone boundaries [5].
11	The Ministries of Science, Technology and Environment, Finance and Prices and, Economy and Planning, need to work together on implementing new tools and payment of taxes at touristic institutions regarding uses of coastal resources, e.g., uses of beaches, or services derived from other ecosystems. Setting up that economic mechanism may lead to acquiring the necessary funding to implement other initiatives and actions to keep coastal zones and fragile geomorphological units in better conditions.

the Small Island Developing States' contexts. That Decree consolidates the legal framework for applying and introducing ICZM Programs in Cuba. Nevertheless, there are specific aspects in DL-212 not being put into practice up to now, such as establishment of coastal zone boundaries and information about the different stages of land-use plans, which must be implemented.

It is well known that DL-212 represents a great contribution to reinforce adequate coastal practices in Cuba. That Decree is pursuant of the principles concerned with sustainable development and takes into account Cuba's condition as a long and narrow Archipelago with a wide insular platform, irregular coasts, and marine-coastal ecosystems of great fragility, which need to be adequately delimitated and protected.

A more technical approach to DL-212 is enabled through the classification proposed in the present research work. The Coastal Geomorphic-typological Units provided herein have led to classifying the different types of coasts according to their physical-natural characteristics, anthropic level, or urban development of the territory. Therefore, the current conditions of the Cuban coasts can be better characterized for future delimitation purposes. At the same time, the proposed classification constitutes a great contribution to improving the implementation of DL-212 in all 15 Cuban coastal provinces, also representing a useful tool for other countries where coastal legislation is needed or where the already implemented coastal legal frameworks need to be improved.

The different coastal geographical areas were taken into account for the set of four variables proposed, their application requiring to follow inter, multi, and trans-disciplinary perspectives on the marine and terrestrial points of view to guarantee better control by the corresponding authorities, as well as land-sea interaction. The variables can be used not only for coastal zone characterization, but also to identify natural or vulnerable zones, depending on the anthropic levels of urbanization in the territories. For that reason, the variables proposed must be periodically evaluated to monitor coastal geomorphology and anthropic variations. The present work sets forth an alternative proposal, open-ended and subject to modification, about the standard nomenclature of the coasts applicable to the Cuban context.

The set of variables are an open-ended proposal, subject to modification, with a standard nomenclature for different types of coasts used in the Cuban context. A systematic evaluation of the variables must be performed in order to check for changes in coastal geomorphology and anthropic variations happening on the coastline through time.

In Cuba, the Government needs to keep on strengthening, accelerating and making all efforts to modify and implement Decree Law 212. The Institute of Physical Planning and the Ministry of Science, Technology, and Environment can lead this endeavor. However, they will only succeed in fulfilling those tasks with the engagement of other governmental sectors, such as the Ministries of Foreign Investment, Economy and Planning, and Tourism.

Possible modifications to DL-212 can serve as models to other Latin-American countries and Small Island Developing States to introduce a new era of sustainable development in the region and to improve the coastal environmental conditions.

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Appendix 1. Graphics of Types of coasts described in DL-212 (Adapted from Milanes C., 2018 [64])

See Fig. A1 here.

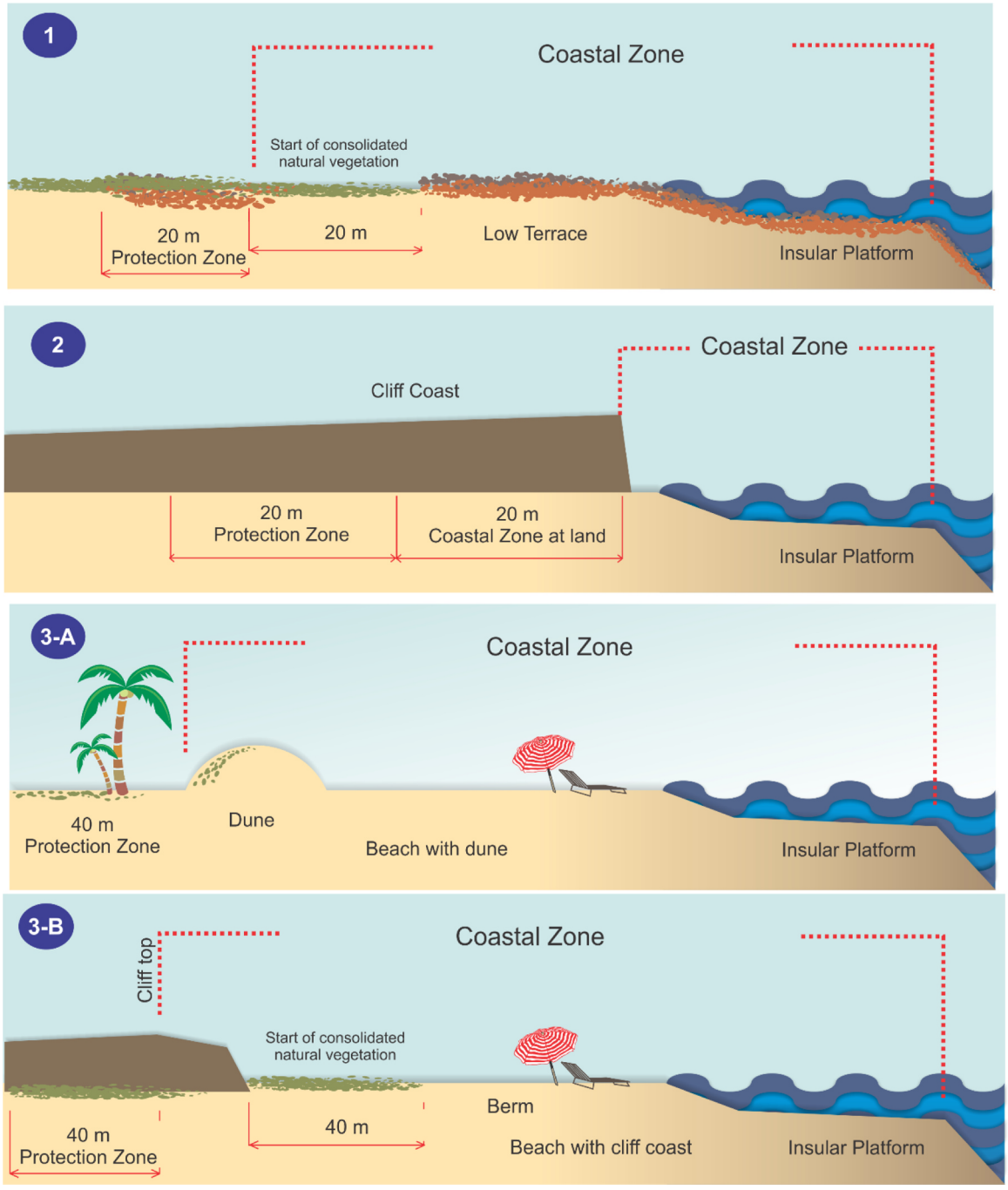


Fig. A1. 1) Low Terrace; 2) Cliff Coast; 3-A) Beach with dune; 3-B) Beach with cliff coast; 3-C) Beach with natural vegetation; 3-D) Beach with coastal lagoon 4) Low Mangrove Coast; 5) River Mouths; 6) Non – identified Coasts.

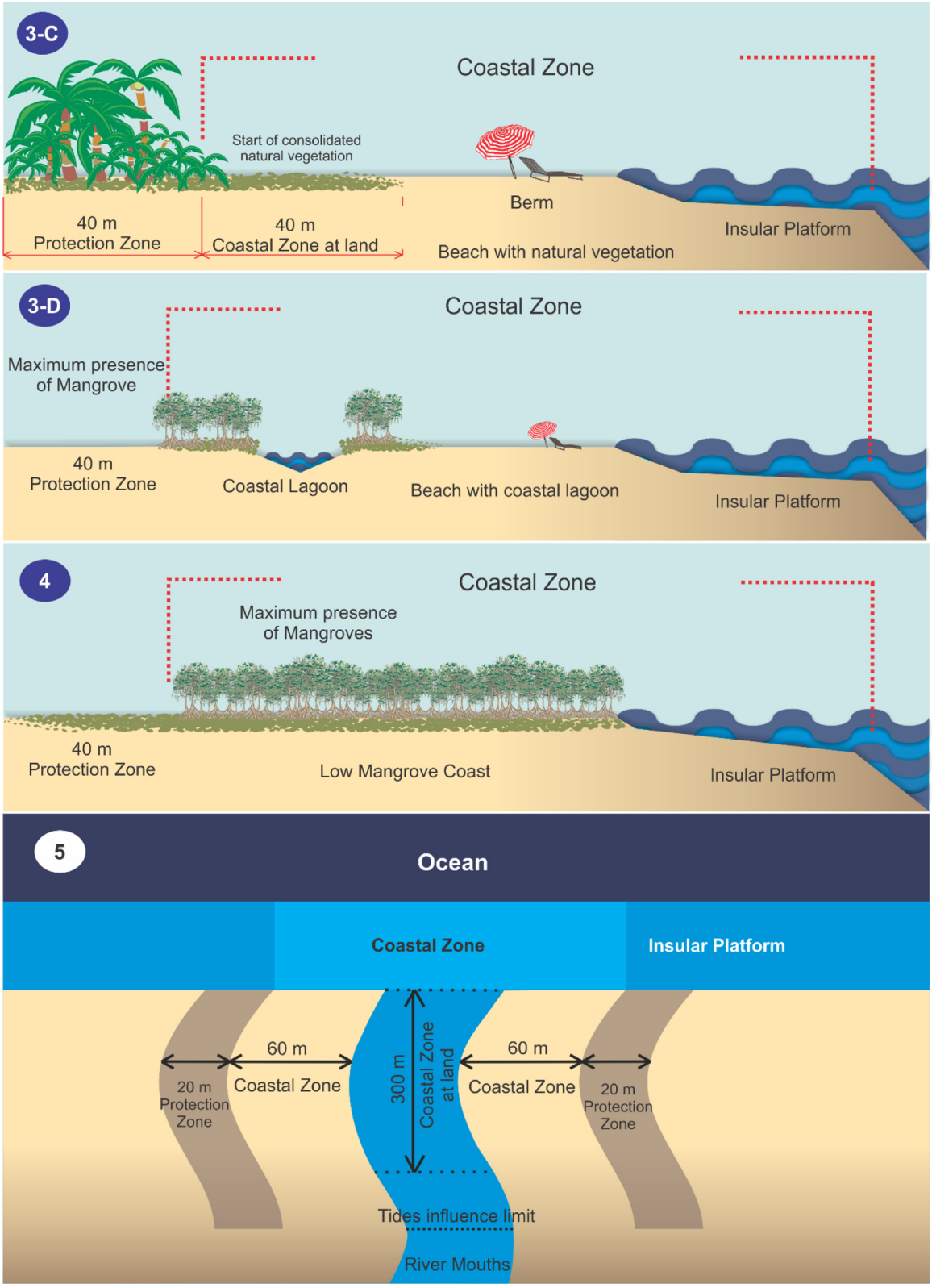


Fig. A1. (*continued*)

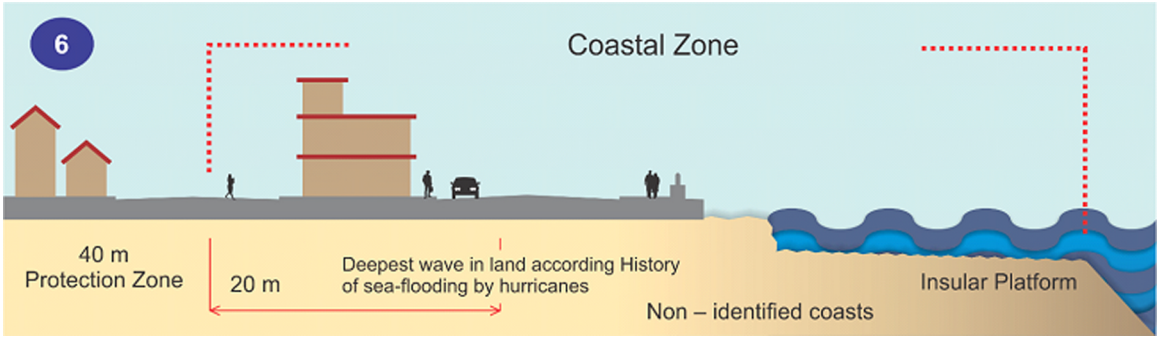
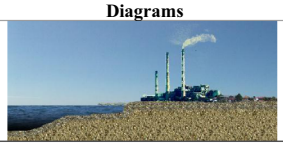
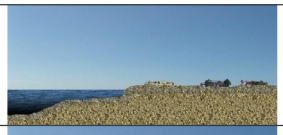


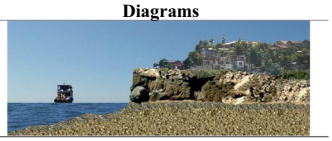
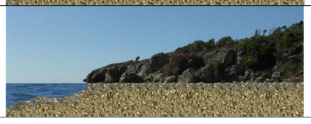
Fig. A1. (*continued*)

Appendix 2. Coastal Geomorphic-typological Units proposed for updating the DL 212

Type 1. Low-lying seacoast or Flat coastal plain.

Sub-types	Descriptions	Examples	Diagrams
1-A	• High density of constructions, touristic or industrial facilities. • High level of environmental pollution. • High level of settled, or floating population density. • Totally anthropic landscape.	Anthropic waterfront. Big or medium urban areas. Harbor areas, industrial zones, large seaside resorts.	
1-B	• Partially urbanized. • No high density of population. • Moderate environmental pollution. • Moderately anthropic landscape.	Cities with seafronts and promenades parallel to coastline.	
1-C	• Medium density of urbanization. • Low density, or no population. • Moderately anthropic landscape. Moderate, or no environmental pollution.	Limited rural population. Presence of very few facilities, parks, cemeteries.	
1-D	• Activities for subsistence. • Traditional way of life linked to the sea. • Low density of urbanization and population. • Moderately anthropic landscape.	Agricultural or fishing coastal communities. Presence of vegetation.	
1-E	• No urbanization. • No population density. • Virgin landscape.	Protected coastal areas. Presence of vegetation, consolidated or not.	

Type 2. Hard rocky or Cliff-lined coast

Sub-types	Descriptions	Examples	Diagrams
2-A	• High cliff-lined. • No exceeded by tidal waves (temporary heights). • High level of urbanization. • Totally anthropic landscape.	Big settlements at the cliff areas. Presence of restaurants, several houses and other rigid constructions.	
2-B	• High cliff-lined. • No exceeded by tidal waves. • Low level of urbanization. • Moderately anthropic landscape.	Limited population. Presence of very few facilities, parks, viewpoints.	
2-C	• High cliff-lined. • No exceeded by tidal waves. • No urbanization. • Virgin landscape.	Only cliff areas, without any kind of construction.	
2-D	• Cliff-lined of fixed or variable heights. • No exceeded by tidal waves. • Great urbanization, or presence of man-made structures. • Anthropic landscape.	Public and private constructions near the coastline, vulnerable to tidal waves.	
2-E	• Cliff-lined of fixed or variable heights. • No exceeded by tidal waves. • Low level of urbanization. • Moderately anthropic landscape	Limited population. Presence of very few facilities, parks, viewpoints.	
2-F	• Cliff-lined of fixed or variable heights. • No exceeded by tidal waves. • No urbanization. • Virgin landscape.	Only cliff areas, without any kind of construction.	

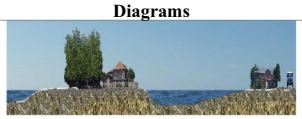
Type 3. Beach

Sub-Types	Descriptions	Examples	Diagrams
3-A	• Composed of fine, medium or thick-sized sand grains, slime, clay and other similar materials. • Biogenic or terrestrial origin. • Located at urban or rural spaces, touristic or not. • High level of urbanization • High density of population. Anthropic landscape.	Coastal dunes modified by great construction activities. Presence of hotels and settlements. No-native vegetation.	
3-B	• Sandy beach located at urban or rural spaces, touristic or not. • Low level of urbanization. • Low density of population. Moderately anthropic landscape.	Coastal dunes with native and no-native vegetation. Some buildings and housing.	
3-C	• Sandy beach. • No urbanization. • Very low level of population. Virgin landscape.	Hardly-accessible areas. Coastal dunes with vegetation, consolidated or not.	
3-D	• Sand with different sizes of grains, gravel, pebble, stones, or blocks. • Biogenic or terrestrial origin. • Located at urban or rural spaces, touristic or not. • High level of urbanization • High density of population. Anthropic landscape	Coastal dunes modified by great construction activities; with rivers and no-native vegetation.	
3-E	• Sand with different sizes of grains, gravel, pebble, stones, or blocks. • Located at urban or rural spaces, touristic or not. • Low level of urbanization. • Low density of population. •Moderately anthropic landscape.	Coastal dunes with native, or no-native vegetation.	
3-F	• Sand with different sizes of grains, gravel, pebble, stones, or blocks. • No urbanization. • Very low, or no density of population. Virgin landscape.	Hardly-accessible areas. Coastal dunes with vegetation, consolidated or not.	
3-G	• Artificial beach located at urban or rural spaces, touristic or not. • Highly urbanized.	Man-built beaches for touristic purposes, located at urban areas or near hotels.	
3-H	• Artificial beach located at urban or rural spaces, touristic or not. • Moderate urbanization. No anthropic landscape.	Man-built beaches for recreation purposes, located rather far from human settlements or hotels.	

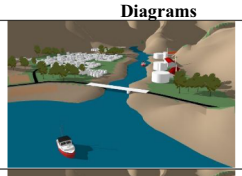
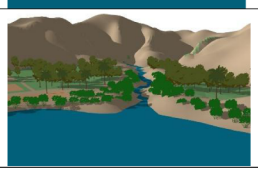
Type 4. Low-lying mangrove coast

Sub-types	Descriptions	Examples	Diagrams
4-A	• Few or isolated mangrove species due to the development of agricultural activities. • Interaction of communities with the coastal resources. • High level of urbanization. Anthropic landscape.	Urban areas inside mangrove zones.	
4-B	• Moderately anthropic or sectioned mangroves due to the presence of roads or bridges. • Low level of urbanization. Moderately anthropic landscape.	Presence of roads dividing the mangrove zones.	
4-C	• Virgin or no-anthropic landscape.	Only mangrove zones, without any kind of construction or infrastructure.	

Type 5. Coastal lagoon.

Sub-types	Descriptions	Examples	Diagrams
5-A	• No-consolidated limiting bar of sandy sea. • Very anthropic shore. • Presence of urban or rural settlements, touristic or not. • High level of urbanization. High density of population.	High level of touristic or housing development.	
5-B	• No-consolidated limiting bar of sandy sea. • Moderately anthropic shore. • Presence of urban or rural settlements, touristic or not. • Moderate level of urbanization. Moderate density of population.	Presence of technical infrastructures, like bridges or roads.	
5-C	• No-consolidated limiting bar of sandy sea. No or limited anthropic shore.	Natural lagoon.	
5-D	• Consolidated limiting bar of sea material. • Very anthropic shore. • Presence of urban or rural settlements, touristic or not. • High level of urbanization. High density of population.	High level of touristic or housing development.	
5-E	• Consolidated limiting bar of sea material. • Moderately anthropic shore. • Presence of urban or rural settlements, touristic or not. • Moderate level of urbanization. Moderate density of population.	Presence of technical infrastructures, like bridges or roads.	
5-F	• Consolidated limiting bar of sea material. No or limited anthropic shore.	Natural lagoon.	

Type 6. River mouth.

Sub-types	Descriptions	Examples	Diagrams
6-A	• Permanent and wide-flowing river. • Very anthropic mouth.	Presence of settlements, bridges, roads, industrial facilities.	
6-B	• Permanent river. • Moderately anthropic mouth.	Presence of bridges or roads.	
6-C	• Permanent river. • Virgin or no-anthropic mouth.	No infrastructures or constructions.	
6-D	• Intermittent river. • Very anthropic mouth.	Presence of settlements, bridges, roads, industrial facilities.	
6-E	• Intermittent river. • Moderately anthropic mouth.	Presence of bridges or roads.	
6-F	• Intermittent river. • No-anthropic mouth.	No infrastructures or constructions.	

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