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D.1.1. Investigate national issues and environmental threats in coastal territories in Latin America and ACP countries

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Abstract	The environmental and resource management context in Caribbean region is analyzed and specifically in Colombia, Costa Rica and West Indies in order to identify the Status Quo for environmental threats and resource depletion in the coastal environment of PCs. This report focuses on biodiversity and both "natural" and anthropogenic pressures deriving from climate change, tourism management, environmental depletion and resource management. The report also analyses tourism in the Caribbean area, its representations and evolution and contemporary challenges.

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LIST OF ABBREVIATIONS

AMP : protected marine areas

CARICOM : Caribbean Community

CGSM : Ciénaga Grande de Santa Marta

CTO : Caribbean Tourism Organization

ECLAC: United Nations Economic Commission for Latin America and the Caribbean / CEPAL: Comisión Económica para América Latina y el Caribe

ENL: National Liberation Army (Ejército de Liberación Nacional)

FAO : Food and Agricultural Organisation

FARC : Revolutionary Armed Forces of Colombia—People's Army (Fuerzas Armadas Revolucionarias de Colombia—Ejército del Pueblo)

GDP : Gross Domestic Product

IDEAM: Institute of Hydrology, Meteorology and Environmental Studies (Instituto de Hidrología, Meteorología y Estudios Ambientales)

IUCN: International Union for Conservation of Nature

MEF: Ministère de l'Economie et des Finances d'Haïti

OECS : *Organisation of Eastern Caribbean States*

SIDs: Small Island Developing States

UNEP : United Nations Environment Programme

1. Diversity and unity of the Great Caribbean region

1.1. Great Caribbean region: geographic and identity fragmentation

The wider Caribbean region is centered around the Caribbean sea (Figure 1). It is a semi-enclosed sea, bounded by Florida and the Bahamas to the North, to the West by Central America, to the South by South America, and on the East by the arc of the West Indies. With its 2.7millions km², the Caribbean Sea is the second largest sea in the world (Augier 2010; Smilke and al. (2010). The Caribbean Basin includes 40 States, including 18 trust territories, dependent on one of the four former colonial powers (France, Netherlands, United Kingdom, United States of America). With an area of less than 0.3% of the world's surface, the Caribbean region welcomes in 2009, 3% of the world's population (Hartog 2011).

Figure 1: Map of the greater Caribbean region. Source: Database mapping, *Global Administrative Areas*, in Daniel 2015.

The Caribbean islands are characterized by: their maritime dimension, associated with a complex arc setting of islands, some coastal mountains ranges or volcanic islands, its great diversity (ethnic, cultural, geopolitical, economical, biological) (Rodriguez 2013); and finally, by its tropical nature.

Hartog (2011) organizes this variety of economic and socio-political developments in four distinct classes:

(1) the territories with a very stable political situation, socio-economic indicators of high value, and the economy directed towards exportation and/or tourism (Costa Rica, Barbados, the Bahamas, Lesser Antilles);

(2) countries with medium economic and human development (Mexico; Andean countries: Venezuela, Colombia, Trinidad and Tobago, Dominican Republic, Saint-Vincent-and-the-Grenadines, Saint Lucia);

(3) Central American countries (excluding Costa Rica and Panama) with weak economic indicators;

(4) Haiti, an isolated case because of its socio-economic development closer to that of a sub-Saharan African country than to a Caribbean country.

1.2. The Caribbean Community (CARICOM)

The Caribbean Community (CARICOM) is a regional organisation comprising of fifteen Member States and five Associate Members, whose main objective is to promote integration, collaboration and resilience among its members, while ensuring that the social, economic and cultural benefits of integration are equitably shared (Caribbean Community n.d). CARICOM's fifteen Member States consist of Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Montserrat, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, Trinidad and Tobago, and the five Associate Members include Anguilla, Bermuda, British Virgin Islands, Cayman Islands, and Turks and Caicos Islands (Caribbean Community n.d).

Having small populations, limited resources, high susceptibility to natural disasters, increased vulnerability to external shocks and excessive dependence on international trade, qualify CARICOM member states to be considered Small Island Developing States (SIDs) (FAO 2002). Due to small size, opportunities for land-based development are limited, making Caribbean SIDs extremely dependent on fragile coastal and marine resources to drive economic activity. With one half of all tourists visiting the coastal area, tourism has become one of the most important economic activities in the Caribbean region, contributing around 33% of Gross Domestic Product (GDP) (up to 77 % in some countries of the Caribbean Tourism Organization (CTO) (Cox et al. 2018). Tourism and the environment are intricately

and inseparably linked, having both beneficial and adverse impacts on environmental quality and the experience of tourists.

Caribbean tourism is primarily marketed based on the “three S’s” of Sea, Sand and Sun, which provides the region with an important competitive advantage as a tourist destination (Banerjee et al. 2018). Coastal assets including spacious sandy beaches, clean coastal waters, exotic coral reefs and mangroves offer ideal settings for tourists to relax and enjoy and are largely responsible for the rate of return visitation to the Caribbean (Schuhmann 2011). However, as urbanization and tourism development in coastal zones continue to increase, issues arise such as habitat destruction and loss of biodiversity, improper waste disposal and increased incidences of vector-borne diseases. These, along with the impacts of climate change present major threats to the tourism product and Caribbean economies. Greater awareness and understanding of the nature of such threats and the impacts on coastal resources, is essential for improving the quality and sustainability of the coastal environment, as part of the tourism product.

1.3. Characteristics of the Central American region.

Central America is composed of 7 countries (Panama, Costa Rica, Nicaragua, El Salvador, Honduras, Guatemala, Belize), and reaches a population of over 42 million inhabitants in a region of 525,000 km2 (Ellison, S.F.). With the exception of Belize, in all these countries, Spanish is spoken, as well as some of their own languages.

It is a cultural melting pot where Afro-Caribbean, aboriginal, mestizo, zambos, and, to a lesser extent, European and Asian populations coexist. The indigenous traditions, added to the arrival of other people who have made big contributions to the arts, the food, the dress, and the traditions in general.

Despite its limited surface area (covering 2% of the planet's surface), Central America is considered a biodiversity hotspot worldwide, since for some, it harbors 12% of the planet's biological diversity. (IUCN, 2011, cited in the State of the Nation report, 2015).

The diversity of ecosystems present in this region (22 types of ecosystems according to Obando and Herrera, 2010, cited in the State of the Nation report, 2015) includes, among others, the tropical rain forest, the very humid tropical forest, the dry tropical forest, the tropical cloud forest, and the wetlands. Reffering these last ecosystems Ellison, S.F. groups them into five systems namely marine, estuarine, riverine, lacustrine and palustrine.

Its landscape (mountainous on the western side and flat in the eastern part), the strategic location in terms of the equator, its inhabitants, food, and various cultural expressions have been used for a few decades to become a well-known tourist destination.

Since the mid-nineties, the region does not register problems associated with civil war issues, which in previous decades this area was stigmatized as a destination of danger.

Currently, the exchange and communication between countries is still active, which allows easy mobilization within any of these countries and between them, which has also influenced the arrival of visitors and extend their stay.

1.3.1 Costa Rica environmental characteristics

Costa Rica is located in Central America, between the Pacific Ocean and the Caribbean Sea (Figure 2). Costa Rica became independent from Spain in 1821. It has a continental area of 51,100 km2 and 589,682.99 km2 of territorial sea. The country is located 8 and 12 degrees north of the Equator, therefore has a humid tropical climate with abundant rainfall on the Caribbean coast and the lowlands. It has two seasons: a dry season and a rainy season.

Figure 2: geographical location of Costa Rica

The topography of Costa Rica consists of a flat coast separated by steep mountains, which generates a dynamic climate that results in a variety of microclimates and diversity of ecosystems. The “Cordillera de Tilarán”, “Cordillera Volcánica Central”

and the “Cordillera de Talamanca” are the main mountain ranges of the country, which function like the column spinal cord of the country, separating the country has 34 mangroves and 112 volcanoes, of which 6 are active (Figure 3).

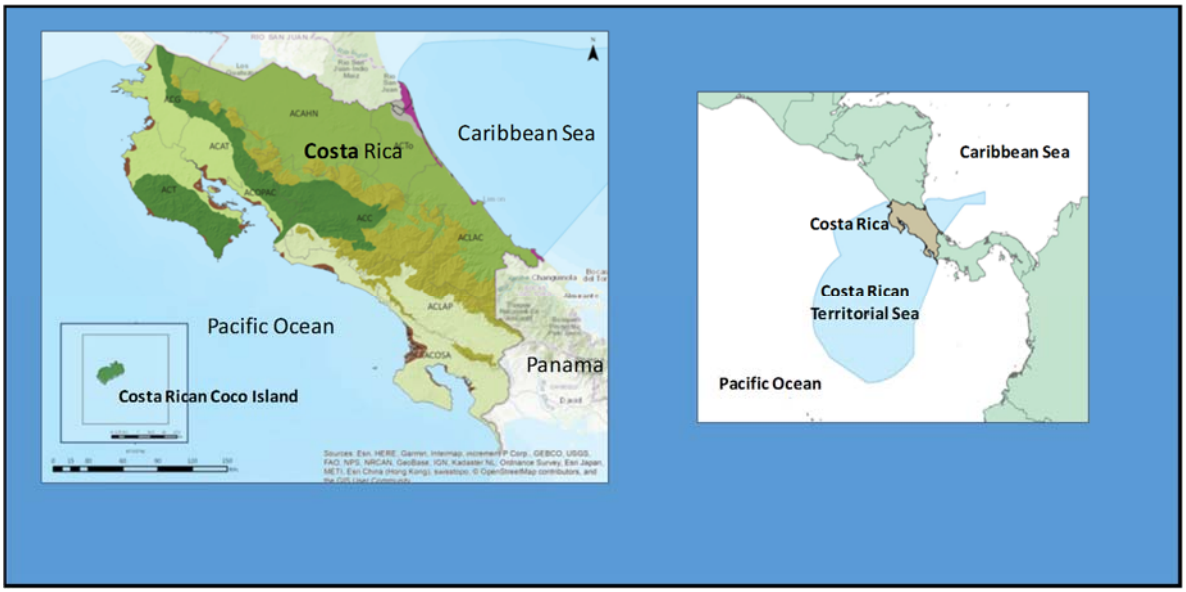

Figure 3 : Costa Rican Territory

Thus, the geology and geography of the country combine to create the best conditions to house an important ground and surface water capital. Volcanic ash and a dynamic climate have resulted in a fertile soil suitable for agriculture production and in turn has created several types of habitats for flora and wildlife in the Pacific and the Caribbean basins. As for the marine-coastal characteristics, the limits of the Territorial Sea and the Exclusive Economic Zone of Costa Rica, amount 589.683 km2 (Figure 3). The country has 1,660 km of coastline in the Pacific and 212 km on the Caribbean coast, with 69 estuaries, most of them of them on the Pacific coast.

Costa Rica also has a number of islands, both coastal and oceanic, which together total 343.90 km2. A particular case to highlight is the Cocos Island. This island with 24 km2, locates about 500 km from the continental littoral in the Pacific Ocean (Figure 3). The island became a National Park in 1978 and was declared a Natural World Heritage Site by UNESCO in 1997, being incorporated as a Wetland of Significance International (RAMSAR) in 1998.

Costa Rica hosts a diversity of animals and characteristic plant species of the inter tropical zone, with life zones that vary from natural landscapes from sea level to paramo landscapes of more than 3,000 m. All these environmental factors create conditions that allow the country to host more than 94,753 known species,

representing 5% of the known biodiversity of the world. Given the importance of this natural heritage, 26% of the country's territory is located under a special protection regime, consisting of about half of that percentage in 28 National Parks. The remaining 13% includes biological reserves, forest reserves and wildlife refuges. In total, 52% of Costa Rican territory has forest cover. Additionally, Costa Rica has 14,291 km2 of Marine Protected Areas, which represents 2.42% of the territorial sea.

The need to understand and interact with high biodiversity in Costa Rica, needs to take into account the broad multiculturalism that owns the country; data and studies indicate that the average Costa Rican is 45.6% European, 31.5% mestizo, 2% indigenous (8 indigenous ethnic groups in 24 territories), 11.7% African and 9.2% Chinese.

Since 2000, the country has the highest immigration rate in Latin America: 7.8% (mainly immigration from neighboring countries Nicaragua and Panama). The Nicaraguans represented three fourths of that percentage. Better economic conditions for jobs that do not require specialization (agriculture and construction), is the main engine that moves large number of Nicaraguans to migrate to Costa Rica for the time of agricultural harvests, although most of the Nicaraguan women are located in the Service area. Different Latin American conflicts have also driven waves of migrants from Haiti, Chile, El Salvador, Guatemala, Colombia, Venezuela, among others. Recently, registers show more migrants form the Caribbean islands, China, Chile, Peru and the United States. The vast majority of USA, Canadian and European migrants have more 50 years old; while the immigrants from the region generally have an age between 20 and 39 years. Together, migrants represent a population of approximately 400,000 inhabitants (8%) of the total of 5 million inhabitants in Costa Rica. All social, economic and environmental improvements and pressures related to migrations, tourism flows and the environment state (as summarized in the following valuation chart) became intensive in the last two decades, forcing the country to make balanced adjustments on public politics.

Table 1. Valuation of some environmental indicators for their national performance, 2017, Costa Rica*

Improved	Steady	Deteriorated
•Generation of electricity from clean sources	•Negative gap between the ecological footprint and the biocapacity of the territory	•Vulnerability of water resources
•Drinking water coverage	•Dependence on hydrocarbons imports	•Extension of planted certified organic products
•Sanitary sewer coverage with wastewater treatment	•Polluting emissions	•Number of threatened or endangered species
•Extension of marginal protected areas	•Absence of urban planning	•Sustainability of marine-coastal resources
•Growth on the environmental situation and ecosystems.	•Socio-environmental conflict	•Impact of disasters
•Public policy tools for environmental management	•Weak management of environmental institutions	•Public management of the fishing sector

* Performance is valued by comparing the value registered by the indicator in 2017, with the trend observed in the period 2000-2016
Source: Estado de la Nación Costa Rica, 2018

1.3.2. Ecological biodiversity in Costa Rica (MINAE – SINAC – CONAGEBIO – FONAFIFO, 2018)

Costa Rica has 8 ecoregions, which house a wide variety of ecosystems and a considerable richness in biodiversity distributed in eleven large conservation areas with different biophysical and land use characteristics (Figure 4).

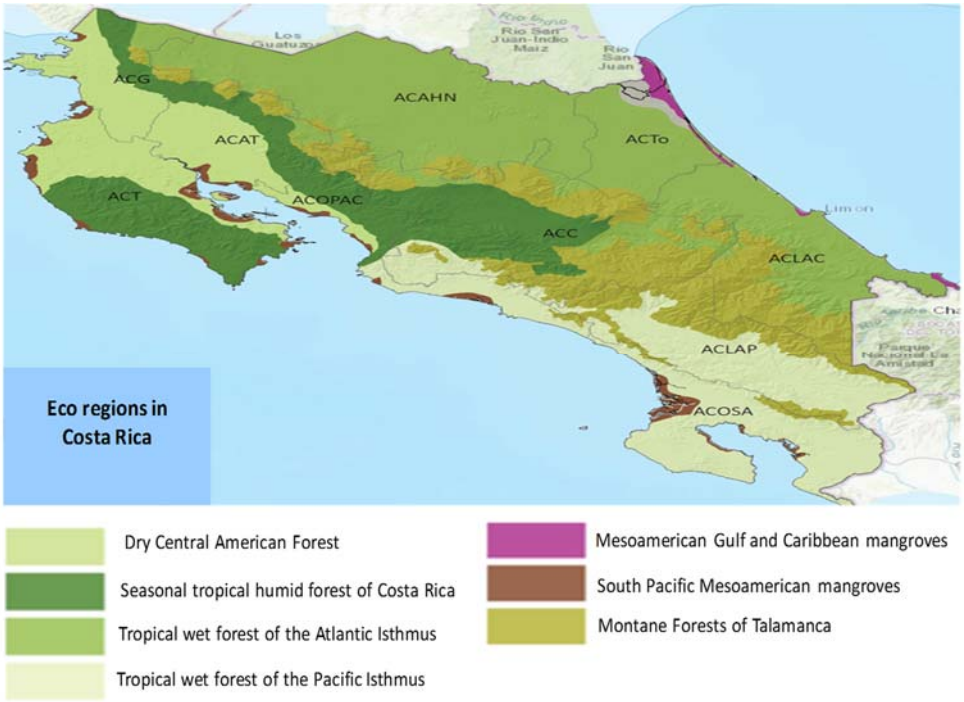

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Figure 4 : ecoregions, ecosystems and territorial sea of Costa Rica

Terrestrial ecosystems in the country include dry forests, tropical rain forests, moors, mangroves, and other wetlands. These ecosystems cover more than half of the Costa Rican territory, although the landscapes are fragmented and there are few blocks of high integrity today. The best-preserved ecosystems are generally found in areas with steep slopes close to flood plains that usually correspond to the protected wilderness areas (ASP). Since 2010, forest cover has remained over 50%, however, with variations depending on the type of ecosystem.

Dry forests show high alteration and recovery over the past decade, while forests in moist soils and cloud forests have low to moderate deterioration levels. Since the decade of 1990, the coverage of moors and mangrove forests has declined. Many wetlands also reflect a high degree of deterioration due to residual pesticides.

Costa Rica has 589 000 km2 of territorial sea. Its coastline length is 212 km in the Caribbean and 1 254 km in the Pacific. Along these shores, are located rich coastal marine ecosystems, including: coral reefs, mangroves, muddy funds, sandy and rocky beaches, seagrass meadows, a tropical fjord in Golfo Dulce, upwelling areas like the Gulf of Papagayo, estuaries, an oceanic island (Cocos Island), coastal islands, an oceanic fossa of more than 4 000 m deep, hydrothermal vents and a thermal dome.

Costa Rica is currently in the process of updating its national wetland inventory (not been finalized to date), but it is estimated that wetlands are covering an area of 284 635 ha. Twelve wetlands have been declared of international importance and subject to the Ramsar Convention, while technical studies have been carried out so that the State requests the incorporation as RAMSAR. At the same time, technical studies have been carried out for the State to request the incorporation as Ramsar sites of another 35 000 hectares of wetland ecosystems, in various sectors of the country (Rivera Wong, 2018). Costa Rica is among the 20 countries with the greatest diversity of species worldwide, it is the habitat of more than half a million species (about 6% of the world's biodiversity). According to the last available data, a total of 121 693 species have been recorded in the main taxonomic groups, while between 2016 and 2017 four new species were described for Costa Rica (2 species of salamanders, a species of frog and a Species of Serpent) and 10 new species of Butterflies (Lepidoptera).

Costa Rica has 4 areas of high endemism: Cocos Island, Sweet Gulf, Central Pacific and the high areas of the Cordilleras Central and Talamanca. In general, 1.5% Costa

Rica species are endemic, considering mammals, birds, reptiles, fish, amphibians and plants.

The key areas for biodiversity (KBA) are sites that contribute significantly to the persistence of biodiversity, which have been identified and agreed on a global scale. The persistence of an element of biodiversity means that it avoids its loss (e.g. species extinction, or ecosystem collapse) or decline (e.g. number of mature individuals) both in the present and in the predictable future. For Costa Rica, 23 KBA have been identified and 74% of the total area of KBA is retained in the protected Areas System (SAP).

At the beginning of 2017, with the creation of the marine area of management Cabo Blanco, the protected area increased by 82818 hectares. Costa Rica has 2.7 million hectares, protected. Of these, 47% correspond to terrestrial systems and 53% to coastal and marine habitats (Figure 3). Also, between 2015 and 2016 increased by 1% the areas attached to the private reserves network, and although they are not recognized as such by the state, these add 2.9% to the total protected areas of the country.

Costa Rica has proposed to increase the 2020 in 0.15% the ecological connectivity in the country, by creating terrestrial biological corridors (BC), considering the climatic scenarios, currently there are 45 BC established. From the management efforts in BC it is evident that 83% of the surface of BC established, present a percentage of natural coverage greater than 50% of its surface and a biodiversity index 59% greater than the average, while 67% of the area in CB presents a low resistance to the mobility of fauna.

Natural ecosystems and agroecosystems provide essential ecosystem services for Costa Rican society, such as the regulation of the hydrologic cycle, soil fertility and health and micro-climatic regulation, and the provision of materials premiums, foods and other. It is estimated that only the value of the ecosystem services of seven wetlands of international importance amounts to 48 814 US $/ha/year, with the regulatory services provided by marine-coastal ecosystems and wetlands, and provision services of agro-Eco agroecosystems which contribute largely to this value.

As one of the inputs for the updating of the National biodiversity Strategy 2016-2025, a territorial analysis was carried out on the services offered by ecosystems in the present, the past and the future, as a manifestation of the biodiversity of the country. The ecosystem service of greater representation for the three periods was the food supply, which corresponds to products derived from the biodiversity of food interest (crops, livestock, catch fishery, aquaculture and food Wild). Also for the three

periods, climate regulation was the second ecosystem service in importance. Water regulation and the obtaining of fiber (wood, cellulose, firewood) were identified as third and fourth in order of importance. In the continental water system, nine ecosystem services were determined on average. In order of importance by the number of identified sites are located fresh water, energy and recreational activities and ecotourism. On the other hand, in the coastal-marine system, nine ecosystem services were identified on average for three periods. The main ecosystem service identified was fishing, followed by recreational activities and ecotourism.

1.4. Specificity of Colombian Caribbean region

1.4.1. Diversity

Colombia is a megadiverse country (2nd in the world after Brazil), worldwide known for its natural resources, rainforests, beaches and wildlife. The Colombian Caribbean Region boasts a wide natural range that can be grouped into three major sets of ecosystems:

- aquatic marine, which is very similar to the island territories of the Caribbean arc
- aquatic inland: the Ciénaga Grande de Santa Marta and the Rio Magdalena that mix lagoons and river ecosystems.
- terrestrial inland: the Sierra Nevada de Santa Marta and the Serranía de San Lucas.

This sub-region covers a fundamental importance for the whole country, being a protected area and recognized by the Unesco as natural heritage, tourist destination of continuous growth, while experiencing at the same time severe biodiversity reduction and historical problems of security from the presence of illegal armed groups. The Serranía de San Lucas, as final part of Andine Central Cordillera is also a strategic ecosystem.

The region is considered as a national priority strategic ecoregion with 5 units of conservation of national importance: Sierra Nevada de Santa Marta National Park, Tayrona National Park, the sanctuary of flora and fauna Ciénaga Grande of Santa Marta, the sanctuary of Fauna and Flora the Flamingos and the Via Parque Isla de Salamanca.

The Sierra Nevada coastal mountain range, due to its height especially (reaching up to 5700m), act as natural orographic barriers. Their geographical position, at the interface between marine influence and continental influence, fragment the great

Colombian macroclimates when penetrating into the mountains. This process leads to the formation of unique microclimates within each subregion of the Sierra, according to the height above sea-level of each subregion (thermic stair process).

Due to its recent anthropogenic pressures and impacts, the Ciénaga Grande de Santa Marta (CGSM) has been nominated for protection under the Ramsar wetland convention in 1998, and, with the Sierra Nevada de Santa Marta, are both under the World Biosphere Reserves list in 2000. On the southwestern part of the studied region, in the named “Cono Sur bolivariense”, the wet plain of La Mojana and the Momposina Depression have many common characteristics (and, mainly, common problems) with La Ciénaga. In the entire region, these are reinforce by many reserves (especially forests) and indigenous reserves.

1.4.2. Fragility

Indeed, in Colombia, like on all other countries of Caribbean region, natural richness contrasts with the state of its ecosystems, as problems related to atmospheric and water contamination have increased over the past few decades (MinAmbiente, 2012). In the 1990’s, the poor state of the environment has caused health issues to 25-33% of the population, concerning especially children under 5 year-old (WHO, 2012). Hence, the main health cost in the country, exceeded only by the cost of traffic accidents, is due to illness related to poor water quality, natural disasters, atmospheric contamination and land degradation due to agricultural use (Larsen, 2004). In 2009, these health problems related to the state of the environment accounted for 2% of the gross domestic product of Colombia (Golub et al., 2014). In the coastal areas, the health and benefits of its ecosystems have been measured and as a result, most aspects (Economy, biodiversity, water quality, coastal management, nutrition and tourism) are below worldwide average scores (Halpern et al., 2012).

1.4.3. Convergences

Within this framework, the Regional system of Protected Areas of the Caribbean (siRap-Caribbean) identifies more than 20 types of ecosystems contributing to the great biological diversity of the region.

Faced with this situation, defining a Caribbean regional cooperation on sustainable development becomes crucial (Daniel 2015; LaHaye 2011). However, the implementation of such a regional cooperation is proved locally difficult because of the economic, geographical and political disparities, as well as the differences of

orientation of the actors leading to conflicts of objectives (Teelucksingh and al. 2010); Vernier 2010). This territorial and geopolitical fragmentation is explained by Saffache and Pelis (2006) by the concept of "barrier island". The Caribbean, made up of far less islands than Japan, is yet defined by a plural identity. According to the authors, this is the reason why "the Caribbean" can also be referred to as "the Caribbeans" .Due to the division by the colonial empires, the authors consider the European supervision as a source of impediment to the willingness to cooperate through regional integration, therefore putting a freeze on the establishment of a large unified Caribbean region. Thus, the disparate situations of the territories constitute a set of barriers, in opposition to the Japanese concept of "absolute island", i.e. a strong nation with a common identity.

2. A remarkable natural richness at risk

Of exceptional biological richness and a high rate of endemism (MEF 2015; Roger and al. 2013; La Haye 2010; Smilke and al. 2010), the Caribbean region is one of the 34 global hotspots of biodiversity (Magnin 2018). With nearly 20 000 km² of coral, 22 000 km² of mangroves, about 33 000 km² of seagrasses, all more or less deteriorated or endangered (Augier and Watson 2010), the conservation of biodiversity is a major regional issue. Small island States are particularly vulnerable to large losses of biodiversity and environmental depletion. Their sensitivity to exogenous impacts (Teelucksignh et al. 2010) is explained by their strong dependence on marine resources (a poorly diversified economy: mainly fishing and tourism) and to exposure to natural hazards aggravated by climate changes (Daniel 2015).

2.1. An asymmetrical situation in front of climate change

The current climate changes will intensify over time, generating multi-scale consequences, economically, socially and environmentally impacting. For example, Colombia provides the 0.35% of global greenhouse emissions, so their decisions regarding the control of greenhouse gases not much impact overall balance. However, it has been rated as the third country most vulnerable to the impacts of climate change: temperature increase, sea-level rise, coastal erosion, loss of ecosystems and extreme meteorological events. Its Caribbean region is threatened by a high vulnerability to phenomenons such as droughts, floods, and tropical storms (hurricanes). According to future scenarios projected by the IDEAM, the Colombian

Caribbean region will have drastic temperature increases due to a strong decrease in precipitation.

The same observations can be made for the entire Caribbean region. Indeed, according to the Economic Commission for Latin America and the Caribbean (ECLAC 2018), the Greater Caribbean region is responsible for less than 10% of global CO2 emissions, but it is also highly affected by the impact of the change climate. Thus, climate change results mainly of negative worldwide externalities to be associated with the current model of economic development. The main manifestations of climate change affecting coastal communities are of two types:

2.1.1. Climate change in Central America

Climate change has drastic effects for this region, generating effects on human populations, ecosystems, water availability, alteration of rainfall patterns, among others. In a study on climate change projections carried out in the Belize river basin (limit between Guatemala and Belize), it was determined that by 2020, there will be a temperature increase at the basin level of 1.4 ° on average and 2.9 ° by 2050.

The Regional Climate Change Strategy of Central America (SICA, 2010) details the main impacts of climate change for this area:

- Increased vulnerability and extreme events
- Food insecurity, deforestation and loss of ecosystems
- Water availability
- Damages to human health
- Loss of marine-coastal resources
- Reduction of tourist offer
- Affectation of the life and culture of the indigenous peoples and Afro-descendant communities.
- Severe damage to the infrastructure.
- High-cost polluting energy sources.

The Central America region has a high rate of water availability, however, it is not evenly distributed, so climate change will exacerbate flood problems in some regions and extreme droughts in others (State of the Nation, 2015)

A sector that is strongly affected by climate change is agriculture, which also contributes 9% of the total regional GDP. It is expected that the production of some crops of great relevance in the area, such as beans, corn and rice will decrease

between 9% and 32%. (State of the Nation, 2015) In the same area of agriculture, production costs will increase and this will also affect the tourism sector, given the dependence they have on food products.

The most vulnerable sectors are those that depend on water: drinking water, hydroelectric energy, agriculture (food security), health and biodiversity (terrestrial and marine-coastal). (SICA,2010)

But not only those sectors will be affected because even the same protected areas face alarming vulnerability rates, for example, all the protected areas of the Central American Caribbean show that "64% present medium to high vulnerability (33.5% each level). and only 33% have low vulnerability (BIOMARC-USAID, 2013). "

Regarding the change scenarios for each country of the UN region, 2011 considers that there will be losses of forest cover in Belize (15%), in Costa Rica (30%), El Salvador (60%), Guatemala (15%), Honduras (45%), Nicaragua (40%), Panama (30%).

Adaptation to climate change in the region will have many difficulties, since it implies reducing vulnerabilities, such as poverty reduction, inequality and socio-economic and environmental vulnerability, while at the same time, it is neccessary to increase the resilience and adaptive capacity of societies and populations (UN, 2011).

From the health point of view, rural populations have been more vulnerable to vector-borne diseases such as dengue or malaria, both of which have a high impact in the Central American Caribbean areas. (SICA,2010)

The effects of climate change also extend to the economy, which is expected to be affected at 2100 with up to 25% of GDP.

Tourism will be affected directly and indirectly, for example, with the issue of variation in temperatures, which, although it can not be asserted that at this time, it has managed to affect tourism so far, but could be an adverse element in the future (UN, 2011). On the other hand, indirectly, the effects they have, for example, on the part of agricultural production could be carried out through the availability of some products or increases in their prices.

In line with the effects on the subject of tourism, they will be reflected in sea level rise that would affect many of the touristic activities that take place in these spaces.

2.1.2. Increased temperatures and sea level rise

Climate change implies a rise in atmospheric temperatures. The moderate scenario of the IPCC (scenario A2) for the Greater Caribbean region predicts a variation of

temperatures of + 3.55° C by 2090 horizon. These projections of the IPCC come from regional climate modelling systems, translated into the PRECIS (*Providing Regional Climate For Impact Studies*) database. The impact of climate change in terms of temperature increase is asymmetrical and varies from country to country (Dupont 2013; (Table 2). Herewith, the islands of Turks and Caicos, St. Vincent and the Grenadines, St. Lucia, Cayman Islands and the Bahamas will be less impacted by the increase in temperatures (< + 3.2° C on the horizon 2090), while Belize, Cuba, and even more so Guyana and Haiti will be hit the hardest by rising temperatures, reaching for example a variation of + 5.04° C for Guyana.

Pays	2030		2050		2070		2090	
	A2	B2	A2	B2	A2	B2	A2	B2
Anguille	1,04	1,17	1,61	1,71	2,57	2,16	3,24	2,25
Antigue et Barbude	1,04	1,13	1,60	1,64	2,54	2,09	3,21	2,11
Les Bahamas	1,13	1,23	1,55	1,74	2,38	2,05	3,17	2,38
Barbade	1,11	1,15	1,76	1,78	2,87	2,25	3,67	2,28
Belise	1,30	1,36	1,99	2,02	3,21	2,60	4,17	2,82
Iles Vierges britanniques	1,03	1,15	1,60	1,68	2,55	2,14	3,23	2,23
Iles Caïman	0,97	1,03	1,55	1,58	2,44	1,97	3,15	2,28
Cuba	1,51	1,55	2,08	2,16	3,35	2,74	4,29	3,05
Dominique	1,03	1,10	1,60	1,60	2,55	2,05	3,20	2,03
République dominicaine	1,52	1,50	1,97	2,25	3,10	2,52	3,89	2,73
Grenade	1,11	1,15	1,76	1,72	2,78	2,21	3,48	2,08
Guyana	1,73	1,94	2,64	2,83	3,85	3,17	5,04	3,55
Haïti	1,44	1,51	2,13	2,21	3,55	2,86	4,56	3,42
Jamaïque	1,04	1,13	1,66	1,73	2,61	2,17	3,34	2,44
Martinique	**1,07**	**1,12**	**1,67**	**1,64**	**2,64**	**2,11**	**3,33**	**2,11**
Montserrat	1,03	1,12	1,60	1,62	2,54	2,07	3,20	2,06
Saint-Kitts et Nevis	1,04	1,14	1,60	1,66	2,54	2,12	3,21	2,16
Sainte-Lucie	1,04	1,08	1,61	1,58	2,55	2,04	3,19	2,04
Saint-Vincent et les Grenadines	1,03	1,07	1,61	1,58	2,54	2,05	3,18	2,04
Trinité et Tobago	1,50	1,59	2,22	2,32	2,90	2,34	3,63	2,17
Turks et Caïcos	0,96	1,15	1,52	1,61	2,36	2,07	3,12	2,21
Caraïbe	**1,18**	**1,26**	**1,78**	**1,84**	**2,78**	**2,28**	**3,55**	**2,40**

Table 2: Projections by 2030-2050 of the annual average temperature in the Caribbean according to the scenarios A2 and B2. Source: Dupont 2013, according to INSMET.

The rising temperatures cause the melting of ice and thermal expansion of the oceans leading to relative sea-level rise. During the period 1950-2009 an increase of temperature of + 1.4 ° C was recorded in the sea of the Caribbean (Romon 2018). Regarding the increase in the relative sea-level, it is not uniform across the globe. During the period 1950-2009 Guadeloupe, Saint-Martin and Saint-Barthélemy experienced an increase of + 1.7 mm/year, Martinique of + 1.9 mm/year and finally, Cartagena (Colombia) + 2 mm/year (Duvat 2015). The Caribbean population is particularly vulnerable to sea-level rise on account of the multiplication and the intensity of coastal issues. Indeed, many islands of the Caribbean arc are volcanic, forcing both populations and their activities towards the coast.

To measure the physical extent of the elevation of the sea-level, Saffache (2014) has developed a model of eustatic variations based on an optimistic projection of + 1.5 mm/year, or an increase of + 12 cm by 2050. Its results reveal an extreme vulnerability of the Caribbean. All the lower coasts of Cuba (65%) and the islands of the Lesser Antilles will be flooded, with a horizontal marine intrusion reaching up to the 800 m locally. Some islands such as Saint-Martin or Guadeloupe could lose up to 6 or 7% of their surface. These already alarming results yet minimize the reality since they do not take into account the cumulative impacts of a potential storm surge, nor the aggravation of coastal risks by the disturbance of coastal ecotones (mangroves, swamp forests, dune systems) and especially their hydrological mitigation function.

In the same time, Colombia´s coastal areas have a high potential for disasters occurrences due to climate change, among those are floods, draughts, strong winds, sea-level rise and landslides. Local communities, especially the poor ones, are the most affected due to their location and the low quality of their households. Thus, it has been estimated that by 2030, 2% of Colombia's coastal population will be victim of one or more aspects of climate change (Minambiante, 2018-a).

Floods and sea level rise will be particularly damaging in San Andrés Islands as most of its industry and national roads are located at sea level. Sea water could contaminate inland freshwater systems, which supplies 82% of potable water for the island. On the other hand, rain will increase by 15% by 2050 and 20% by 2080 in the Colombian Caribbean islands and most of its Pacific coast, which could alter the nutrient balance of the coastal waters (Minambiante, 2018-b; Minambiante, 2014).

In continental regions such as Atlantico, la Guajira and Magdalena, the existence of serious environmental imbalances with severe manifestations in the temperature and the wind regime, along with alternating extreme periods of rain and drought,

such as the registered during the El Niño phenomena have been already happening in the last decade (NECCC, 2011, Rodriguez, 2013), which allows scientists to predict the growth of La Guajira desert to almost double its present extension (PDA, 2016). Low levels of the Magdalena river by great part of his trip throughout Colombian Caribbean region, opposed to events such as the catastrophic flooding in the South of the region in the year 2010, highlights the magnitude of the problem, demonstrating the risks of the management of geological hazards and water shortages. By 2050, the loss of ¾ parts of the glacial ice coverage at the Sierra Nevada de Santa Marta, will dramatically affect several ecosystems from the páramo to the dry forests (Bueno et al., 2008). Forests are crucial for the caption of carbon and therefore, for the mitigation of climate change. But, rain and dry forests growth will be limited, their mortality rate will increase, as will forest fires (Instituto Humboldt, 2014).

In marine ecosystems, the rise in temperature, the hurricanes, and the sea swells have dramatically affected coral reefs coverage, affected by bleaching episodes. These factors, along with coastal erosion and the unbalance in fresh- and seawater, have an impact on estuarine ecosystems trough the decrease in mangrove both in the Caribbean and the Pacific coasts (Urrego et al., 2013; Riascos et al., 2018; Taillardat et al., 2018; Jaramillo et al., 2018; Castaño-Isaza et al., 2015).

2.1.3. Intensification and increased occurrence of marine weather events

A tropical cyclone is an atmospheric disturbance forming over the tropical oceans. They have social and environmental destructive consequences on the Caribbean arc, located in the path of most large-scale tropical hurricanes (MEF 2015). The phenomenon occurs in Caribbean during hurricane season, which matches the rainy season, from June to November (Roger et al. 2013). There are three categories of tropical weather events depending on the speed of the winds (Bohle 2014): a tropical depression for winds below 60 km/h, a tropical storm for winds between 60 and 118 km/h, and beyond it is a hurricane. Between 1990 and 1999, 18 extreme cyclonic episodes have been identified on the North Atlantic (Moullet and Saffache 2013), increasing in intensity and occurrence since 1995 (Dupont, 2013) due to global climate change.

Two conditions must be met in order to form a tropical storm (Bohle 2014):

(1) the presence of an atmospheric depression;

(2) water temperature above 26 ° C up to 50 m of depth.

However, in the context of climate change the critical threshold of 26 ° C will be reached at increasingly closer intervals. Thus, over the period 1975-2004, the number of hurricanes of category 4 and 5 has increased by 56% (Dupont 2013) and the IPCC predicts a persistence of the trend to intensification by the horizon of 2100.

The increase in wind speed and atmospheric depression induced by cyclonic or stormy activity also generates distant swells, combined with a hurricane surge (Roger et al. 2013). Marine submersions caused by the swells and the surges strongly affect the geometry of the insular Caribbean coast (especially the West Indies) due to its hyper oceanic position (Duvat 2015). The accumulation coasts are eroded by the sedimentary pullout (dune levelling, beach erosion), while powerful swell undercut rocky shorelines. Marine weather events have serious socio-economic consequences. For example, according to the World Bank, the cumulative cost of extreme hurricanes in Haiti from 2004 to 2008 reaches over 7 billion USD (MEF 2015). Furthermore, the Ministry of economy and Finance of Haiti predicts a cumulative cost in case of inaction until 2025 of 1.8 billion USD.

2.2. Caribean biodiversity

The Caribbean Sea's water is poor in nutrients due to the North Equatorial current entering through the Lesser Antilles, and continuing into the Gulf of Mexico. Therefore primary productivity is mainly moderate, except in areas of upwelling, in large river mouths (ex. Orinoco and Amazon), in coral reefs and coastal waters near wetlands and seagrass meadows (Smilke and al., 2010). The Caribbean is composed of three key coastal ecosystems: mangroves, seagrass of phanerogams and coral reefs.

2.2.1. The Caribbean mangrove

Mangrove forests are coastal ecosystems of importance to humans due to the variety of services they provide: among other things, wood supply; fish stock renewal (Benzeev et al. 2017); regulation of water quality by the process of nutrient filtration (eg. phosphorus) and contaminants storage (eg. heavy metals) (Wingard and Lorenz 2014). Mangrove forests also play an important role in the mitigation of the effects of climate change by protecting the coast against from natural hazards and by promoting carbon storage (Augier 2010). Mangroves are coastal natural barriers against erosion. They encourage the sedimentary accumulation and lessen mechanical wave impact (MEF 2015).

The Caribbean region includes 13% of global mangrove (Augier 2010). They are characterized by a low biodiversity in mangrove trees with four species, against 44 in the Indo-Pacific (Augier 2010): Red mangrove (*Rhizophora mangle*); Black mangrove (Avicennia*germinans*); White mangrove (*Laguncula*riaracemosa); grey mangrove (*Conocarpus erectus*). Haiti presents colonies, unique in the Caribbean, made up of only two species and suffering from a form of dwarfism due insufficient freshwater input (Saffache 2006). The ecological functions of the colonies of Haiti are therefore more limited than elsewhere. Martinique has of wide coverage with 20 km² of mangroves which nevertheless suffer from water pollutionand coastal urbanization as elsewhere in the Caribbean (Failleret al.. 2010). Thus, between 2000 and 2005, the national mangrove coverage loss reached from -0.1% for Belize, to -5.6% for the United States Virgin Islands and-10.6% for Barbados. Only Anguilla, Aruba, Costa Rica, Montserrat, St. Lucia and the islands of Turks and Caicos showed no significant change over this period (Augier 2010).

2.2.2. Marine phanerogam meadows

Seagrass meadows of marine phanerogams are well represented in the Caribbean Sea (Figure 5). The regional distribution of species varies: the most common species are turtle grass (*Thalassia testudinum*) and manatee grass (*filiform Syringodium*), present in the shallow waters of the region (up to 25 m depth); the Caribbean centre is populated by two species, *Halodule wrightii* on sand and mud in the intertidal zone (up to 5 m deep) and *Ruppia maritima* in brackish bay waters and estuaries (0 to 2.5 m deep); and finally, three species of the genus *Halophila*: *Halophila decipiens*in deep water (30 m), *Halophila Engelmanni* restricted to the Bahamas, Florida and the Greater Antilles (up to 5 m), *Halophila Baillonii* in the waters of the Lesser Antilles.

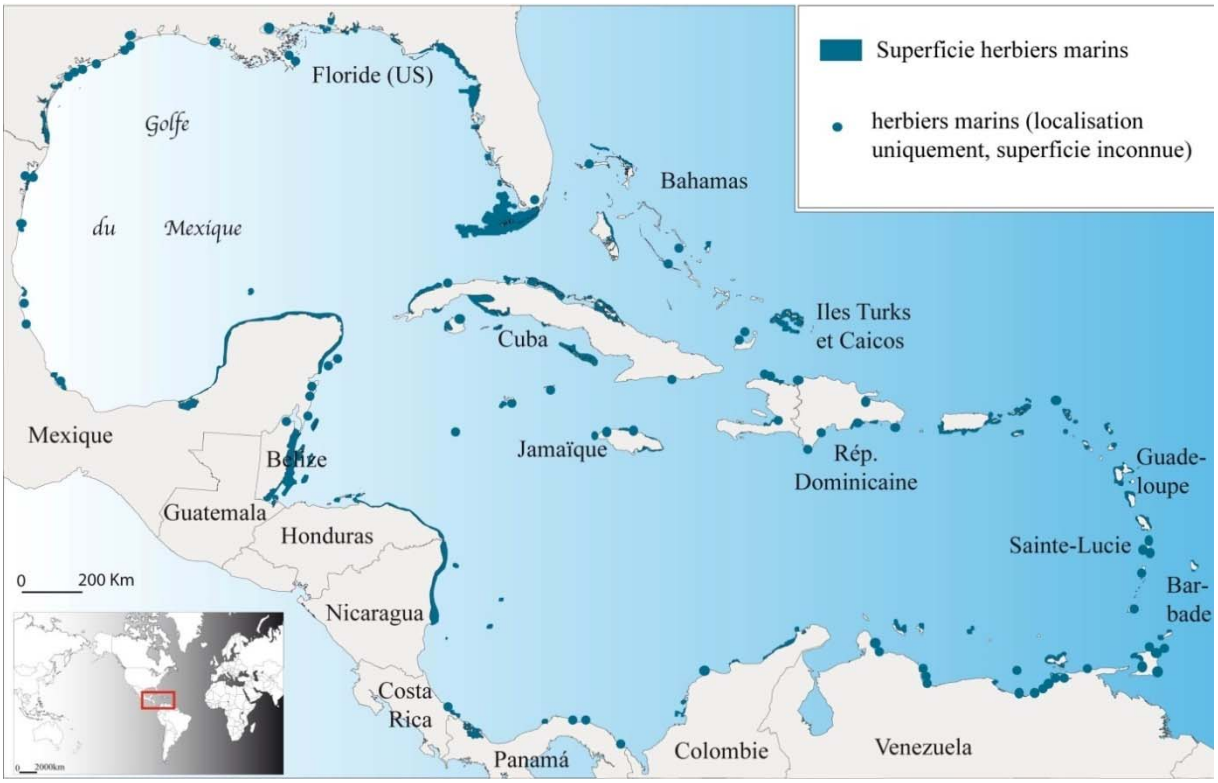

Figure 5: Distribution of seagrass meadows in the Caribbean. Source: Green and Short 2003, in. Augier 2010.

Haitians seagrass meadows, like mangroves, are uninteresting from an ecological point of view due to important siltation (Saffache 2006). In Martinique, seagrasses suffer also from siltation and pollution, indeed 12% are considered as severly degraded, 49% as degraded (Failleret al. 2010).

2.2.3. Coral reefs

Coral reefs are a highly represented coastal ecosystem in the Caribbean Sea (Figure 6) with a coverage of 20 000 km², or 7.64% global coral (Smilke et al. 2010). The Caribbean reefs are of several types (Augier 2010): the fringing reefs (ex, Anse Michel in Martinique, Le Moule in Guadeloupe, Vieux-Fort, St. Lucia, Bequia and Union in the Grenadines), single or double barriers (e.g. Martinique and Belize); annular Reef (e.g. Tobago Cays, Grenadines and Glovers Reef in Belize); and the keys (e.g. Bay of Barraderes in Haiti). The Mesoamerican Reef is the largest coral system of the northern hemisphere. It begins at the northern tip of the Yucatan Peninsula, runs along the coast of Belize and Guatemala and ends at the north shore

of Honduras. Its coverage has reduced by 80% since the mid-1970s. Lesser Antilles also have an important coral barrier of 29km long (Magnin 2018).

The Caribbean reefs are composed of three key species that foster structural reefs building (Augier 2010): deer horn coral (*Acroporacervicornis*) and the elk horn coral (*Acroporapalmata*), both in critical danger of extinction; the massive star coral (*Montastraeaannularis*), threatened since the early 2000's. Caribbean reefs have low biological diversity (25massive coralspecies, Romon 2018) thus increasing their vulnerability to environmental change. The study on the State of health of the Caribbean coral reefs by Romon (2018) reveals a decline in coral coverage of 34.8% between 1970 and 1983, of 19.1% between 1983 and 1998, and of 16.3% between 1999 and 2011. Same alarming report on Martinique reefs with almost 80% of the reefs considered degraded. According to Failler et al. (2010), 20% of the reefs of Martinique have disappeared since 2000 and the species richness in coral has drastically decreased (37 species in the late 19th century against 6 species in 2010).

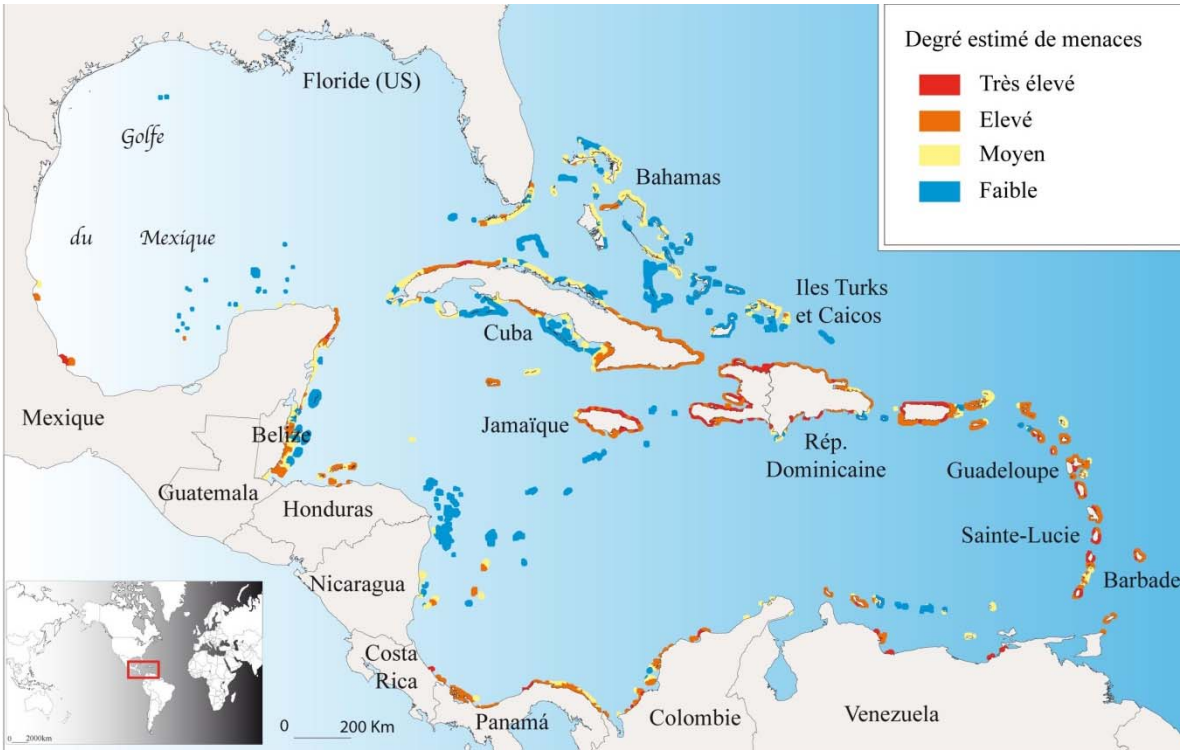

Figure 6: Distribution and degree of threat to the reefs of the Caribbean. Source: Burke and Maidens in 2004. Augier 2010.

In Haiti, coral reefs are poorly represented and have a low species richness with two main species. The majority of the colonies are stressed, necrotic due to the hypersedimentation, or algae-dominance (Saffache 2006).

The coral reefs and their associated ecosystems (seagrass and mangroves) have a high economic value. Failler et al. (2010) have studied the total economic value of these ecosystems in Martinique under a scenario of total loss of their surface. Their results estimate the economic value of the meadows at 2 M€ / km² (38% of the total economic value) and that of the mangroves to 1.7 M€ / km² (31% of the total value). The disappearance of coral reefs would represent an annual economic loss to Martinique of 100 M€. 38% of the value of these ecosystems is related to the regulating services that they produce (carbon sequestration, fish biomass production, coastal protection, water purification).

2.2.4. The fauna and the flora

The fauna and flora of the Caribbean arc displays an important richness which can be partially explained by local geology. The geographical isolation due to the closure of the Panama isthmus 3 million years ago (Magnin 2018), resulted in a high rate of endemism in both flora and fauna. For example, the Caribbean Sea hosts more than 500 species of fish (Smilke et al. 2010).

Some species have an ecological role for the regulation of the whole Caribbean sea. Marine turtles are an example of engineer species, whose ecological role has been studied by Teelucksingh et al. (2010). When grazing the seagrass leaves in large quantities, they shorten and thin the leaves thus limiting the sedimentary capture, reducing the temperature of the water and the shadow generated by the large leaves, which improves oxygenation of the water and limits stagnant biomass infection and putrefaction risks.

On the other hand, there are many species in danger of extinction (the turtle loggerhead, *Caretta caretta*, the green turtle, *Chelonia mydas*, the olive turtle, *Lepidochelys olivacea*) and in critical danger of extinction (the Leatherback marine turtle, *Dermochelys imbricate*, the Kemp turtle, *Lepidochelys kempii*).

2.2.5. Natural Resources

As mentioned above, it is considered that this region hosts up to 12% of the planet's biodiversity. On the other hand, it is estimated that 54% of vertebrates and 59% of plants found in the region are endemic.

From the forestry point of view, there is a coverage of 19,499,000 hectares, which represents 38% of its surface area (FAO 2014, cited in UNEP, 2016). Through these zones, a series of hydrological basins runs, 23 of which have transboundary

importance and 13 of them give rise to rivers that serve as a border between countries. (GWP, 2011, cited in IUCN, 2012)

In marine-coastal zones there are 567,000 ha of mangroves, 1,600 km of coral reefs and 237,650 km2 of extension. These numbers are very important because in the coasts of this region, live just under 22% of its population. (CCAD, 2008, cited in IUCN, 2012)

Each of these ecosystems, with their respective communities, generate ecosystem services, some of them have a link with the Wider Caribbean region, such as marine ecosystem services.

According to MEA, 2005 cited in Pendleton, L. Krowicki, F. Strosser, P. Hallett-Murdoch,J. 2014, is understood by marine ecosystem services to the benefits that people obtain from these ecosystems. In this sense, there are services that range from food sources, carbon fixation, nutrient exchange and even many that can be directly linked to tourism, especially as a basis for attraction, such as landscape beauty.

Lohrop, 2018, believes that understanding the values of these services is fundamental for an adequate use and management of them, which is why in the region, there have been some approaches on ecosystem services that can be very useful for the construction of public policies.

Much of these areas and marine resources are currently used (agriculture, housing, recreation, research, use, tourism), however, their inadequate management, as well as the effects of global change, could cause severe negative effects on them, because there are already clear signs of stress in coastal regions throughout Latin America. (Lothrop, 2018)

Continental Aquatic Ecological Systems

Rivers, lakes, lagoons, mangroves and other high water saturation systems surface conditions depend directly on the magnitude of the precipitation, its distribution throughout the year and the quality of the waters. In particular, the temperature determines the metabolic rates of the organisms and therefore the functioning general for the processing of organic and inorganic matter. In this line, is that some of Catherine Pringle's research and her students of the University of Georgia at La Selva Biological Station-OET.

It is suggested, incipiently, that global warming will not accelerate the rates of decomposition of litter accumulated in the bed of rivers, but it can reduce carbon sequestration rates. However, the studies continue because according to Pringle,

tropical streams and rivers, in particular, they seem to be especially important, due to the higher temperatures warms which translate into higher carbon processing rates per part of the bacteria and fungi, but relatively few studies have focused on carbon in tropical streams. Also it is considered that many countries in the tropics, having a rapid economic development, the dynamics of the carbon in streams and tropical rivers are affected by pressures from the urbanization and the change in land use, what is possible, disproportionately aggravated by the effects of climate change. Only this research group has generated little more than 70 publications on streams and rivers in the Caribbean Costa Rica (OET-La Selva Biological Station). Some directly associated with climate change and others base knowledge for the identification of impacts of this total, there are 12 publications between the years 2008 and 2011.

The University of Costa Rica through CIMAR, has contributed 512 publications between 1979 and the year 2008. These publications incorporate efforts in the scope of rivers and streams (William Bussing, Margarita Silva, Monika Springer and collaborators); lakes and lagoons; mangroves coastal and oceanic areas the job directed towards the rivers has the current leadership of Monika Springer with a group important of students. They concentrate on taxonomic and systematic aspects of species of macroinvertebrates, a group that is currently being used as indicator of the quality of aquatic systems. In the years 2009 to 2011, the team of the CIMAR-UCR has generated 33 publications, of which, Research relevant to the analysis of the impacts of the climate change. However, these efforts are concentrated in coastal and oceanic environments still remaining to work the rivereños and lacustres systems.

The efforts directed to the lakes and lagoons includes the generation of information for just over 100 lakes throughout Costa Rica with data of basic water chemistry, plankton and some morphometric data and paleolimnology. The communities of these systems with less studies are those of the littoral, both plants and benthos and the composition of fish. Is not found publications that show long-term monitoring results that allow perform an analysis on the effects and impacts of climate change on the functioning and structure of biodiversity in rivers, streams, lakes and lagoons from Costa Rica.

The coastal marine environment in Costa Rica

The oceanic marine area of Costa Rica also contains several areas of interest such as the Dome Oceanic and seamounts whose biodiversity has been poorly documented. Currently, research is being carried out in the oceanic areas that they

circle Coco Island. The main purpose of the expeditions will be to obtain information on the physico-chemical parameters of water, from the surface to a depth of 400 m, including temperature, salinity, density, dissolved oxygen, nutrients, contaminants, composition of plankton, chlorophyll, turbidity. Likewise, the fields of marine currents to a depth of 100 m. The depth data and density will allow marine geostrophic currents to be determined up to 400 m, as well as the transport of heat and mass of the water along the routes eleven pre-established. A portable weather station will be installed on the vessel in order to measure wind speed and direction and other characteristics of the atmosphere, such as humidity and temperature. All this information will serve as a basis for assess climate change over time and study its effect on physical and chemical characteristics of the ocean and the atmosphere, as well as their impact on the marine biodiversity of the Isla del Coco National Park.

Impacts on Marine Coastal Ecological Systems have been identified related to:

1) changes in the abundance and distribution of inter-tidal species,

2) imbalances temporary and spatial changes in food availability,

3) imbalances in processes of depredation and competition,

4) coastal erosion, thermal stress and change in the characteristics of the beaches with more or less sediments, directly will affect the nesting dynamics of sea turtles,

5) modifications in the mixing and salinity dynamics in the estuaries will generate changes in the abundance and distribution of estuarine species, which will be measured in changes in the overall productivity of these ecosystems,

6) the changes in Acidity (pH) in seawater increases the ability to dissolve carbonates responsible for the proper development of the shells (i.e. "corrosive" capacity of the water),

7) for the particular case of coral reefs, there will be a loss in present species and death of corals ("coral bleaching") as result of its low tolerance to increases in water temperature,

8) the thermal stratification will be stronger and lasting by modifying the dynamics of outcrops resulting in lower frequency but with higher productivity when they occur

and finally, 9) the behavior of pollutants will have changes as a result of differences in temperature, acidity, salinity and thermal stratifications.

2.3. Environmental pressures

The pressures on the Caribbean environment are of two types: natural pressures, aggravated by climate change; and anthropogenic pressures, which have aggravated the effects of climate change.

Often, the environmental deterioration appears high and with cross-sectoral issues: for example, in La Guajira Colombian department, the shortage of water, the advancement of the process of desertification, the lack of knowledge by the society about the function, vulnerability and potential of resources natural, the presence of erosion processes in the coast, births and margins of river basins, the improper disposal of solid waste, trafficking of species of flora and fauna, deforestation pressure on the Sierra Nevada de Santa Marta, Serranía del Perijá, coastal zone, Serranía de Macuira, among others, are the factors with the greatest impact to the environment.

Natural resources in the Central American region have been also very affected by different dynamics, highlighting the change in land use, the deforestation, the construction of large-scale infrastructure, the overexploitation, among others.

2.3.1. "Natural" pressures[1]

- Marine or continental floods and droughts

More continental, Colombia doesn't escape to threats and difficulties: the country has the third highest rate of natural disasters among the countries of Latin America and the Colombian Caribbean is particularly vulnerable to these disasters.

The risk of flood is acute in the eastern part by inappropriate landfills of the existing marshes between Sabanagrande and Soledad, restricting the water mirror and, consequently, causing flooding of urban areas, affecting in particular sectors with very vulnerable population. It was, perhaps, the region most affected by the winter of 2010, when it registered 1.6 million victims and 308 thousand homes impacted par big continental floods. Landslide is a phenomenon that usually arises in the coastal subregions (Tubara, Juan de Acosta) and central, especially the Momposina depression, the municipality of Usiacurí and, minimally, in the East.

Droughts ration, in drastic cases, the depletion of the resource. Reducing the levels can also affect the reservoirs for the generation of electric power, with similar effects in terms of rationing that affect the quality of life of the communities.

[1] The distinction between *natural* and *"natural"* refers to Demangeot (1984)

- Landslides and soil erosion

In the District of Barranquilla, in particular sectors located in the South-West slope and the coastal subregion, occurs mass removal. This phenomenon is generated by soil degradation involving displacements of surface and subsurface layers under the combined condition of gravity and water saturation, characterized in expansive clay soils.

More largely, the presence of important mountains combined with often-violent rains provokes erosion throughout the whole region either by nature action or anthropic activities.

Coastal erosion on the Caribbean Sea is an already recurrent phenomenon in all Caribbean Colombia, which is affecting tourism, demanding works of stabilization and containment works.

- The marine-weather events

On the one hand, the marine-weather events damage coastal ecosystems by removal of seagrass meadows and coral reefs (Saffache 2014). On the other hand, the intensification of run-offs into the watershed lead to massive arrivals of terrigenous sediments into coastal waters(Ismaili 2010, Saffache 2014), reducing coral and seagrass productivity, and suffocating them in extreme cases of water turbidity (Saffache 2014). The mechanical wave impact and wind transport of sediment levels the dune ridges (Vernier 2010), rip the mangroves and floods coastal wetlands, thus limiting their buffering role (ECLAC 2018) which increases coastal erosion and marine weather events. Moullet and Saffache (2013) observe an average erosion of a meter (3 meters maximum) on 18 of the 20 beaches considered as being the most beautiful of Dominica between 1990 and 1999. Likewise, important erosive processes occur in Colombia. 30% of the 233 km^2 of beaches in the Colombian Caribbean are affected by this phenomenon.

- Climate change and biodiversity erosion

The biological richness of the region is eroding and this trend will continue as the effects of climate change will intensify (ECLAC 2018). Endemic species in the Caribbean mature in very specific environmental conditions and thus have a limited biogeographical area. However, climate changes alter the limits of these

biogeographic areas resulting in a shift in species, and sometimes a loss, or even a total disappearance of these (MEF 2015). Cuba, Haiti and the Dominican Republic are particularly prone to this risk because they have the most diverse flora of the Caribbean (MEF 2015) and a high rate of endemism (ex. 37% of endemic vascular plants) due to their geomorphological features. Similarly, coastal ecotones will experience a significant loss of biodiversity. When sea-level rises, an excessive root flooding forces the ecotone to migrate inland (MEF 2015). However, if it cannot migrate (eg. because of land artificialization) the ecosystem will collapse. The change of temperature and regime of sea currents will also affect the distribution of marine species (Ismaili 2010), significantly altering fish stocks.

The rising temperatures affect coral reefs through coral bleaching phenomenon. During heat stress, the coral polyps expel the symbiotic algae living in their tissues, causing coral bleaching. This bleaching causes a physiological downturn of the coral (Failleret al. 2010). According to Magnin (2018), bleaching has increased by a factor 10 since the 1980s in Guadeloupe, from an episode of bleaching every 20-30 years in the early 1980s, to an episode every three years in 2017. Finally, the IPCC regional estimates predict 75% of additional coral bleaching by 2050 (Dupont 2013). The massive bleaching of constructive coral species (*Orbicella SP*., *Montastraea SP*., *Acroporapalmata*, *Acroporacervicornis*) leads to a significant decline of biodiversity and population in fish (Romon 2018). Moreover, the decrease in grazer species accelerated the transition from a coral-dominated system to macroalgae-dominated system. This transition has been widely permitted by the disappearance of key Caribbeanspecies of sea urchin: *Diademaantillarum*, due to an epizootic disease occurring in 1983 (Romon 2018).

Regarding the loss of biodiversity in Central America, it is considered that up to 52% has been lost. The weak institutional framework, the lack of human and financial resources, the problems of compliance and monitoring, and the low importance of the issue seem to be the trigger for bad practices in the use and exploitation of resources (Murillo et al, 2007).

On the side of natural resources in the terrestrial part, one of the greatest pressures is deforestation, motivated especially by the advance of the agricultural frontier (State of the Nation, 2015), with the only exception of Costa Rica that has managed to reverse their deforestation processes.

It is estimated that Central America has lost 52% of its original biodiversity, due to anthropogenic pressures (CCAD, 2011 cited in the State of the Nation) especially land use change, road infrastructure construction, fragmentation of protected areas

and climate change. In addition, the number of endangered species has gone from 426 to 872 (State of the Nation, 2015).

Impacts of climate change on species in Costa Rica

The analysis of the impact of climate change in Costa Rica at the species level is usually done in relation to changes in the size of the populations as well as in the known "normal" distribution scope. In the following paragraphs we extract the results to which the researchers in Costa Rica have come, for some species of the main groups such as amphibians, reptiles, birds, bats and plants.

The amphibian species show a decrease in the size of the populations up to disappearance of species of amphibians in the high areas of the country. These manifestations in the presence of amphibians have been associated with climate change, habitat isolation, pollution (particularly the atmospheric caused by acid rain) and diseases that may or may not stimulate their affectation due to climate change. In the lower areas of the country, changes have also been observed in the size of amphibian populations at the level of litter on the forest floor tropical wet; however, it is the reptiles that may manifest significant changes in the permanence and survival of species such as result of increases in ambient temperatures. Turtles are sensitive to the temperatures during the incubation of the eggs, thus determining the proportion of sexes at birth. Alligators in continental waters with higher temperatures they will affect the embryonic development and size of the individuals. In other parts of the world there is already evidence that from the year 2080 onwards, some Crocodile species will only produce males as a result of greater environmental temperatures (Mitchell et al., 2010). With regard to birds (Barrantes et al., 2011, Barrantes 2009, Fuchs et al., 2010), conducted analysis of the birdlife associated with very high areas in Costa Rica (i.e. páramo) and it has been concluded that this has been determined by factors climate during the Pleistocene as well as sporadic migration opportunities.

Most studies show that the altitudinal migratory capacities of the Costa Rican avifauna, as long as food conditions are found and necessary reproductive, thirst will give looking for the conditions that allow its daily survival. Other examples documented are in studies of hummingbirds in the cloud forest of Monteverde, where the species richness in hummingbirds is found correlated with annual precipitation; The more precipitation, the greater the number of species. The answer has a logical explanation because the lower the precipitation lower production of nectar by plants. The various studies show that in those years when precipitation is significantly less, the size of the populations of hummingbirds is diminished, taking the species for several years to recover the previous levels (eg La Selva Biological Station-studies of Stiles 1992).

For decades the bat species in the forest Cloudy of Monteverde and its surroundings have been studied. Recently, he concludes that the appearance of new species of bats that are more common in the lower areas of the NP Santa Rosa, is associated with general increases in temperature, so that bats seek higher altitudes. It is not yet clear if bats are looking for zones of lower temperature in response to modified gradients of their groups food or in response to a physiological compensation of individuals.

The reproductive success of plant species is not only dependent on the presence of pollinators and seed dispersers but is affected by habitat modifications (e.g., deforestation) and changes in climate order (Fuchs et al., 2010). For example, some tree species in the rain forest tropical (Clark et al., 2010), show that the growth rate, in terms of increase in the amount of wood, is diminished by 1) increases in the average annual night temperatures (1-2 degrees Celsius) and by 2) decrease in precipitation during the dry season.

It is important to highlight then, that the available studies relate the affectation of climate change on species in Costa Rica to decrease in the area of geographic distribution and committed reproductive capacities. Both cases, indicate that the vulnerability of the species will be increased along with all the anthropogenic changes that continue to occur in the territory.

In Costa Rica, intensive work has been carried out on various types of forest in life as the "Cloud Forest-in the areas of low Montane and Premontane life"; the Tropical dry forest and very tropical rain forest. Particularly, at the level of systems or forest types, it is found that the impact of changes in temperature and precipitation intensified by changes in land use in the surrounding the cloud forests, it is significant since the operation general and forest structure are dependent on the presence of clouds (high horizontal precipitation). Similarly, in the tropical dry forest, heat increases affect biological diversity. For example, changes in hydrological regimes are reflected in the permanence of species that they depend on the humidity in the riparian zones. Additionally, it is possible to observe changes in the structure of dry forests with the replacement of species with leaves deciduous species with more succulent leaves that have the ability to accumulate water. This is in response to the reduction of the index of foliar area is accompanied by an increase in evapotranspiration or loss of Water.

Life zones are defined by precipitation and temperature, in addition to the evapotranspiration. According to a model that uses diverse scenarios of change

climatic change, Jiménez (2009) finds that climate change will generate changes in the Location of defined life zones in Costa Rica. Most of them will manifest geographical transfers in altitude, disappearing from Costa Rica since 2020, the páramo, the near disappearance of montane rainforest, low montane and pre montane as well as the very humid montane forest. From the year 2080 they appear new life zones such as the "Very Dry Tropical Forest" and the "Dry Forest" Premontane. "

Basically, the analysis of the affectation of variables such as precipitation and temperature on the functioning and structure of the forests is made from of direct studies over many years, as well as from the use of models predictive Clear examples of these efforts that apply different models with information of 1) runoff, 2) index of leaf area, 3) evapotranspiration and 4) types of forest cover. These Studies have been conducted at the level of the Mesoamerican region. With these inputs it is possible to work the simulation of the impacts of climate change on the balance water and vegetation in Mesoamerica. The results of these studies show that there will be potentially changes in wet forest types towards those drier. Runoff will decrease throughout the Mesoamerican region even when precipitation increases, mainly as a result of increases in evapotranspiration. Additionally, the reduction in the area index is expected foliar in the forests and changes in the water balance will have important consequences on biodiversity and ecological functioning of terrestrial systems.

The trends in the elements of biodiversity can be summarized as follows.

Table 3. Summary of observed trends in the elements of biodiversity in Costa Rica

Level	Biodiversity element	Trend	Observations
Landscapes	Forest cover (forest, plantations, wooded pastures)	S	75.5% of the terrestrial territory without decrease
	Forest coverage (forests only natural)	I	52.4% terrestrial territory, according to the experts consulted, it is expected that by 2020 the coverage will rise to 61%
	Structural connectivity of landscapes	I	59% CB area higher than average biodiversity index and 63% CB area index of resistance less than 200
	Intact forest landscapes	D	2% decrease between 2000 - 2016

	Protected ecosystems terrestrial	S	26% of the terrestrial territory without decrease 2.75% of the marine territory (EEZ), creation of new marine areas Protected in 2014 - 2018
	Marine protected ecosystems	I	2.75% of the marine territory (EEZ), creation of new marine areas Protected in 2014 - 2018
Land Eco systems	Tropical dry forest	I	Recovery in the last Nasa Project - Human Footprint, 2018), however, the experts consulted indicate that there is evidence about the negative effects of the change climate that has caused massive tree deaths
	Tropical moist forest	D	Agroindustry deforestation, the experts consulted report negative effects of climate change, decrease drastic in invertebrate population in general
	Mountain forest	S	Levels of deterioration from low to moderate
Ecosystems coastal and wetlands	Paramo	S	No data
	Mangrove swamp	D	Affectation due to sea level rise, sedimentation and drying (European Union, in prep)
	Reefs	D	Affectation due to an increase in the temperature of the oceans, an increase in the level of the sea, acidification, sedimentation, unsustainable fishing
	Seagrasses	D	Affectation due to an increase in the temperature of the oceans, an increase in the level of the sea, acidification, sedimentation
	Sandy beaches	D	Impact due to sea level rise and erosion processes, fishing unsustainable, overload of tourist visitation, sedimentation, infrastructure.
	Lagoons	D	Affectation by sedimentation, eutrophication, the experts consulted add that there is a change of type of lacustrine or marsh wetland by sedimentation and desiccation

	Swamps	D	Affectation by sedimentation, eutrophication, drainages, fillings, fires and Pollution, the experts consulted demonstrate drying and sedimentation processes in the swamps or marsh systems of the North and North Caribbean
	Rivers	S	The experts consulted indicate that while terrestrial water bodies they present affectations by sedimentation and contamination (MINAE, 2018), and others linked to the expected effects of climate change, in general the tendency of these ecosystems is to be maintained
	Oceans and seas	I	The experts consulted indicate an improvement in ocean ecosystems due to the conservation efforts made with the extension of the AMP and the Large Pelagic Platform
Species	Plants	NA	Without data, the experts consulted do not agree on a general trend for the group
	Celebrated or Cnidarians (Corals)	D	Downhill except in specific sites such as Golfo Dulce where the The main coral formation (Sandalwood) has shown recovery important. The increase in water temperature continues, as well as the coastal sedimentation. Additionally, also contamination by plastics and the competition for coverage with invasive algae Caulerpa sp.
	Annelids (Polychaetes: marine worms)	S	No information available, although the habitat of most of the species has deteriorated, experts agree that the group remains stable.
	Molluscs	S	The experts consulted indicate that the group remains stable in general, but shows a decrease in populations in the species of commercial value
	Crustaceans	S	The experts consulted indicate that the group remains stable in general, but shows a decrease in populations in the species of commercial value

	Echinoderms	S	The experts consulted indicate that there is little information available, although in general the group remains stable, but it is considered that habitat has deteriorated
	Cartilaginous fishes	D	Experts consider that it is the most impacted marine group and threatened directly by human activities, and present many populations in decline
	Bony fish	S	The experts consulted indicate that the group remains stable in general, but with populations of queen corvina (Cynoscion albus) and fish sword (Xiphias gladius) in descent. Decrease in catches
	Amphibians	D	Decrease in populations, increase in threatened species
	Reptiles	NA	Decrease in populations, increase in threatened species. The experts consulted do not agree on a trend general for the group.
	Birds	D	Decrease in populations, increase in threatened species, the experts consulted report that 50% of the species in Central America are rated as vulnerable
	Mammals	D	Decrease in populations, increase in threatened species
Agro ecosystems	Bananas	I	Increase in the area dedicated to permanent crops, linked to export products
	Pineapple	I	Increase in the area dedicated to permanent crops, linked to export products
	Rice	S	No changes
	Sugar cane	D	Decrease of 10% of the area dedicated to cultivation
	Oil Palm	I	Increase in the area devoted to permanent crops, linked to export products
	Pastures	D	There is a decrease in the areas destined to livestock

D: Decreases I: Increases N/A: Not apply or information not available S: Steady

D.1.1. Investigate national issues and environmental threats in coastal territories in Latin America and ACP countries

Source: Information collected and queries made with experts (Period 2014 – 2018)

- Salt intrusion and relative sea-level rise.

The increase of the frequency and the duration of landflood will have two consequences:

a salinization of soils (MEF 2015), making it unsuitable soils for agriculture;

an increased intrusion of saline water in fresh water aquifers and fresh water rivers, contaminating the already limited drinking water sources of the Caribbean (Vernier, 2010; Romon 2018).

2.3.3. Anthropogenic pressures

- Domestic and agricultural pollution

The management of domestic waste in Caribbean is often inefficient. Inadequate management of household is one of the main environmental problems of the Caribbean Colombia. This situation is particularly serious in rural areas, where solid waste are usually burned or deposited in uninhabited places or in riverbeds, causing significant environmental impacts and enhancing the proliferation of disease vectors that put at risk the health of the most vulnerable population. All around the Caribbean Sea, urban waste is not regularly collected, so they are proliferating in wild dumps before being carried out towards marine outfalls during hurricane and flood season. Inefficient management a waste has also disastrous impacts on the environment. For example, the accumulation of debris between the roots of mangroves cause an obstruction of the hydrological circulation. This obstruction dries up the marine part of the mangroves, thus limiting their development (Failler et al. 2010) and causing their loss. This explains why management of household waste is a major issue in the Caribbean region in terms of both preservation of public health and the preservation of water quality (Moullet and Saffache 2013).

In Martinique, only 47% of municipalities are connected to a wastewater collection network (Saffache, 2014) and many homes lack septic tanks. It is the same in Dominica (Moullet and Saffache, 2013), and in Haiti, where there is also a problem of human waste deposited in the mangroves (Saffache, 2006). Martinique coastal waters have important concentrations of heavy metals due to oils spills (Saffache 2014). Finally, coral reefs of the Caribbean were hit heavily by the the white band disease as a result of direct discharges of ballast water in the middle in the 1960s (Romon 2018).

Leaching from agricultural soils to coastal waters is considered to be the main source of degradation of coral reefs and mangroves (Dupont, 2013). One of the most prominent examples of environmental degradation related to bad agricultural practices is the chlordecone pollution, "the cause of a major health, ecological and socio-political scandal"(Morandi and al., 2018) in Martinique and Guadeloupe. This organochlorine pesticide compounds was used heavily until 1993 for the banana culture and has led to a poisoning of water compartments and soils (Dupont, 2013). It's effects on the environment are still noticeable 26 years after the banning of the compound (Magnin, 2018). Organochlorine products absorbed by mangrove oysters can be found in the flesh of some marketed fish, via the process of bioaccumulation, beyond legal toxicity thresholds (Saffache, 2014), contributing to the increase of food insecurity (Morandi et al., 2018). The agricultural and domestic nitrogenous materials runoffs fertilizer, pesticides, organochlorines, wastewater) causes an enrichment in nutrient of waters, promoting the development of algae, at the expense corals.

- Physical degradation of ecosystems

Nautical and aquatic activities, when they aren't under control can be very impactful on the marine environment. In the absence of regulation of mooring areas, unwanted anchors shear corals (Romon, 2018) and tear up the seagrasses. Diving (in 2000, 80 000 dives in Guadeloupe, Saffache, 2014) and the installation of traps contribute to damage the physical structure of marine-coastal ecosystems.

In Colombia like in many other islands, environmental pollution generated by the presence of open trashes dumps, clandestine slaughterhouses, burning wastes and vegetable layers for the preparation of land for planting, the use of coal and firewood for cooking of food and quarrying are within its most critical aspects, without disregarding the seriousness of water dumping produced by industries and towns without sanitary sewer. Such a situation has a negative impact on land as marine ecosystems and productive sectors, with loss of agricultural products, reduction of the bovine population.

For example, the Canal del Dique, canal basin of the dam, integrated in the "Regional Natural Park of Dry Forest El Ceibal Mono Titi" is also a strategic body of water for the economic, social and environmental development of the region. But this ecosystem is presenting multiple problems: high sedimentation, sewage dumping, dumping of waste and deforestation. All these situations impact negatively the populations settled on this body of water since it reduces the quality of the water resources for human consumption and for the conservation of biological diversity,

while in its mouth at the Bay of Cartagena are reflected problems such as high pollution and sedimentation which affect the navigability and the quality of life of the second urban agglomeration of the Colombian Caribbean.

In this Bay of Cartagena, the main sources of pollution are sedimentation and the heavy metals carried by the Canal del Dique, the discharge of wastewater from the sewage of the district (organic matter, coliforms), dumping areas of Mamomal and the forest industry, and maritime and port activities (oil residues and hydrocarbons). The Bay of Cartagena system presents problems of anoxia in subsurface waters, fauna pauperization below 10 m depth, high levels of pollution fecal by hydrocarbon and accumulations of mercury in sediments. The growth of the city has changed the local plant community structure. A process of occupation of the land in areas of high importance for biodiversity is observed as in La Ciénaga de la Virgen with loss of the water mirror to the contour of the swamp (flood areas and mangroves of high productivity). The mangrove ecosystem has been strongly impacted by indiscriminate logging and filling of wetlands areas, caused by the cumulative impacts generated by discharges of sewage and solid waste, which have decimated populations of flora and fauna. Species such as the snail scoop and the *chipi-chipi*, they no longer exist. One of the problems facing the fish species is exposure to polynuclear aromatic hydrocarbons and heavy metals as mercury. According to Olivero et al. (2004), mercury has been detected in the bile of the lisa (Mugilincilis) and in the muscles of the crab (Callinectessp.) caught in the Bay (as opposed to Álcalis plant). These species reach concentrations average mercury near the maximum permissible limits for human consumption.

- Hypersedimentation and fragmentation of habitats

The extension of human activities causes habitat fragmentation. However, more an ecosystem is isolated, the less resilient it is because they cannot share enough genetic material necessary for the renewal of the species.

Deforestation is a major issue in Guadeloupe, where primary forests only remain on the heights of Basse-Terre (Magnin, 2018). Human development on volcanic islands,particularly steep like Guadeloupe, is constrained by the geographical configuration. It is the same in Haiti where massive deforestation results mainly from uncontrolled urbanization and the country's dependence on charcoal energy (Saffache, 2006). In Colombia, deforestation, urban expansion, mining and construction of roads, the expansion of agricultural land and mining are factors directly contributing to the fragmentation of habitats and landslides, polluting soils,

currents and open coastal waters. The rains and flow drag eroded soils to rivers and bogs which provokes, for example, lentic overflow of the Ariguaní River.

Deforestation increases landslides and runoffs. This mobilization of large sediment volumes accumulate in coastal waters, causing necrosis of the coral platforms, fossilization of seagrass beds and benthic organisms shortage and migration to less turbid waters (Saffache, 2006). Siltation is one of the main causes of degradation and the loss of biodiversity of coastal and marine ecosystems (Moullet and Saffache, 2013).

- urbanisation and tourism as threats to biodiversity

It must that recognized that threats to coastal resources utilized by the tourism industry can arise not only outside the sector but within the sector. Tourism, especially nature tourism, is closely related to biodiversity and the multiple attractions created by a rich and diverse environment.

Ironically, the Caribbean tourism sector, which is heavily reliant upon environmental quality, is the leading threat to its degradation and in some cases causing irreparable damage, consequently bringing losses to the tourism sector (George 2007). Habitat destruction and alteration is one of the primary causes for the loss of biodiversity (UNEP 2001). Rapid and uncontrolled coastal tourism uses and modifies fragile coastal resources for construction of general infrastructure including roads, marinas, airports and tourism facilities such as hotels, resorts, restaurants, shops, to attract tourists. Such tourism development however, affects the quantity and quality of coastal resources available for present and future tourism activities.

Interlinked coastal habitats such as beaches, coral reefs, mangroves, sea grass beds, wetlands and estuaries are highly vulnerable to loss due to poor, unplanned or illegal development practices to facilitate mass tourism. Degradation or destruction of these sensitive habitats results in complete loss or reduction of ecosystem services, which directly or indirectly support tourism. Investigations on the value of key ecosystems conducted by Guannel et al. (2016), revealed that the existence of coral reefs, seagrasses and mangroves together provide greater ecosystem services, notably coastal protection, compared to any one habitat or a combination of any two habitats. However, intact and healthy ecosystems are becoming rare (George 2007). Apart from coastal protection, these habitats support enormous biodiversity, host commercial and endangered species, provide a nursery habitat for juvenile species and maintain coastal water quality, thus providing ideal recreational and aesthetic opportunities for tourists, once sustainably used.

Activities on land, such as land clearing, construction of roads and buildings, not only have in situ impacts but ultimately impact coastal and marine ecosystems some distance away from the site. Coral reef and seagrass ecosystems are highly sensitive to sedimentation and turbidity. Sediments released during construction, dredging and clearing of vegetation can ultimately enter the marine environment and become suspended in nearshore waters. Suspended sediments decrease water clarity and light penetration thus affecting photosynthetic processes of coral reefs and other suspension feeders. In worse cases, sedimentation results in smothering of corals. Sedimentation in general is one of the largest sources of degradation of coral reefs worldwide (UNEP 2001). As coral health becomes impacted, biodiversity on reefs is reduced as a result, limiting recreational and tourism opportunities and also ecosystem function and productivity (OECS 2009). Corals are also impacted by physical damage during dredging, drilling, anchoring, mining, careless snorkeler and SCUBA diver contact which reduces the structural integrity of the reef.

Unmanaged development such as construction and sand mining can destroy critical sea turtle nesting habitats. These endangered species, are further threatened by artificial lighting from coastal buildings which attract emerging hatchlings, causing disorientation away from the sea. Tens of thousands of hatchlings perish yearly as a result (Lorne and Salmon 2007). These implications on biodiversity highlight the need to develop sustainable strategies that minimize negative impacts on the coastal and marine environment, allowing for long-term ecological and economic benefits to accrue.

2.3.4. The introduction of invasive species

According to the IUCN, invasive species are the third threat on global biodiversity, after pollution and overexploitation. As the Caribbean has gradually opened up to international trade, invasive species have been introduced despite and sometimes because of human acitivities, causing a competitive situation at the expense of the endemic species. In Guadeloupe, 15% of the flora is now naturalized (Magnin, 2018). Locally, Magnin (2018) identifies several experiences of catastrophic introductions in the habitats: the small Indian Mongoose (*Herpestes javanicus auropunctatus*), introduced for rat-control ; the manioc ant, an accidental intruder (*Acromyrmex octospinosus*); and the more impacting, affecting the entire Caribbean Sea (Saffache, 2014), the lionfish (*Pterois volitans*) accidentally released in Florida during the 1980's.

2.3.5. The increase of vector-borne diseases

Over the past decade, the number of outbreaks of vector-borne diseases have been increasing, raising many public health concerns, especially in highly urbanized territories (Githeko et al. 2000). Recent altered ecologic conditions, due to changes in global climate (increasing temperatures and rainfall), globalization of travel and trade, urbanization and increased waste management issues, all set the stage for the expansion of vector-borne diseases (Leslie et al. 2017). As climatic conditions rapidly change, increased water temperatures, will likely promote precipitation and flooding which present ideal breeding conditions for vector-borne diseases such as dengue, Chikungunya and Zika, formerly identified as epidemics in the Caribbean.

Apart from the social and climatic contribution to the incidences of vector-borne diseases, the vectors themselves are biologically changing. Mosquito vectors, such as the Aedes aegypti mosquito are sensitive to changes in temperature. Studies reveal that in warmer temperatures, female mosquitoes feed more often and digest blood faster, thereby increasing the intensity of transmission (Githeko et al. 2000). To exacerbate the issue, not only are mosquitoes adapting to warmer climates, but their larvae are also adapting. Mosquito larvae decrease their maturation time as water temperatures increase, consequently reaching adulthood faster (WHO).

With less control over the direct climate change threats, other threats such as improper waste disposal can be addressed at the household, national and regional levels. With Caribbean economies being highly tourism dependent, outbreaks of vector-borne diseases can have serious implications on the Caribbean's tourist destination image. This has already been observed during the Zika outbreak where numerous foreign travel health advisories were released by international governments, informing their citizens of the outbreak. Tourists' perception is greatly influenced by media coverage and if potential tourists perceive the health risks of a particular destination as high, the individual may be more inclined to seek another safer destination. This was demonstrated with Réunion Island where the 2006-2007 Chikungunya outbreak reduced tourism arrivals by 37% (Caribbean Council n.d).

3. The management of the resource

3.1. Water Management

According to ECLAC (2018), climate change in the region poses the need for interrogation on the establishment of a sustainable economic growth model. The

commodities of the Caribbean economy (economic dependence on the export of primary products or *primarization*) leads to a high use of non-sustainable natural resources. In addition, a large part of the population is highly vulnerable to economic shocks and natural disasters.

3.2. Forest management

As a whole, the municipalities of Colombian southern Bolivar, along Magdalena River, have 73% of its territory in area of forest reserve, a situation that prevents their residents from cultivating legally and access title to their houses or plots, as well as loans granted by the financial system of the Government. Without titles and property rights, without access to credit, this situation makes it more vulnerable the farmers.

All the municipalities are mostly rural (max. 83% of the population living in the countryside in Achi). In 2007, they returned to increase coca cultivation, through the so-called itinerant crops cultivation, as well as fumigation, increasingly in the San Lucas Range. The problem of this practice are the environmental costs involved, as well as the side effects on human health. In this sense, manual, forced or voluntary eradication programs are preferable, as well as the implementation of alternative development programs.

Traditionally, in the mining areas of southern Bolívar, the presence of the State has been very scarce, which has allowed part of this void population to be filled by illegal armed actors, such as the guerrillas of the ELN and the FARC. Then the paramilitaries and more recently by the so-called emerging groups, which continue with the mafia practices of their predecessors. This illegality and the abandonment of the State have led to a significant percentage of the mines being exploited informally, without any type of planning, with negative implications for the environment and the population. In effect, during the gold beneficiation process, most miners use mercury, cyanide and nitric acid, many of which are discharged without any treatment into water bodies near the mines.

The risks are diverse: during the smelting process, the heating of amalgam in the open air produces mercury vapor emissions, which affects the health of workers and mining communities. Also, by becoming organic mercury, it is highly polluting for water, air and soil. On the other hand, the gas produced by cyanide has effects on the central nervous system.

In La Guajira Colombian region, hunt endangered species like the turtle, deer and iguana and, with lower intensity, margay, partridge, local turtledove (*guacharacas*),

pink flamingos, and even jays (*tourpiales*, national bird on the close Venezuela). All have been victims of human consumption affecting their survival.

Cutting firewood and misusing of resources by residents in the Sierra Nevada de Santa Marta and the Serrania del Perijá, has caused deforestation of watersheds, of area used as protection of births and margins of streams. On these spaces, overgrazing succeeds the deforestation and leads to a worsening of environmental damage overgrazing.

But, out of the mountains, the deforestation is also agroindustrial and linked with urban activities (along the Magdalena River, Valley of the Ariguaní).

3.3. Freshwater management

The preservation of drinking water resource and the lack of water in some countries is one of the major socio economic challenges related to climate change in the Caribbean (Dupont, 2013). Regional resources are abundant but very unequally distributed (ECLAC, 2018): the resource is sufficient for the majority of the Caribbean islands with the exception of Haiti, the Dominican Republic, Antigua and Barbuda, which are in water deficit (Hamel Pépin, 2013). In addition, the rise in temperatures and rainfall variation will result regionally to a drier general climate (ECLAC, 2018), and therefore more limited drinking water resources.

Colombia is the sixth country with greater water supply in the world. However, approximately 50% of these resources have quality problems. According to InveMaR, the three pillars (municipal, industrial, agricultural) and waste of maritime, port activities, and oil industry are the main general sources of pollution of the waters of the Colombian Caribbean region.

In the same way, the greediest activities in terms of water use in the region are agriculture and tourism. However, the most touristic regions of the Caribbean arc happen to encounter the greatest deficit in water, such is the case for Barbados (Hamel Pépin, 2013). In the agricultural sector, thermal stress damages seeds, intensifies attacks by pest and diseases, alters the adequacy of the nature of crop agriculture to the field, decreases productivity and finally, increases the need for water (CEPAL, 2013) leading to an inevitable competition for water.

In Guadeloupe, running freshwater is under significant pressure. 70% of the drinking water of Guadeloupe is withdrawn on Basse-Terre rivers, contributing to the imbalance of aquatic ecosystems (Magnin, 2018). In Martinique, agricultural pollution, including chlordecone pollution, caused a freshwater fishing ban on rivers of major interest (Morandi et al., 2018). River fishing is a locally under controlled,

isolated activity not structuring an economic sector unlike sea fishing. Fishermen's ignorance of pollution impacts and risks leads them to maintain their activities for their own consumption, causing significant food safety hazard (Morandi and al., 2018).

3.4. Management of marine resource

Caribbean fisheries are mainly artisanal and small scale, with the exception of a few industrial fleets essentially foreign-flagged (South Korea, Japan, United States). Main commercial catches are medium-sized pelagic fish, shrimps and lobsters, benthic mollusks, for a total catching of 330K tons over the period 2000-2004, mainly caught by Venezuelan fisheries (Figure 7). For instance, the Mesoamerican reef provides a biomass of 204, 6 t/km² (Alvarez-Hernandez 2003, in. Smilke and al. (2010).

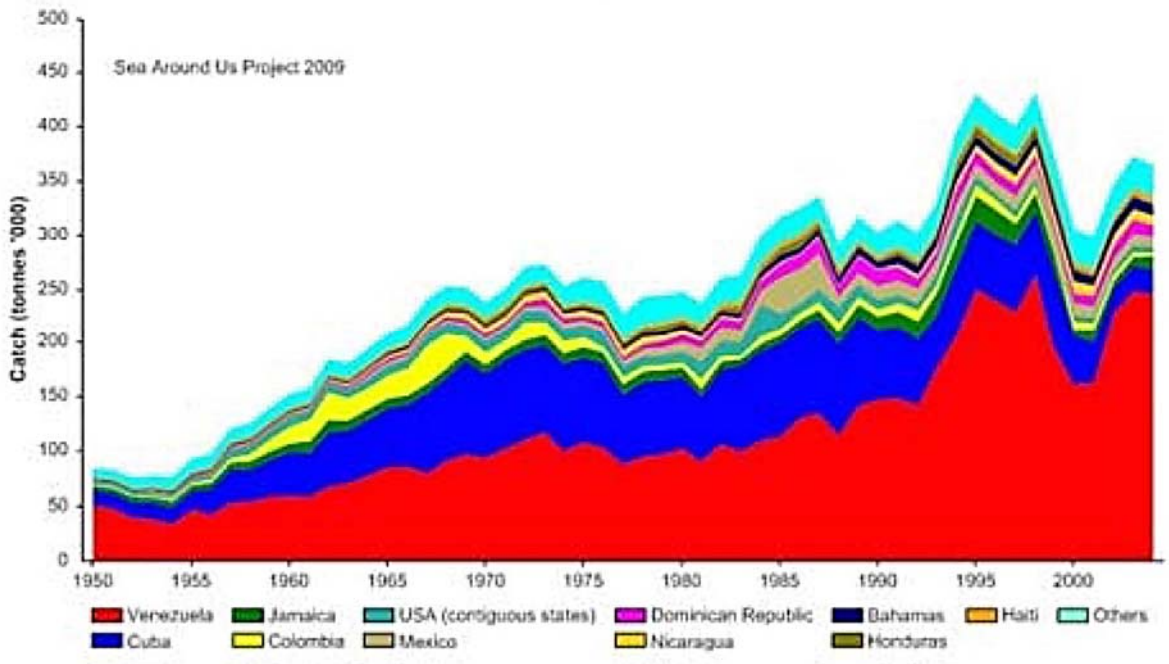

Figure 7: Fish catches by country over the period 1950-2004. Source: Sea Around US in 2009. Smilke and al., 2010

Smilke and al. (2010) have studied the impact of fishing on fish stocks and trophic stability. The Caribbeantrophic network is controlled mainly by detritivorous benthic species and to a lesser extent by herbivorous: it is a bottom-up control. Indeed, the

ecological strategy of the Caribbean reef (characteristic of a poor nutrient basin) is based on fast recycling of the biomass by benthic invertebrates, energy which is then transferred to higher-level consumers. However, the great human population density and the absence of rational fisheries management led, since the 1970's, to a decline in detrital benthic species (shells) and herbivorous (e.g., Parrotfish *Scarus sp.* and Surgeonfish *Paracanthurus sp.*) (Romon, 2018). Another example ofdrastic stock declinearound the island of Hispaniola where commercial fish juveniles have disappeared from coastal waters, and furthermore shell and the crustaceans are now unable to reach growth maturity (Saffache, 2006). However, fishing is essential to the economic and social offset of many Caribbean states. With high unemployment rates and a difficulty in creating new economic opportunities (geographical distance, small size of the market), "the ocean is the first creative source of employment and local dynamic" (Angelelli, 2010).

Given the situation, many states are taking action for the protection of marine resources, yet not effectively. In 2010, Augier has identified a total of 285 protected marine areas (AMP) in the region, however only 6% ensuring full protection of the coasts and marine areas, 13% providing partial protection, while 48% are providing no protection. The only countries having no marine resource protection areas are Anguilla, Haiti, Montserrat and Puerto Rico (Augier 2010). Regarding the protection of coral reefs, 30% of them are protected but with a management that is estimated to be ineffective for 40% of these protected reefs and fully effective for only 6% of them (Romon, 2018).

3.5. Improper waste disposal

The combination of population growth, rising tourism, limited land areas and resources available for safe disposal of wastes, has made and continues to make effective waste management a serious challenge in most Caribbean islands (UNEP 2015). Coastal and marine areas have been serving as dumping grounds for marine and land-based wastes, both intentionally and incidentally, while negatively affecting coastal and marine ecosystems, public health and tourism.

In coastal marine areas, the inadequate wastewater disposal is one of the sources of pollution of coastal environments throughout the Caribbean (UNEP, 2001), in addition to the dumping of solid waste, the exploration and extraction of hydrocarbons, the sedimentation, and the discharge of nutrients that cause eutrophication processes. In regards to the spill of liquids in Central America, only

Guatemala has an advanced and integrated system of environmental accounts (State of the Nation, 2015). Another important problem is the overfishing that constitutes a direct pressure on the fishing resources (State of the Nation, 2015). The region in general has an ocean health index (OHI+) lower than the global average (State of the Nation, 2015).

Despite the benefits that we receive from natural resources, these benefits, the environmental degradation of coasts and marine areas suggest, as Lothrop, 2018 points out, that there are weaknesses regarding policies and institutional framework for the management of natural resources.

The dumping of garbage, hazardous waste and sewage from coastal towns into the marine environment has been a common practice, under the misguided notion that wastes would dissipate, with minimal harm to the environment, due to the vastness of the ocean. Only 15% of all sewage entering the Caribbean Sea is treated, due to an inadequate number of operating sewage treatment plants, poor operating conditions and poor disposal practices of mostly untreated wastewater (GEF-CReW n.d). This is a serious health threat not only to locals, but to tourists who visit the region, expecting to stay in a clean and healthy environment. The implications of release of untreated sewage and wastewater has already been seen, for example in Negril, Jamaica where disposal of these wastes deterred diving, leading to a substantial reduction in visitors (Schuhmann 2011). If inaction continues, this result is likely to become wide-spread throughout the region, significantly decreasing the region's demand as a tourist destination.

Untreated sewage effluents, along with excess runoff of nitrogen and phosphorus compounds used in agriculture fertilizers and pesticides, released into the marine environment, contain nutrients and other pollutants that are detrimental to marine ecosystems. Excess nutrients promote algal growth (eutrophication), which can occur naturally. However, in the Caribbean, eutrophication is occurring as a result of sewage and runoff into the marine environment (UNEP n.d). Not only is the aesthetics of the environment lowered, but ecological implications arise such as degraded seagrass and coral reef ecosystems and reduced fisheries production (OECS 2009). Sewage has been identified as one of the main factors contributing to the loss of approximately 80% of living coral in the Caribbean, over the last twenty years (GEF-CReW n.d).

Rivers, streams, mangrove and coastal zone have been repository sites for increasing amounts of solid waste such as plastics, glass, metal and other materials, having considerable impacts on marine life. Poorly managed landfills in close proximity to the coast can become sources of debris, especially during periods of

rainfall, where wastes are flushed into marine environment (UNEP 2001). In Barbados 70-80% of marine litter comes from shoreline or recreational activities, with the majority being single-use plastics. Waterway and ocean activities, mainly fishing, produce around 20% of marine litter in Barbadian waters (Schuhmann 2011). Scientists and researchers have documented a rising number of injuries and in worst cases, death, among fish, marine mammals, endangered sea turtles and sea birds, due to entanglement and ingestion of solid wastes, thus having implications on biodiversity (UNEP 2001). It is important to note that this is a transboundary issue due to the movement of the ocean, therefore release of wastes from the coasts of one country, may ultimately arrive to coastal waters of a neighboring country, stressing the need for regional collaborative action.

3.6. Environmental balance in Costa Rica (PEN, 2018)

The comparisons of the environmental status in 2017 with respect to the trends observed in the period 1990-2016, highlight the way in which Costa Rica promotes its economic growth and the weakness of environmental sustainability in this context. There was an advance in the creation of formal policy tools and efforts to generate information. However, it was not enough for sustainability to be a criterion that accompanies the productive processes and the management of economic and social actors in the use of the territory and natural resources. This situation was evidenced in at least four areas.

Scope 1: The country has great capacity to take advantage of the use of its territory and its resources in order to generate services that promote human development, but also has many limitations to reduce the negative effects of that use and to insure that its economy and life in society are environmentally sustainable. For example, the provision of water and energy to the population, does not have the necessary effort to treat wastewater or to reduce polluting emissions.

Scope 2: The territorial initiatives that have transformed the land use, have not been accompanied by tools to give them sustainability. Costa Rica has 8 ecoregions, a wide variety of ecosystems and a considerable wealth in biodiversity distributed in eleven large conservation areas with biophysical characteristics and land use differences.

In this sense, Costa Rica sets aside a portion of the territory to dedicate it to the conservation of ecosystems, generating the country strength and international prestige. However, the patterns of urban and agricultural use have not derived from instruments of territorial ordering or public policies that ensure their sustainability.

This happens, for example, with the tendency to export products with high environmental impact or with dispersed and horizontal urban growth. The foregoing has direct consequences on water resources, soil affectation and the increase of vulnerability to disasters.

Scope 3: Development of very diversified public institutional sector, denotes tension. In this sense, entities in charge of managing natural resources to provide public services have the greatest technical and financial capacities; However, the Institutions that focus on the care of these resources or on controlling and minimizing the environmental impacts of the productive activity, are weak.

Scope 4: social conflicts also show a mismatch between development and sustainability. In 2017, the mobilization trend was lower in the country, but despite a decline in general, protests over environmental issues were relatively consolidated within the group of collective actions.

It should be noted that the analysis of Costa Rica's environmental performance still faces obstacles due to information weaknesses, not because of a lack of specialized studies, but because of the lack of a consolidated system of indicators, as this is still incipient. For example, for issues such as the import of agrochemicals, there were no data in 2017 since for the first time in several years they were not available and in other cases, the updates are not frequent. On the other hand, highlights the milestone represented by the publication of the State of the Environment Report 2017, presented by the Ministry of Environment and Energy in 2018. This annual report has been a pending task since 1995, as the Organic Law of the Environment had it assigned to the National Environmental Council. If this Report is maintained over time, it will be an important input for the country, whose corresponding analyzes will benefit from the existence of this official source.

From an international perspective, there are few reports, tools and indicators that allow the analysis to be reinforced through comparison exercises. Under this reality, the last measurement of the ecological footprint indicates that Costa Rica remained in debt or with a breach of 58.4% between the use that its population makes of the resources and the capacity of the territory to provide and replace them. In addition, the update of the environmental performance index (EPI) was published in 2018, which classifies nations for their performance on high-priority issues in two areas: protection of environmental health and vitality of ecosystems. Overall, their results show relatively low scores. With respect to 2016, the country suffered a deterioration in its score (from 80 to 67.8 on a scale of 1 to 100) although, for circumstantial reasons, it improved its position in the world, going from 42 to 301. There were

setbacks in five issues, especially in agriculture, water and sanitation, and forests. In climate and energy, fisheries and water resources, progress was reported.

4. Tourism in the Caribbean area

Tourism in the Caribbean area has been growing and changing, from elitist to mass tourism, and has now become essential to most of the economies of the Caribbean islands. But this touristic growth is also causing various issues, notably social, economic and environmental ones. The spatial concentration of tourists exacerbates degradation of natural resources and raises questions about profit distribution, urban planning, access to drinking water or waste management (Dehoorne, Saffache et Augier, 2007). That's why several researches and politic strategies pay more and more attention to sustainable tourism and ecotourism as an answer to these problems, all the more since Costa Rica has initiated a national approach of ecotourism and has become a regional model (Weaver 1994, Raymond 2007).

4.1. Caribbean imaginaries and tropical paradise representations

Traditionally, the Caribbean region is imagined as a "tropical paradise" and an "unspoilt place". Caribbean's position in the global imagination has been repeatedly thought and narrated as a tropical paradise in which the land, natural resources, identities, people and cultures are constantly invaded, occupied, dominated, used, viewed and consumed (Sheller 2003, Feldman 2011). The images of the Caribbean in the wider world relate to the reproduction of colonial/postcolonial power relations.

The development of romanticized place myths contributed as a factor in the rise of organized tourism. The myth of the tropical island appeared during the XVIII centuries thanks to the stories of navigators and explorers (Samuel Wallis, then Cook and Bougainville). Their testimonies and writings contribute to produce in Western industrialized societies, the idealized figure of the island still wild of an uncontaminated nature and the wild man myth (*Robinson Crusoe*, D. Defoe) and the sensuality of a fantasy exoticism (*The Marriage of Loti* is an autobiographical novel by French author Pierre Loti pseudonym of Louis Marie-Julien Viaud, French naval officer). This fascination with the insular island, a relic of an earthly Eden, spreads during the last half of the 19th century through the works of several artists such as Paul Gaugin and Henri Matisse (Staszak, 2006) and continues to be perpetuated today through cinema and films, such as *Taboo, Blue Lagoon, Rapa Nui* and more recently *The Beach* or *Pirates of the Caribbean*. This long process helped to create

the imaginary of a "tropicality" defined from Western culture point of view, which considered it as "a form of itself inferior and repressed" (2003 [1978]). “Tropicality” is conceived as a discourse based on Western ideas, attitudes, knowledges and experiences, which for centuries were shaped by differentiation between temperate and tropical lands, with the “temperate world” constantly exalted over its tropical equivalent (Clayton and Bowd, 2006). These ideas and imaginaries have become central to the definition of tropical as extreme and indolent, both human and physical environment (Clayton and Bowd *op cit*). The imaginaries centred on the vision of the nature still wild and unspoilt place is at the base of the "symbolic attraction of island destinations" (Cazes, 1989), which have transformed several Caribbean countries into important tourist destinations. If the tourist attraction of these places rests on several economic and political stakes, the natural environment is at the heart of the tourist production, that it is about the quality of the beaches and the littoral spaces (Duvat, 2008) or vegetal landscape (Germanaz and Sicre, 2012). Still today in the Western imagination the tropical island is a small territory, colonized by lush vegetation and circumscribed by a coastal strip of white sand, relayed at sea by lagoons with turquoise waters (Dehoorne and Saffache, 2008). This pattern of representations has tended to hide the social and cultural processes as well as power relations implicated in the production of ‘‘tropical paradise”. The metaphors of paradise and plantation, underline how colonization, slavery, domination and exploitation have been intertwined with paradisiacal representations. Several researchers analyse how Caribbean paradise images are sell in the global marketplace are increasingly shaped by international and regional competition under conditions of neoliberalism (Feldman 2011, Wong 2015). Through the analysis of the cultural dynamics of Tobagonian tourism and within the logic of ‘‘unspoilt Tobago,’’ Feldman (2011) emphasis how local culture emerges as a new vehicle for a hegemonic paradise discourse: tourism appears like a pathway to continue colonial subjugation, outlining similarities between the social dynamics of contemporary tourism and the system of plantations, including the extraction of natural resources, hierarchical social organization, dependency on foreign capital and imports, and establishment of political and economic power in the colonies.

The tropical paradise representations tend to refer to Caribbean region as an almost homogenous space. Spatial organisation is very different in the Caribbean region, depending if we talk about mainland or island. Caribbean region is a diverse space of interactions and exchanges, where islands and mainland are articulated through different elements: natural resources, migration, heritages, cultures, economic networks.

4.2. The Caribbean islands: from “backyard” to “pleasure periphery”

Caribbean countries are at the core of many political and economic influences since colonization. The Caribbean region is a strategical space dominated predominantly from United States since the first independences. The region known as “America’s backyard” is characterised by inequality, poverty and instability that conduct most of times to conflicts. In general the countries from the region are characterised by lack of land and natural resources, reinforced too often by inappropriate ways of exploitation of space. Since the 19th century, farms and the agriculture sector are controlled by the United States companies (sugar, coffee, fruits). The economic and social structures inherited from the colonial era have long time prevented any development of the industrial sector and contributed to the economic delay and dependence of the region. In the 20th century the weakness of the economic facilitated the penetration of transnational companies and large fruit companies. The political fragility and lack of social cohesion allowed foreign powers to intervene directly or indirectly in theoretically independent countries. The old colonial powers are still present and the United States effectively occupies through military and economic power a land considered strategic for them (Rouquié 1998, Dabène 2008).

At the same time, the transformations of society in the region are accompanied by a profound change in the economy increasingly oriented towards the tertiary sector. Since the end of the World War II, many small islands in the Mediterranean, Pacific and Caribbean have become touristic destinations (McElroy, 2003), and have been defined as the new "pleasure periphery” (Turner and Ash, 1975) regarding European, North American and East Asian cities. The development of air transport and telecommunications has produced a "geographical opening" (Grenier, 2010) which allowed bringing together these hosting “peripheries” and the “centres” issuing tourists. The first airline routes date back to the early 20th century, especially with the opening of Pan American Airway’s lines between La Havana and the United States. Initially, flights are limited to connections with regional and national airports, from which tourists joined their places of vacation, more or less close. Many island areas remained difficult to access, requiring relatively long local transport (Giordano and Tuci, 2016). By the end of the 1980s, in several small island areas, strategies in favour of tourism are developed, where natural resources are seen as one great chance of development perspective. The proliferation of charter flights and the liberalization of air transportation have increased tourist arrivals over the last twenty years in the main tropical destinations.

However, all these places are not the object of the same infatuation. Indeed the presence of these destinations in the tourist market depends on several factors: have significant natural and human resources, the presence of major touristic facilities

(hotel complexes, casinos, duty-free shops, golf resorts, marinas, etc.), a good communication network with the rest of the world and the political stability of the destination. Finally, according to (Dehoorne and Saffache, 2008) the international positioning of non-independent islands seems easier thanks to the presence of national airlines and an external central authority such as Martinique, Guadalupe or Saint Barthélemy for France, Saint Martin for France and Netherlands, or Cayman Islands for United Kingdom, just to give some examples in the Caribbean Region. All these developments produce a significant growth in the number of visitors. Long-time limited to elitist tourism practices, many tropical islands are entering the era of mass tourism. The growth of touristic flows, in small but often densely populated areas characterized by the fragility of tropical ecosystems, produces numerous social and environmental problems.

Analysing the case of the islands of the South Pacific, Zurich (1995) highlighted a series of critical issues arising from the increasing anthropic pressure generated by tourism, such as the emergence of environmental problems related to the production and waste elimination, the pollution of water resources, the destruction of fish stocks and the loss of natural and agricultural areas due to new urbanizations. Other problems identified are soil erosion, threatened flora and fauna, emergence of illegal hollows and the concentration of industrial activities that contribute to widespread pollution of natural resources. Recently other researchers (Dehoorne and al. 2011) highlighted how economic benefits generated by tourism are unevenly distributed, often in favour of international operators who control an important part of touristic activity. At the same time, they underline the growing privatization of tourist areas that cause discrimination in terms of access between international tourists and residents. In the case of the Caribbean region, present-day tourism reflects to a large extent of the legacy of past colonial practices. The images of the Caribbean in the wider world are related to the reproduction of colonial/postcolonial power relations (Musset 1998, Rouquié 1998, Dabène 2008). The economic and social structures inherited from the colonial era have long time prevented any development of the industrial sector and contributed to the economic delay and dependence of the region. In general the countries from the region are characterised by lack of land and natural resources, reinforced too often by inappropriate ways of exploitation of space. In the Caribbean islands, soils are currently threatened by erosion and exhaustion related to the ways of occupation and exploitation of the spaces imposed by the intensive and monoculture plantation system since colonial times. Deforestation as well contributed to the erosion.

In this sense, McElroy (2003) identifies generally three main reasons for the failure of development policies in these contexts:

Strong pressure from stakeholders on policy-makers to rapidly create new jobs in island economies depressed by the loss of competitiveness of agriculture and secondarily by the end of economic aid linked to the Cold War.

Unbalance power between world-wide tourism operators (airlines, tour operators), interested in developing a mass tourism and island states often characterized by limited resources and skills.

The emergency of the cumulative impacts of mass tourism, which have often found the political decision makers unprepared. In fact, while the economic benefits of tourism development are presented in a linear way (activities diversity, economic development), costs often appear later, when their effects are hardly reversible.

4.3. Urban growth and tourism development in small islands

The evolution of the tourism phenomenon in small islands had a profound impact on island urban areas. These centres, generally small, have undergone rapid growth due to the arrival of functions and services disproportionate to their physical and demographic size. In connection with the idea previously mentioned, Weaver (1993) developed a model to analyse the development of urban areas in small islands affected by a strong tourism development. The model he proposed is characterized by a first phase defined as pre-tourism. This phase does not imply the absence of tourists, but the absence of a tourism sector capable of generating specific services and of transforming the urban landscape on a large scale. Next step is defined as mature. In this situation, the growing importance of tourism organizes the urban space in a series of four concentric areas, with decreasing tourism importance, which have as their centre in the port area. The non-touristic activities, including residential ones, are expelled from the central areas causing strong urban sprawl. The poorest part of the population and economic activities considered as undesirable place the urban question at the centre of development policies. In fact, an unplanned urban development is able to provoke, in contexts with such small dimensions, a series of environmental and social problems that are difficult to predict and control.

Analysing the urbanization processes of small islands and their dynamics is a condition sine qua non to develop strategies that allow preserving their tangible and intangible heritage and ensuring sustainable development. Urban development takes place at the expense of agricultural areas, often rapidly and unplanned, making a clear distinction between urban and rural space. Coastal urbanization caused by tourism flows results in an accumulation of domestic pollution and consequently, irreversible damage to certain very popular sites. Jones and Lea (2007) identify this

type of urbanization as one of the most pervasive phenomena affecting small islands, supporting the need to place the urban question at the centre of development policies.

4.4. Tourism trends and contemporary challenges in Caribbean region: From the island to the coastal regions

The subject of Caribbean tourism in small islands has been studied extensively during the past 3 decades (ECLAC, 2009) parallel with the development of tourism on a global scale. This development enabled the “southern peripheral areas” to be integrated into touristic flows worldwide. These flows were guided by the search of the last virgin and wild areas of the planet. Yet the integration of the Caribbean islands into the touristic globalization has not immediately benefited the coastal regions of Central and South American countries, which were traditionally publicized only by its political violence and conflicts. Yet In the last two decades the situation has started to change.

For example in the case of Costa Rica, the mythical representations of nature and the peaceful representation of a small state without an army are at the core of the tourist identity (Raymond 2007, Boukhris 2012). The power of the tourist imagination has helped to make Costa Rica the first ecotourism destination of the Central American isthmus. Costa Rica was the subject of a positive individualisation process at the origin of its ecotourism destiny made by tourist imagination and the production of tourist places. However, those images are contradictory, since Costa Rica presents high rates of deforestation and a serious economic and social crisis, which calls into question the idea of stability. The power of touristic imagination has also contributed for the construction of territorial symbols and the crystallization of the national collective identification (Boukhris, 2012). Even today the power of images continue to promote those representations, besides the growth of a seaside tourism and resource-intensive model, as well as Costa Rica's increasing role in the “narcotrafic geography”, being no longer just a transit area for drugs but becoming a hub for cartels.

4.4.1. Threats for tourism activity in the coastal regions

The Caribbean climate is a principle resource for tourism that aids in the shaping of the demand (Cashman et al. 2012). However, sea level rise, increasing temperatures, more severe storms and hurricanes, more intensive rainfall and lengthy droughts, all associated with climate change, present significant threats to

the vulnerable coastal area, which hosts a substantial portion of tourism related activities. The effects of climate change have already had devastating impacts on Caribbean economies and according to WTTC (2018), 2017's hurricane season resulted in an estimated loss of 826,100 visitors which had the potential to generate US$741 million.

Accelerated sea level rise has been identified as the most significant impact of climate change for beach systems, which are undoubtedly a major part of the tourism product. Sea level rise can lead to beach erosion and beach loss, as well as damage to tourism infrastructure due to sea encroachment into low-lying areas (Cashman et al 2012). This is especially concerning for low-lying islands such as Barbados where 90% of the tourism plant is along the coast. Sea level rise, compounded with increased severity of storm surges associated with tropical storm activity, will have direct impacts not only on the level of expenditure required to protect coastal properties and infrastructure but also on the funds needed for greater marketing effort to safeguard the attractiveness of coastal properties and attractions. With projections of further sea level rise, beach erosion is expected to continue and possibly increase (Cambers 2009).

Coastal and marine ecosystems such as coral reefs and mangroves are high value assets to the tourism and fisheries industries. The rich biodiversity offered by coral reefs draw snorkelers, divers, sport fishermen from various parts of the world. UNEP (n.d) estimates the reef recreation value in the Caribbean as roughly US$1,654 per hectare per year. These 'rainforests of the sea' are among the most threatened ecosystems on Earth, as global temperatures and ocean acidification increase, combined with existing anthropogenic pressures associated with local development, resulting in loss of ecosystem services, coral bleaching and mortality (IUCN n.d). As reefs lose their biodiversity and integrity, they also lose their attractiveness to tourists, who will be less inclined to spend money to visit degraded reefs. Reefs are further impacted by physical damage due to increased frequency and severity of hurricanes. Degraded reefs host fewer reef associated species available for supply to local restaurants, desirous of serving local cuisine to tourists.

In recent years (2011, 2014-2015 and 2018) the Caribbean region has been facing a new threat, resulting from thousands of tons of pelagic sargassum piling up on beaches and inundating nearshore waters. Scientific studies have identified global climate change as a contributing factor to sargassum growth and proliferation, due to increased sea surface temperatures (Monnereau and Oxenford 2017, Ramlogan et al. 2018). Sargassum influx events have been described as "the greatest single threat to the Caribbean's tourism industry," as islands reported cancellations of vacations and decreases in tourist arrivals during periods of influx events. Marketed

as ‘white sandy beaches and crystal-clear waters,’ many beaches and nearshore waters fell short or this expectation during sargassum influxes, possibly running the risk of being associated with ‘false advertising’. Property values and prospects of investment have declined due to the appearance and smell of decaying sargassum on beaches (Cox et al 2018).

Although the Caribbean region has minimal contribution to the global greenhouse emissions, the region is among the most vulnerable to the impacts of climate change. As the coastal and marine environment continues to suffer from the impacts of climate change, its attractiveness may decrease, and likewise its demand.

4.4.2. Tourism in Colombia

Colombia faces the typical sustainability challenges due to deforestation, large-scale oil spills, pollution and poor environmental practices in different sectors. From being recognized as a country almost exclusively for its complex socio-political situation and violence, Colombia has increasingly begun to be seen as a tourist destination with great natural and cultural heritage potential. The rapid growth of the tourism sector in Colombia have brought important concerns related with its impact on the ecosystems. Coastal environments account for diverse ecosystems such as seagrass, beaches, reefs, sandy soft bottoms, wetlands and coastal lagoons; most of them are affected by the tourism (Enriquez-Acevedo, Botero, Cantero-Rodeloa, Pertuza, Suarez, 2018). The impacts on coastal environments have been investigating on fragile ecosystems such as coral reefs which not only have been dramatically affected by climate change, sedimentation and contamination, but also by the tourism industry, through boat anchoring, species extraction and direct contact of tourist with the reefs (Castro, Pereira, 2016; Jacob-Lozano, Echeverry-Galvis, 2019). But these environmental concerns are mostly linked to the lack of basic infrastructure for roads, potable water, sewage systems, water treatment plants, and disposal of solid waste, as well as informal employment, weak governmental backup and reinforcement of the law[2]. Tourism legal framework is stated in the Law 300 of 1996 and in 2004, the government issued the National Policy for the Development of Nature Tourism, with nine strategic lines: Land policy, infrastructure needs identification, monitoring programs and solving environmental issues, assignment of responsibilities, education for local populations, research, development of quality standards, strengthen of the industry and services

[2] www.sectorial.co/articulos-especiales/item/52652-el-impacto-negativo-de-la-bonanza-del-turismo-en-colombia

marketing[3]. The main objective of these initiatives has been to promote tourism in the country and to turn tourism into a central tool for security and economic development policies (Guilland and Ojeda, 2012). The wish to develop a tourist market in the country has reconfigured the forms of control, use and access to resources. This process of tourism promotion combines, not without ambiguity, the imperatives of environmental and sustainable development and the cultural protection promoted by the multiculturalism state from the Colombian constitution (1991).

Despite the late efforts, the tourism sector impacts started at the Caribbean coast in the 70´s and a decade later in the Pacific coast, due to its rapid spontaneous growth that led to informal land ownership for hotels building without having the infrastructure for basic needs[4]. Tourist activities in both coasts have been marked for its informality and massification, with little or no organization among the elements involved (local communities, local and national government, tourism operators), therefore the development and launch of good practices is crucial for the health of the environment (Alfonso, Hernández, Hernández, 2013; Cortés-Leal, Aranda-Camacho, 2017). At the local level, local communities need to respond and become guardians of the natural and cultural heritage and key actors of tourism at the same time. This double requirement leads to local communities to become a tourist resource through the adoption of a new "tourism consumable identity" (Guilland and Ojeda, 2012).

In the Colombian history, the Caribbean region has been relegated, since independence (1819), to the periphery of the Nation. The Republic symbolizes the rejection of Cartagena (known as Cartagena de las Indias is a major port founded in 1533, located on the northern coast of Colombia in the Caribbean Coast Region) by a country defined by its Andean and continental character and which sees the coastal regions as underdeveloped due to racial, territorial and cultural elements (Cunin and Rinaudo, 2008). In the case of the Colombian Caribbean region, tropical imaginary fantasies are associated with the Afro-Caribbean world, while being in the setting of a Spanish colonial city. Yet foreign tourists can be still reluctant to travel to Cartagena, because of contradictory images and representations. In the last 30 years, the process of tourism promotion in the country employed elements of the Colombian Caribbean culture at national level. The magical realism and the work of Gabriel García Márquez, Nobel Prize in 1982, was also a central element in the construction of a regional identity more wide and rich that goes beyond the afro-

[3] http://www.mincit.gov.co/loader.php?lServicio=Documentos&lFuncion=verPdf&id=64224&name=POLITICA_DE_TURISMO_DE_NATURLAEZA_22_SEPTIEMBRE.pdf&prefijo=file

[4] https://www.ptp.com.co/CMSPages/GetFile.aspx?guid=56e56497-881d-41f6-b23c-4df2d0685f6b

Caribbean and “costeño” predominantly characterised by tropical paradise imaginaries. In other hand and in the case of Sierra Nevada de Santa Marta always in the Colombian Caribbean, the tourism pressure lead the indigenous natives to a strategic essentialism through the re-affirmation of their ties with pre-Hispanic heritage and culture. The purpose of this process was to guarantee territorial legitimacy of the indigenous population and the re-appropriation of its resources, seen as “green guardians” (Guilland and Ojeda, 2012). Colombian legislation regarding cultural rights, material, intangible or natural heritage, considered tourism as an economic resource. In this context, the indigenous communities are obliged to enter in the tourist circuit. Despite this, it is necessary not to fall into the radical stigmatization of tourism as an activity only imposed. According to Néstor García Canclini (1990) “cultural hybridization exposes to the public light the dynamic encounter of different practices that come from many cultural and temporal matrices”. This dynamic process allows to analyse the different scales and issues of tourism in the country as well as the relation with the Great Caribbean.

4.4.3. Tourism in Central America

Tourism in the Central American region has become a very important industry for the generation of financial resources, this despite the 2008 international economic crisis. (Cañada, 2010). Throughout the region, tourism and, in particular, ecotourism, are of great importance for national and local economies (UNEP, 2016)

The proper management of the natural resources available in the region is key to receiving visitors, but also for the impact of these to not be negative. The numbers of UNWTO 2015 indicate that tourism in the American continent was 15.9% in 2014, of which 2% reached the Caribbean and 0.8% reached Central America. In this last region, the leaders in tourist attraction are Costa Rica, followed by Guatemala and Panama.

In the same way, the dynamics of the region have changed in terms of the percentage of generation of financial resources of this segment, which represented 6% of the Central American currencies in 1978, while for 2012 it rose to 17% (UNWTO, 2013).

Since the nineties, the Central American countries united through the declaration of Montelimar to carry out a process of "regional tourism integration, in order to project to the world, the value of this space as a unique destination. (Cañada, 2010)

An important type of tourism for the region is that which is linked to coastal marine zones, from the economic point of view, they generate very important contributions,

for example, it is estimated that tourism in the Caribbean associated with coral reefs is greater than 50 thousand million dollars (Lothrop, 2018). In **Belize,** you can point to places such as coral reefs, which have been essential to obtain a UNESCO declaration as a World Heritage site. On the Caribbean coast of **Guatemala**, there are white sand beaches, a great attraction for tourism, especially international. **El Salvador** offers 300 kilometers of beach in the Pacific, highly valued for sun and sea tourism. **Honduras** integrates the island of Roatan into its tourism offer and the Cayos Cochinos region and its underwater life is especially important. **Costa Rica** offers on both coasts a great variety of beaches that are used both by vacationers and for the development of activities of great ecological importance such as the nesting of sea turtles. Panamanian beaches, both coasts are recognized for allowing the development of different tourist activities including diving, surfing, among others, although it also has important coral reefs on its Caribbean coasts. The region of Bocas del Toro deserves special mention with its cays and islets of great beauty and ecological value. **Nicaragua** has a little developed Caribbean coast, touristically speaking, but the Pacific presents conducive conditions for different types of tourism. In this region, the southern wetlands that make up the San Juan river basin and Lake Nicaragua stand out. On that same issue of reefs, both are found in the Bay of Honduras, in the Miskito Cays in Nicaragua and in the Costa Rican Southeast. (Ellison, S.F.).

In this western region of the Greater Caribbean, the main sites for diving occur in the Mesoamerican reef, which runs from Quintana Roo, in Mexico, to Honduras, including the reef barrier of Belize, and in the eastern part of the Caribbean, the Cayman Islands, Jamaica, Dominican Republic Turkos and Caicos Islands, The Bahamas, British Virgin Islands, The US Virgin Islands, Puerto Rico, Saba, Saint Lucia, Barbados, Antigua, Grenada, Tobago, Margarita Island, Bonaire, and Abrolhos (Brazil) (Lothrop, 2018)

Positive examples of tourism management are found throughout the region, especially in Costa Rica, which is considered the cradle of ecotourism (Mack, s.f.). Some of the opportunities offered by the region for ecotourism are whale watching, mainly in the Panamanian Caribbean or in the Costa Rican Pacific, observation of sea turtle spawning in the Costa Rican Caribbean; in the Pacific North of this same country you can develop activities of diving and snorkeling. In the same way throughout the Mesoamerican reef you can practice sport fishing and other adventure activities, bird watching, sun and beach tourism, cruise tourism, scientific and educational tourism, gourmet tourism, among others (Agardy, Gomez-Garcia, vivas, Vignati, 2016

Along with practices such as diving, the observation of cetaceans is also contemplated, especially on the coast of the southern Pacific of Costa Rica, as well as the observation of sea turtle spawning in both Costa Rican coasts. On the issue of the spawning of sea turtles, it has been estimated that in regions such as Tortuguero National Park in that Central American country that generates up to 8.5 million US dollars in a year (Pendleton, L. Krowicki, F. Strosser, P. Hallett-Murdoch, J. 2014).

5. Conclusion

Colombia and the Caribbean area host some of the most pristine and diverse ecosystems of the world, but they highly depend on natural resources to generate economic growth. By its location in the tropical zone, the countries of the greater Caribbean have a great diversity of terrestrial, marine and coastal ecosystems. These include some of the systems with the greatest biodiversity on the planet, such as tropical forests, coral reefs and mangroves, among others. All of them, moreover, are of medium or high biological productivity and they are of great importance to local economies, but they are very threatened because of the environmental anthropogenic impacts resulting from decision-making and development policy-strategy, as well as territorial model of occupation.

This diversity reveals the great ecosystem importance of the Caribbean Region, however the impacts and environmental transformations, retains much of its natural potential. However, in this context of medium and high potential, it faces not only environmental deterioration, but also climate change. It is expected that changes will affect severely many ecosystems and sectors with the effect to reduce the diversity of plant and animal species, the reduction of available water and hydroelectric power generation, as well as the decrease of the resources and economic activities in coastal areas.

This raises the need to structure articulated policies for protection, conservation and recovery of strategic areas for biodiversity and coastal protection. For this reason, it is important to consider both the conservation of ecosystems as goods and services generated by these, depending on the functional physical connectivity between the different types of environments and ecosystems, at local and regional level.

While the archipelagic Caribbean region can be described as tourism-dependant, some of the regions, especially in Columbia, are still developing their touristic sector. The region thus shows important variations regarding tourism infrastructures, strategic policies and temporalities. Tourism destinations are transformed by the development of tourism, but in different ways according to the type of tourism

activities (cruise tourism, big sailing, long-stay tourism, ecotourism, etc). But all these touristic activities have environmental impacts, which can bring losses to the tourism sector, therefore emphasizing the need to aim at a more sustainable kind of tourism. For example in Colombia, as studies have reported, tourists have a high interest in the environmental issues of the locations they visit and are willing to pay to maintain beach environmental quality, this becomes an important issue for the sector as it is an opportunity to launch conservation campaigns in order to offer good environmental sites.

TABLES

FIGURES

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