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Anthropogenic impacts on Iberoamerican coastal areas: Historical processes, present challenges, and consequences for coastal zone management

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ABSTRACT

The coastal zone in Portugal, Spain, Brazil and Argentina is declared as a common resource. However, since the touristic boom started in the 1960s, these countries have not considered adequately the available management instruments due to the rapid demand for seaside spaces, the interest to improve rapidly the national economy, and the limitations of the scientific knowledge about the impacts on the natural systems. The environmental consequences of anthropogenically-triggered processes in Latin America occurred somewhat later than in southern Europe, but similar errors were repeated. The investors demanded rapid benefits, without care for social development or environmental protection, and disregarding scientific knowledge. As in other coastal areas of the world, there are strong concerns about the consequences of climate change and sea-level variations on these coasts, especially in areas of extensive urban development.

1. Introduction

At present the appropriate management of coastal areas is an unavoidable task in order to develop a sustainable society. As a highly complex activity, coastal management requires a holistic knowledge of the reality, which is very difficult to achieve as an integration of very diverse components. Another difficult task is to deal with the different aspects that define the planet's surface: lithosphere (comprising hard rocks, sediments and their sedimentary processes); hydrosphere (including salt, brackish and freshwater environments and their complex dynamics); atmosphere (considering weather, climate and its short- and long-term changes, together with interactions with the ocean and continents), and the biosphere (ranging from unicellular micro-organisms to large mammals).

Although part of the Biosphere, but due to his more complex interactions and impacts (Anthroposphere), Man is the main factor to be considered in environmental management. His impact capacity has been exponentially increasing over time, to be considered presently as the most important driving force in coastal areas (Rivas and Cendrero, 1991; Dias et al., 2012b).

Most appropriate coastal management should be based upon scientific knowledge, coming from the integration of different disciplines, such as oceanography, cultural anthropology, geology, sociology, physics, history, biology, psychology, and chemistry, amongst others. However, such interactions between diversified disciplines are not easy to establish, especially when considering integration between natural and social sciences. Nevertheless a holistic approach is forcing such integration, whilst global knowledge of coastal systems demands a deep and unavoidable interdisciplinary effort.

Accepting that Man dictates the need for coastal management, the restricting dimensions should be stated clearly in order that any human decision or activity could not surpass certain limits: as such, society can continue to manage resources in a sustainable manner.

Within this context, each natural system should be evaluated taking into account its attractiveness and suitability for human activities, the different ways in which humans can exert their impacts on it, changes directly or indirectly produced by the impacts, and if such impacts are modifying the original suitability for human activities. In this sense, coastal systems are subject to continuous changes, and cultural aspects should be considered where the preservation of the inherited goods seems worthwhile. Models of coastal development consider the concept of "resort

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cycle", in that a touristic attraction passes through several stages, known as: 1) exploration; 2) involvement; 3) development; 4) consolidation (when the carrying capacity is achieved); and 5) stagnation (Butler, 1980).

The purpose of this contribution is to describe some interactions between Man and the environment, over a latitudinal elongated space (with common cultural roots but different histories, administrations and diverse natural environments), comprising countries from the Old and New Worlds, but with common cultural roots.

2. Characterization of the areas considered

The coastal areas considered span from the Iberian Peninsula (Portugal and Spain, southern Europe), to Eastern South America (Argentina and Brazil), ranging over latitudes from 44°N to 55°S.

The Portuguese coast is about 1800 km long, half of which corresponds to the archipelagos of Madeira and Azores. From its northern end to about the mouth of the river Mondego, the coast is low and mainly sandy. To the south of this location, until Cape S. Vicente cliffs alternate with lowlands and sand dunes. The Algarve coast, west–east in direction, has two areas of different characteristics: a western part that corresponds to a cliffed coast with some sandy beaches; and the eastern part extending to the border with Spain, which is characterised by continuous sandy beaches (Fig. 1).

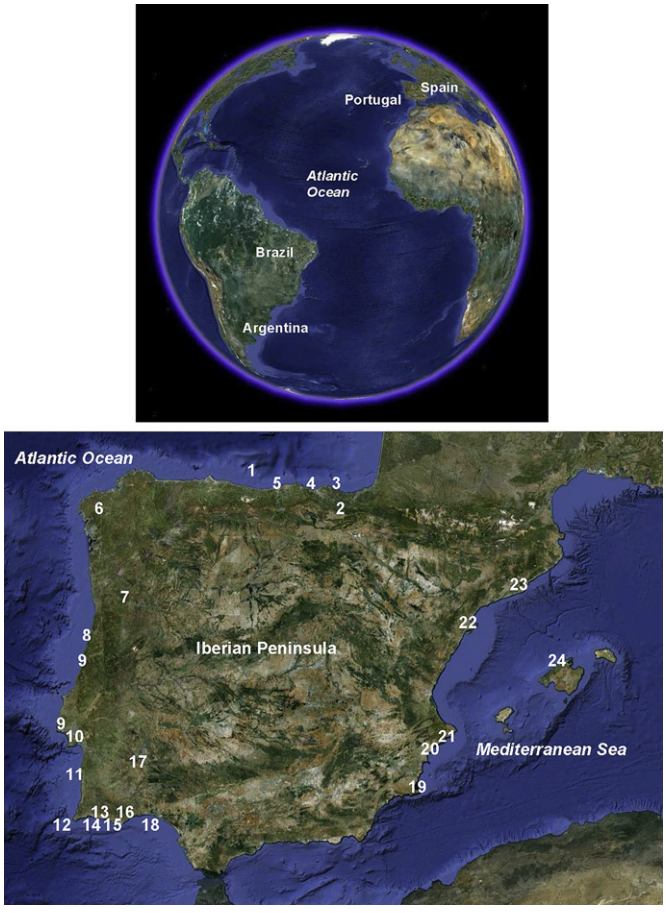

Fig. 1. Geographic location of coastal areas from Portugal and Spain mentioned in the text: 1. Cantabrian Coast; 2. Basque Country region; 3. Oka estuary; 4. Bilbao estuary; 5. Suances estuary; 6. Galicia region; 7. Douro river; 8. Aveiro lagoon; 9. Mouth of the Mondego river; 10. Cascais; 11. Sines; 12. Cape San Vicente; 13. Algarve coast; 14. Sagres; 15. Vale do Lobo; 16. Ria Formosa lagoon; 17. Alqueva dam; 18. Guadiana delta; 19. Albufera, Mar Menor; 20. Elx lagoon; 21. Benidorm; 22. Ebro delta; 23. Barcelona; 24. Balearic islands.

The Spanish coast is overall about 8000 km in length (5000 km in the Iberian Peninsula and 3000 km on the islands); it consists of 4000 km of cliffs, 2000 km of beaches, 1400 km of coastal lowlands and 600 km of artificial coast. Important differences can be found between Mediterranean and Atlantic coastal areas. The Mediterranean coast exhibits sediment accumulation processes by the river mouths (deltas), as a consequence of its microtidal regime. In contrast, the Atlantic coast is characterized by cliff morphology, mesotidal range, and intense wave activity. Consequently, most of the sediments transported by rivers are deposited on the continental shelf, relatively far away from the coast (Ministerio de Medio Ambiente, 2005).

The Brazilian coast has an extent of about 8000 km (islands not included), from 6°N to 33°S (Fig. 2). Such large latitudinal variability leads to the development of a great variety of environments, such as: macrotidal plains covered by mangrove forests in the north; semi-arid coasts, bordered by Tertiary cliffs, and delta-like coastal plains in the central coast; and wave-dominated environments in the south, either characterized by dissipative beaches at the border of Late Quaternary coastal plain or rocky shores; and eventually interrupted by reflective to intermediate pocket beaches.

The coastline of Argentina is 5700 km long, comprising a fairly stable area in the north to a generally rising area in Patagonia and tectonically-affected coasts in Tierra del Fuego (Fig. 3). A continental shelf, in places over 800 km wide, is covered by terrigenous sediment accumulated during Quaternary sea-level oscillations (Schnack et al., 2010). Although only a small portion of this coastline was covered by ice during the last glaciation, most of the beaches of Patagonia are composed of gravel.

Fig. 2. Geographic location of coastal areas from Brazil mentioned in the text: 1. Amazonia; 2. Igarapé do Inferno; 3. Amazonas delta; 4. Fortaleza; 5. Natal; 6. Recife; 7. Salvador de Bahia; 8. Jequitinhonha delta; 9. São Francisco delta; 10. Porto Seguro; 11. Doce delta; 12. Vitória; 13. Paraíba do Sul; 14. Búzios; 15. Guanabara bay; 16. Araruama lagoon; 17. Santos; 18. Iguape/Ilha Comprida; 19. Paranaguá; 20. Balneario Camboriú; 21. Florianópolis; 22. Rio Grande do Sul; 23. Porto Alegre; 24. Lagoa dos Patos.

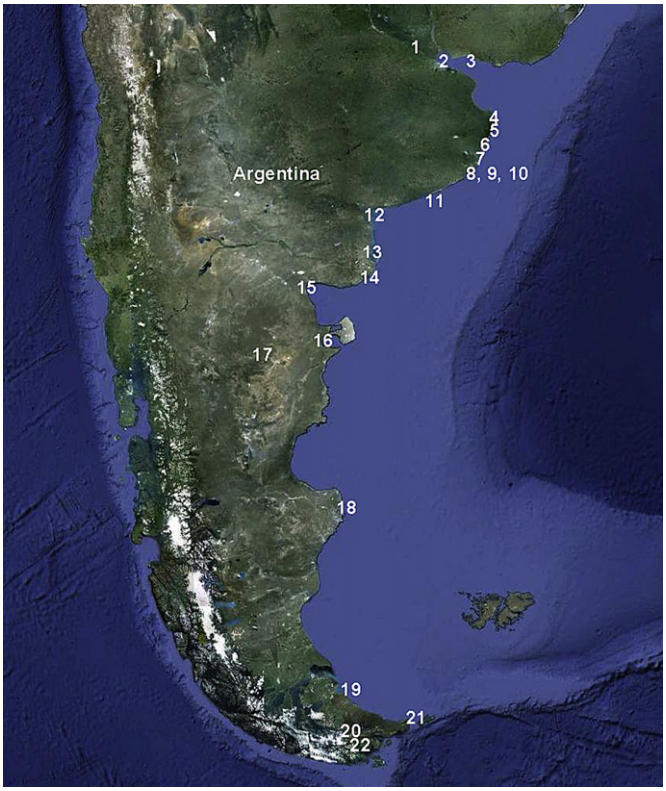

Fig. 3. Geographic location of coastal areas from Argentina mentioned in the text: 1. Paraná delta; 2. Buenos Aires; 3. Rio de La Plata; 4. Mar del Tuyú; 5. San Bernardo; 6. Pinamar; 7. Villa Gesell; 8. Mar Chiquita; 9. Mar del Plata; 10. Punta Mogotes; 11. Necochea; 12. Bahía Blanca; 13. Colorado delta; 14. Rio Negro; 15. San Antonio Este; 16. Puerto Madryn; 17. Patagonia; 18. Puerto Deseado; 19. San Sebastián bay; 20. Tierra del Fuego; 21. Península Mitre; 22. Ushuaia.

Semidiurnal tides dominate in all these countries, whilst mixed tides are common in southern Brazil and northern Argentina. Microtidal environments dominate also along the Mediterranean Iberian coast. Mesotidal (2–4 m) ranges dominate along the Iberian Atlantic coast, northern Brazil and northern Patagonia. Tidal ranges greater than 4 m are characteristic of southern Patagonia and the Amazonian coasts. Maximum ranges of 10–11 m can be recorded at Igarapé do Inferno, Amazonia (Centro de Hidrografia da Marinha, 2007) and San Sebastián Bay, Tierra del Fuego (Isla and Bujalesky, 2005).

The prevailing wave climates are also very diverse. At the Iberian Atlantic coast, the mean significant wave height (H_{sig}) can reach 2–3 m, with swell periods of 8–12 s (Sines, 37°N). Considering a return period of 25 years, the maximum significant wave height expected during a storm is about 9 m (e.g. Pessanha and Pires, 1981; Ferreira, 1993; Costa, 1994). The energy delivered by waves can be even higher along the Galician or Fueguian coasts.

These regions exhibit a diverse range of coastal types: sandy coastal barriers (e.g. Rio Grande do Sul, Brazil or Buenos Aires, Argentina), gravel coasts (e.g. Patagonia, Argentina); high cliffs, composed of carbonate (e.g., Sagres, Portugal or Cantabrian Coast in Spain); and metamorphic (e.g., southern Brazil), eruptive (e.g., Puerto Deseado, Patagonia), or even soft rocks (e.g., Vale do Lobo, Portugal). Some of these coasts have characteristic estuarine environments: rias (Galicia, Spain or Patagonia, Argentina), large estuaries (e.g. Tagus in Portugal, Río de la Plata in Argentina and Uruguay). Some coastal lagoons are very important in relation to their large dimensions (Lagoa dos Patos, southern Brazil), or their heritage importance (Albufera, Mar Menor). In relation to deltas, some are dominated by waves (Guadiana in Portugal, Paraiba do Sul, Doce, Sao Francisco and Jequitinhonha, in Brazil, and Colorado in Argentina); others are very important as substrate to economic centres (Ebro in Spain). Some deltas (e.g. Amazonas in Brazil and Paraná in Argentina) are very large and have significant effects on the surrounding coastal waters. Tidal areas are occupied by mangroves in low-latitude areas such as in northern Brazil, or extended marshes in the mid-latitude estuaries of Patagonia or Iberian Peninsula.

In relation to land urbanization, some bays are very densely occupied (Río de Janeiro, in Brazil), whilst the Fueguian *Nothofagus* forest (Peninsula Mitre, Argentina) has no human population whatsoever. Massive tourism demand during recent decades has led to coastal areas being characterized by verticalization (tall buildings), such as Benidorm (Spain), Rio de Janeiro and Balneario Camboriú (Brazil) and Mar del Plata (Argentina).

3. Histories and occupation impacts

Human activities and their impacts on coastal areas have been very different between the Iberian countries and those of South America. However, certain parallels can be found, in recent times.

3.1. Iberian Peninsula (Portugal and Spain)

Iberian inhabitants have impacted upon their coastal regions for centuries. Romans introduced their improvements (aqueducts, structured agriculture, mining methods), from 218 BC to AD 411, causing severe environmental impacts (Irabien et al., 2012). After them, the successive invaders (Alans, Swabians, and Visigoths) did not produce the impacts of the Romans. The Islamic occupation brought new impacts namely due to new agricultural methods and salt exploitation in estuaries and lagoons. During the long period when the Christians conquered the Peninsula from the Muslims, the deterioration of the landscape increased significantly. Demographic growth caused increasing demand for agricultural fields, wood and timber, causing an indirect significant impact on coastal areas: deforestation induced fluvial erosion and reinforced littoral drift. In the Aveiro region (northern Portugal) the original open bay area was transformed, consequently, into a closed lagoon, in response to a huge increase in the littoral drift (e.g., Dias et al., 2012a).

The direct and indirect consequences of human activities were increasing progressively during the Modern Age. Improvements in agriculture, with the introduction of new yields, had indirect effects on the coast. However, the discovery of the New World demanded more ships (therefore, more forests being cut down) and new harbours. The demand for salt and shelter for ships signified important changes in some estuaries, together with the dredging of some tidal inlets.

Until the Contemporary Age, the open and sandy coasts were avoided by the population due to several aspects, namely the lack of freshwater and wood; they had been treated as deserts, until the health benefits of oceanic baths were known (e.g. Corbin, 1989; Dias, 2005; Freitas, 2010). This new behaviour opened up a demand for touristic villages during the summer time. Tourism has been responsible for the flourishing of the southern areas of Spain and Portugal, since the 19th Century. Improvements in airline connections, emergence of low-cost airlines, together with expansion of leisure times, progressively easier credit, and the democratization of the 20th Century, have increased the demand of tourists from northern Europe. In spite of the economic fluctuations related to the oil-industry crisis, the touristic boom during the 1960s and 1970s caused environmental changes, without recovery. Unfortunately, the decision-makers of these times did not plan adequately

for rapid urban (mostly vertical) expansion. As such, very often services that the summer season requires were increasingly demanding, but lacking. New water reservoirs were needed, in order to satisfy the needs of agriculture and industry. For example, the Alqueva Dam (Guadiana River, Portugal) commenced operation in 2002, as the largest water reservoir of Europe. Harbours were extended also as larger ships (transporting either tourists, oil, or other goods) were demanding deeper ports and larger jetties. In summary, coastal demands are still increasing, without sufficient time and funds for planning. Natural areas were converted, irreversibly, into artificial coasts that need expanding services.

3.2. Brazil

The pristine coast of Brazil suffered significant environmental changes when the Europeans arrived, with their demand for the Brazilian wood (*pau-Brasil*; Souza, 1939). The original abundance of woods at the Atlantic Rainforest diminished to 10% of its original coverage ever since (Dixo et al., 2009); it became almost extinct, within most of the Brazilian states. Human population established here mostly in estuarine areas (Salvador de Bahia, Rio de Janeiro, Santos, Iguape, Paranaguá, Porto Alegre), as the coastal areas dominated by sand were considered as deserts. However, much of the population lived within the hinterland, whilst city-ports were conceived exclusively for commercial purposes. One of the first descriptions of Brazilian coastal cities (Salvador, 1627), refers to them as being composed of "*houses without inhabitants, as their owners live in rural areas, and returning to the coast only during festivals. The urban population consists only of merchants and employees devoted to Justice, Economy or Security, and obliged to live there*". The occupation strategy was based upon colonisation from the coastal areas into the hinterland, creating small isolated towns (Natal, 1991). The most frequent practice was focused on economic activities, related to a single crop (sugar, cotton, coffee). The impacts of these practices on the coastal areas are still on-going research. Certainly, the settlement of the Portuguese Royalty in Brazil (1808), together with Independence (1822), were significant facts that caused an increase in the activity of harbours (expansion, dredging, inlet fixation, breakwaters, jetties) and urban growth along the shore. The former city-ports became large cities, with a harbour.

Although tourism developed some time later than in Europe, the Rio de Janeiro landscape became very popular, whilst new beaches began to develop for touristic purposes (Búzios, Recife, Florianópolis, Fortaleza, Natal). At the same time, economic agreements with the USA (1941) initiated mining activities related to iron and steel industries; this induced indirectly significant changes in some ports, such as Santos, Rio de Janeiro, Paranaguá and Vitória. Pollution was becoming a problem within the estuarine areas of Guanabara and Sao Paulo states (Baptista Neto et al., 2013).

Within the middle of the 20th Century, the same touristic boom as in Europe was beginning to influence the Brazilian coastline. From 1968 to 1973, tourism was reinforced by the "Brazilian economic miracle": GDP (Gross Domestic Product) increased by 10% per year, even with inflation levels of 15–20% per year (Veloso et al., 2008). More cars were bought and this induced improvements in the transport network and an increase in domestic tourists. The economic stability handled by the "Plano Real" encouraged, in 2001, low-cost air companies to be established. Globalization has also caused an international interest in tropical beaches and exotic locations within Brazil. Multiple resorts were constructed and promoted, ranging from cities with buildings of more than 20 floors, such as in Fortaleza (Paula et al., 2013), Recife (Costa et al., 2008), Balneário Camboriú (Costa et al., 2006) and Santos (Mello, 2008); others with completely different characteristics (e.g. Búzios or Porto Seguro).

The Brazilian coast is not exempt from erosion or pollution problems. There are several impacts caused by anthropogenic activities. Some beaches can be referred to as being completely artificial, whilst the degree of deterioration is increasing in recent last years (Galvão and Nolasco, 2013; Sousa et al., 2013).

3.3. Argentina

Over a considerable period of time, coastal development was limited to estuaries (Río de la Plata, Río Negro), where freshwater guaranteed settlements. In the middle of the 19th Century, several towns were established along the Buenos Aires coast (Juárez and Mantobani, 2006). In the meantime, Buenos Aires city was growing, without a proper planning along the Rio de la Plata shoreline (Marcomini and López, 2006). Towards the end of that century, Italian fishermen installed their small boats within the small embayments of Mar del Plata. Every day, boats were transported to the sea with the help of horses. In a short period of time, conflicts occurred as the same bay was occupied by boats, horses, and bathers from Buenos Aires. In response to these "coastal management" circumstances, the construction of a harbour was decided, in order to transfer the fishermen to another embayment to the south. Other harbours were built or improved, with specific characteristics: Buenos Aires was devoted to commerce; Necochea and Bahía Blanca for cereal export; Mar del Plata and Puerto Madryn oriented mostly towards the fisheries industry; and San Antonio Este for the exportation of fruits. However, as in other countries, tourism provoked the most significant coastal change. The social improvements introduced during the middle of the 20th Century permitted many workers to spend summer holidays at the beach. Touristic villages grew, in relation to the improvements of the middle classes. Tall buildings were constructed very close to the most popular beaches, although they were occupied only two months of the year (Isla, 2013). Tourism brought pollution, freshwater demand, sand mining and altered wilderness (Dadón and Mateucci, 2002). However, it must be made aware that tourism only impacted upon the beaches of northern Buenos Aires. The coasts of Patagonia and Tierra del Fuego are less impacted upon by tourism. Several protected areas were defined for the conservation of penguins, sea lions, sea elephants, whales and killer whales. In 2007, 44 protected areas were defined, from Buenos Aires to Ushuaia (Delfino Schenke, 2007).

4. Present situation

4.1. Anthropization levels

As a consequence of the historical processes referred to previously, coastal areas have been altered substantially. Over the Iberian Peninsula, such anthropization levels are almost completely generalised. In Brazil, with an average population density of 22 inhabitants/km^2, the anthropization is less evident; however, it is highly concentrated in coastal areas. Several regions have coastal concentrations even higher than those of the Iberian Peninsula. In Argentina, the demographic density is much less (14 inhabitants/km^2), and concentrated in the northern region. Coastal areas are very densely populated along the Río de la Plata coastline and, during summer, the coast of Buenos Aires Province becomes very crowded.

Within these regions, several anthropogenic processes are related to well-defined activities:

a) "Chemical anthropization". Water and sediments are subject to pollution, because of human activities. Although heavy metals have been investigated repeatedly to characterize such

pollution, over recent years phosphorous and/or chlorine pesticides have been causing worse problems. Barcelona was the first city to promote the Industrial Revolution, within the area considered in this study; today, its continental shelf sediments have very high levels of copper, chromium, cadmium, lead, nickel, iron and manganese (Palanques and Díaz, 1990). There are other examples, with critical levels in the Suances estuary (Irabien et al., 2008), Guanabara and Santos bays (Martins et al., 2011; Farias et al., 2007), or the Rio de la Plata (Esteves et al., 2000; FREPLATA, 2004).

b) "Salt-anthropization". Historically, it was common to build structures for the production of salt (salt ponds) in lagoons and estuaries; these structures strongly affected the physiography of those coastal zones. Some examples have been described for Portugal, such as the Aveiro coastal lagoon (Bastos, 2009; Morgado et al., 2009) or the Ría Formosa (Gamito and Erzini, 2005; Gamito, 2008). In Brazil, the Araruama lagoon complex was subject to these practices (Kjerfve et al., 1996), as it occurred also within the Elx coastal lagoon, Spain (Blázquez and Usera, 2004). During colonial times in Argentina (1555–1810), several saline tidal flats were exploited in Patagonia.

c) "Bio-anthropization". It is the name given for those coastal areas where the authocthonous specimens became replaced artificially, by others. In Cascais, Portugal, the original vegetation of sand dunes (*Elymus farctus* and *Ammophila arenaria*) has been replaced by the African *Carpobrotus edulis.* The sand barrier of Rio Grande do Sul was subjected also to these plant introductions (Vieira et al., 2008). Although some European plant species were introduced to selected coastal barriers, in order to forest them (Turno Orellano and Isla, 2004), endemic and threatened species act as justification for the conservation of some barrier communities (Monserrat et al., 2012). Coastal ecosystems of northern Spain are threatened and affected also by the invasion of alien plants, especially shore dunes, salt marshes and cliffs. Campos et al. (2004) have analysed the expansion of these species and have pointed out the negative development of monospecific *Baccharis halimifolia* communities; this has prevented the growth of the heliophilous species typical of salt marshes, provoking a marked change in the structure, physiognomy and diversity of the community invaded.

d) "Touristic-anthropization" is perhaps the most efficient mechanism to impact upon a coastal area. The infrastructural facilities to implement the "sun and beach" industry can increase the deterioration, transforming natural spaces in urbanized spaces (e.g. disappearance of dune fields under touristic urbanizations, rivers and streams channelized through buried concrete tubes, etc). Benidorm in Spain increased from 5000 inhabitants in 1950, to 70,000 in 2008, with a population density of 2000 inhabitants/km^2 and offering additionally more than 38,000 beds (Giussani et al., 2010). Such a situation has been made possible by a very strong urban verticalization and periodical beach nourishments. In the Santa Catarina State, Brazil, Balneário Camboriú is concentrating 100,000 stable inhabitants onto a narrow sand barrier; however, the population exceeds one million during summer (Moraes and Tricario, 2006). Brazil has other examples of such a high population density, in Recife (Costa et al., 2008) and Fortaleza (Paula et al., 2013). Similar examples occur also in Mar del Tuyú, San Bernardo, Pinamar, Villa Gesell and Mar del Plata, Argentina, where the population increase dramatically during January or February (López and Marcomini, 2013; Isla, 2013).

e) "Sediment-anthropization" means the alteration of coastal balances due to human activities, implying either strong littoral drift reduction or increase, or beach nourishment. However, same impacts have occurred where reservoirs have prevented sediment from nourishing deltas, or where large jetties block the littoral drift. The dams built within the Ebro watershed have caused significant changes to its delta. The same effects on the littoral drift occurred due to the dams constructed on the Guadiana and Douro rivers (Dias, 1990; Dias et al., 2004), at the inlet of the Lagoa dos Patos (Toldo et al., 2006) and the coastal defences practiced at Mar del Plata (Isla et al., 2001). Dredging and dumping activities at the Oka estuary, Spain, during 40 years, have been reported to cause severe alterations to the sedimentary processes in this coastal area (Monge-Ganuzas et al., 2013).

f) "Anthropo-environments" are environments dependant completely upon their preservation by man's efforts. As a paradigmatic example, the Aveiro Lagoon exists only due to the artificial inlet opened in 1808 (and since then systematically improved), and to extensive dredging of the lagoon channels; consequently, it was termed an "anthropo-lagoon" (Dias et al., 2012a). Another example is the lagoonal area of Ilha Comprida (Sao Paulo, Brazil), where interventions in the Ribeira River induced siltation processes which made "non-operative" the historic harbour of Iguape (Mahiques et al., 2009). In Argentina, the Escobar (artificial) Lagoon on the ancient estuarine plain of the Rio de la Plata altered the original landscape and the associated ecological balance of the wetlands ecosystems (López et al., 2013). Also, the tidal inlet of the Mar Chiquita coastal lagoon closed several times. Since 1971, this inlet became more stable, as a groyne field diminished the littoral transport (Isla, 1997). The original Bilbao estuary (Spain) was reduced rapidly in size, through land reclamation to form a tidal channel, completed by 1885. This was isolated, by dyking, from its original intertidal areas, to permit a navigable watercourse from the city to the open sea. Nowadays, the estuary is a largely artificial system, which bears little resemblance to the original estuary (Cearreta et al., 2000, 2002).

All of the areas mentioned here can be considered anthropogenic, to a different degree, at their present situations. However, coastal impacts in several areas of South America could be reversed easily, without serious consequences for the ecological function of the natural environments. At the Iberian Peninsula, on the other hand, the impacts are more severe and without the possibility of reversal, as there are almost no pristine coastal areas. Nevertheless, in many coastal areas of South America, the degree of these anthropogenic impacts is growing exponentially, due to intense human demands.

These situations should be focused, in relation to present trends in climate change or sea-level. Climate change would cause significant variations related to human demand and tourism. Some predictions focused upon recreation (Coombes et al., 2009), together with other analyses, forecast an increasing demand for coastal protection schemes (Ferreira et al., 2008; Leorri et al., 2013). However, the interactions between social and physical needs are very difficult to envisage.

4.2. Assessment of coastal zones

At both of the Iberian countries, together with Argentina and Brazil, opposing the legislation of other countries, the coast is considered as a public domain; recognised as such at least since the 19th Century. However, the expansion of the "sun and beach" tourism during the 20th Century has produced the rapid

occupation of coastal areas, leading to degradation of their environment. In some cases, this degradation could be reversed.

4.2.1. Portugal

In Portugal, the Public Maritime Domain was conceived in 1864 with the Decree of 31 December 1864; afterwards, this was modified repeatedly and adapted: Civil Code (1867); Decree 8, from 1892; Decree 952, from 1914; and Decree 5787-IIII, from 1919. This Public Maritime Domain should be understood, as a response to the increasing interests for the coast, as a guarantee for the Government for the control of the territory; the security against external threats; the guarantee for navigation; and public access to beaches and the management of natural resources. However, the width of this public coastal domain was established in 1926 as a minimum of 50 m, measured from the maximum high-tide level (Decree 12445, art. 14, 3 rd. paragraph).

During the middle of the 20th Century, due to the expansion of touristic pressure claiming improvements in the legislation, the paradigm of Public Maritime Domain was changed. Law 468 of 1971 established the legal regime of the Public Hydrological Domain, for the bottom and margins of the marine areas and any water body adequate for navigation where the limit of the coastal domain was settled as the maximum high-tide level during maximum spring tides. The width remained as 50 m. As the risks for the coastal occupation was envisaged already, this decree introduced the new concept of "adjacent zone", as the neighbouring areas that could be of private domain but subject to restrictions by public needs.

In the last decades of the 20th Century, due to the increase in the erosion rates, the claims for occupation of coastal areas, as well as the international awareness about climate change and projected sea-level rise, coastal legislation was modified once more by the Decree-laws 206/93 and 46/94; these proposed new instruments for assessment, as the management plans for the coastal zone. These plans proposed not only to legislate on the uses within the public maritime domain, but to incorporate also rules for the coastal area; then increased this domain as a land protection buffer zone of 500 m, together with an oceanic protection buffer zone towards the depth contour line of −30 m, expanding in this way the areas of government intervention.

Presently, there is a policy to establish a *non-edificandi* zone, with a minimum width of 50 m measured from the maximum spring high tides (Public Marine Domain/Public Hydrological Domain), complemented by other restricted ribbons (risk, safety, land protection, marine protection) that comprised a distance of 500 m landwards and extended to a depth of −30 m. Exceptions were established for the harbours or previously urbanised areas, where the restriction widths are smaller. Environmental reserves or protected areas comprise more than 40% of the coastal zone, with the objective to preserve: biodiversity; ecosystem services; geologic heritage; or valuable landscapes.

4.2.2. Spain

As a consequence of extensive coastal urbanization and massive "sun and beach" tourism, the natural and cultural heritage of the Spanish coast has suffered a strong decline, particularly during the period 1960–1990. Today, considering the 45 million inhabitants of Spain, 44% of this population lives in coastal cities and towns that represent only 7% of the total national surface. Population density on the coastal area is 4 times greater than the average for the whole country, showing an increment of 300% during summer (Ministerio de Medio Ambiente, 2007). Furthermore, 60 million tourists arrived to Spain in 2007, three quarters of which went directly to the coastal area.

Artificialization of the coast is a severe reality in Spain, particularly on the Mediterranean and insular shores (Balearic and Canary islands). In these coastal regions: 32% of the littoral shows critical levels of environmental deterioration; 51% of the coastline needs some kind of environmental restoration; 70% of the sand dunes have disappeared, or are in very poor conditions; 40% of the coast is urbanized; 16% is already artificial coast; and, finally, 57% of the beaches are located within urban environments. The concentration of economic and residential activities within the coastal area has been favoured by the increasing importance of tourism that, in turn, has generated a displacement of population and its activities towards this narrow and fragile portion of national territory (Arenas, 2010).

During the 1960s, 1970s and first part of the 1980s Spain lacked a real coastal management policy. However, since the second part of the 1980s, the government decided to implement an adequate protection of the marine-terrestrial public domain, as the main instrument for a progressive coastal management through the Law of the Coast (1988). This law corrected a series of historical mistakes, favoured by the previous law (1969), defining adequately the public domain goods following: the criteria included in the Recommendation 29/1973, from the Council of Europe about the protection of coastal areas; and the Chart of Littoral (1981), from the European Economic Community (Barragán, 2004).

However, real estate development, increasing communication framework, maritime promenades, beach nourishments or artificial groynes, have been favoured simultaneously. During the 1990s, the acme of both the coastal urbanization wave and the reclassification of urban soil to favour speculation were reached. The spectacular increment of the Spanish GDP runs parallel to the enormous deterioration of coastal environments and cultural heritage.

Until the 1990s, the specific administration of the coastal area was assigned to the Ministry of Public Works. Coastal management was understood then only as related to engineering works, in order to control coastal erosion, beach nourishment, construction of maritime promenades and coastal infrastructures. In fact, civil servants and heads of department in the regional offices of the Coast Department have been traditionally engineers, then lawyers and architects; this shows, in this way, a bias towards hard structures. After the United Nations Conference on the Environment (Rio of Janeiro, 1992), the Spanish Ministry of Environment was created for the first time (in 1996); it assumed the General Direction of the Coasts. However, despite the approval of ambitious management legal instruments (for instance, the Wetlands Territorial Plan of 2004, or the Littoral Territorial Plan of 2007 in the Basque Country region), intensive urbanization of the coastal fringe was impossible to be stopped, until the arrival of the recent economic crisis.

4.2.3. Brazil

A good review on the development of the concept of legal coastal area in Brazil has been provided by Mesquita et al. (2011). According to these authors, the first regulation regarding the use of the coastal zone dates from 1710, when Brazil still belonged to the Portuguese. A main concept defines that the legal sea-land limit is the area along the beach that is swept by a line 33 m long from the mean high water of the year 1831, towards the land, the main challenge being the definition on where exactly was the reference of this level. Management of this area, named "Terrenos de Marinha", is under the responsibility of the Federal Government.

From the Brazilian Constitution of 1988, a series of laws, decrees and other regulations have been issued, to define the limits and competencies (federal, state and municipal). The present National Coastal Management Plan (PNGC) is regulated by Decree 5300, issued in 2004, whose purpose is a more precise definition of the "legal" coastal zone (Jablonski and Filet, 2008). According to the plan, one of main objectives of land uses in the coastal zone is to promote the conservation and protection of coastal and marine

resources, together with the management process developed in an integrated, decentralized and participatory manner.

4.2.4. Argentina

In Argentina, the ownership of the beach is public, with legal administration by each province. There is only one exception (Punta Mogotes, Mar del Plata), where the private use of the beach preceded the legislation; this reasoning was stated by the Supreme Court of Buenos Aires Province, in 1971. The improvements introduced to the Argentina Constitution in 1994 considered minimum budgets for the protection of the national territory, recognizing for the provinces the ownership of the natural resources (art. 124). On the other hand, an Environment Law (25675) establishes a minimum and uniform level for the protection of the environment, whilst the provinces can approve their own laws relating to the care of their environments. Unfortunately, Argentina does not have a specific Coastal Law. There are other laws concerning the assessment of industrial wastes (25612), water management (25688), polychlorinated biphenyls elimination (25670) and domestic residues (25916).

5. Final remarks

1. Contrary to the situation in the majority of other countries, in the regions subject to a strong Iberian influence (in the present paper, we analysed Portugal, Spain, Brazil and Argentina), the coastal zone is considered as a common resource (with few exceptions) that belongs to all citizens; it is defined as a *non-edificandi* zone. This concept has roots based upon policies and laws created since the 19th Century; therefore, before the touristic boom demanding "sun and beaches".
2. In this sense, the touristic boom that has occurred since the middle of the 20th Century found these countries with management instruments to orientate the coastal development, but they were not considered. The reasons to disregard those statements, which may have contributed to organize the new urbanizations were:
   a) the rapid demand for seaside spaces and the lack of experience in some institutions, to manage these demands;
   b) the needs for foreign investments, to stimulate the local, federal or national economies;
   c) the national interest to improve the economy of the population, at the same time that these social improvements triggered a new demand for more beaches, leading to the democratization of the accesses to the coastal zone; and
   d) the limitations of the scientific knowledge on coastal dynamics, and about the impacts on the natural systems.
3. Due to different natural characteristics, there are geographical differences in the touristic pressures (or anthropogenically-triggered processes). The first difference is latitude-dependent, and related to climatic conditions: a) the south of the Iberian Peninsula was more impacted upon than the northern part due to warmer waters and milder climate; b) northeastern Brazil, on the same line of reasoning, developed on warmer beaches than the southern portion or the Argentinian coast, where the tourist season is limited to the two summer months and is cooler. The second difference is longitude-dependent: in a similar way that the summer tourism increased from northern Europe to the Mediterranean countries during the 19th Century, this touristic (bathing) experience was imitated and extrapolated to the former colonies. The economic improvements which took place after World War II encouraged travel companies to incorporate low-cost flights and touristic packages.
4. The environmental consequences of these processes in Latin America occurred somewhat later. It could have been expected that these developing countries did not commit the same mistakes, but similar errors were repeated. The investors demanded rapid benefits, without care for the social development or the environmental protection, and disregarding scientific knowledge.
5. Some exceptions can be outlined, where preservation has been considered in the touristic formula. In southern Portugal, corrective decisions were adopted in a policy that follows the "building with Nature" principles. It happened, for instance, in the Ria Formosa lagoon with dune reconstruction, inlet opening and "environmental" dredging (Vila et al., 1999; Dias et al., 2003). Also in Brazil, participative management in the "Reservas Extrativistas" (extractive reserves) enabled environmental preservation and evident benefits to traditional populations (Murrieta and Rueda, 1995).
6. As occurs in other coastal areas of the world, there are strong concerns about the consequences of climate change and sea-level rise on these coasts, especially in areas of extensive urban development. In this sense, any improvement in knowledge needs to incorporate new strategies and legislation. Some objectives can be summarized within the context of coastal planning and scientific knowledge.
7. In order to plan the future of the coast, it is unavoidable to consider changes in behaviour and culture. As an example, dune preservation is very difficult to achieve, if future generations are not introduced to the benefits of such changes. Only legal improvements cannot assure benefits. Today, there are many laws concerning coastal property that are not accomplished.
8. Many areas of the littoral zone are artificial. The resilience of several coastal systems is overpassed at the Iberian Peninsula, or the northern coast of Brazil. Whilst along the Iberian Peninsula there are few and small fully-preserved areas, large preservation areas have been delimited in some Brazilian islands or the coastal areas of Patagonia.
9. Governments, non-governmental organizations and population are progressively more devoted to reduce the impacts of climatic changes, within certain areas. Some principles concerning social interests, people's opinion and the challenges of unpredictable impacts are more frequently managed, when decision-makers are compelled to take a chance.

In the considered regions, governments, non-governmental organizations (NOGs) and general population are progressively more sensitized to environmental issues, impacts of human activities, and consequences of climatic change and sea-level rise. They are more and more concerned with the inter-generational sustainability of coastal areas. It is the beginning of a practice designed to enable a fairer, with greater solidarity and more sustainable future, based on principles such as social cohesion and equity, public participation and full practice of citizenship. In this context, it is essential to get higher social co-responsibility (government structures, populations, economic framework, citizen associations), more operational management options, as well as greater recognition of the importance of scientific knowledge as the base for any intervention in the coastal zone.

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