

Long-Term Impacts of Non-Sustainable Tourism and Urban Development in Small Tropical Islands Coastal Habitats in a Changing Climate: Lessons Learned from Puerto Rico

Edwin A. Hernández- Delgado¹, Carlos E. Ramos-Scharrón²,
Carmen R. Guerrero-Pérez³, Mary Ann Lucking⁴,
Ricardo Laureano⁵, Pablo A. Méndez-Lázaro⁶ and Joel O. Meléndez-Díaz⁷

¹*Center for Applied Tropical Ecology and Conservation,
University of Puerto Rico-Río Piedras*

²*Island Resources Foundation & Department of Geography and the Environment,
University of Texas at Austin*

³*Instituto para un Desarrollo Sustentable*

⁴*Coralations, Inc.*

⁵*Vegabajeños Impulsando Desarrollo Ambiental Sustentable, Inc.*

⁶*Department of Environmental Health,*

University of Puerto Rico-Medical Sciences Campus

⁷*Department of Environmental Sciences, University of Puerto Rico-Río Piedras*

^{1,3,4,5,6,7}*Puerto Rico*

²*USA*

1. Introduction

1.1 Importance of the coastal tourism and urban construction industries in Puerto Rico

Characterized by a very high biodiversity that include some of the richest, productive, and fragile ecosystems on earth, tropical coastal areas represent the transitional zone between the land and sea (Cenacchi, 2010). Easy access to these coastal and marine resources, in combination with their natural allure, has made coastal resources highly vulnerable to tourism, population growth, and urban expansion pressures. More than half of today's world population lives in coastal areas (within 200 km from the sea) and this number is on the rise (Hinrichsen, 1998; Creel, 2003). In the particular case of the Commonwealth of Puerto Rico (PR) (Figure 1), about 70% of the island's population of 3.7 million live within close proximity to the sea on municipalities that lie adjacent to the coast (U.S. Census Bureau, 2010). Coastal areas are also those which are most visited by tourists, often presenting the most important economic activity. In the Insular Caribbean for example, tourism is one of the premier economic activities. The construction sector and tourism are two of the most important economic drivers in PR (PRTC, 2008, 2009). Tourism is the largest

expanding industry that has substantially contributed to increase employment rates around the world, has represented a significant source of revenue (WTTC, 2005, 2011), and is projected to keep expanding over the next decade. The total number of visitors in PR increased from 4.6 million visitors in 1999 to nearly 4.9 million in 2010 (PRTC, 2011). The number of tourists staying on hotels increased by 28% between 1999 and 2010. Total tourism-related employment increased from 30,225 in 1985 to 54,656 in 2010, or by a factor of 81%. The total amount of employees directly working on hotels increased from 7,300 in 1985 to 12,800 in 2010, or a magnitude of 75%. Overall hotel room availability increased by a factor of 27%, from 11,061 in 1999 to 14,076 during 2010. Overall number of hotel facilities increased by a factor of 15%, from 137 in 1999 to 158 during 15 2010. This has evidently triggered a recent large boom in construction of tourism facilities, but also has launched a major increase in urban development along coastal zones, often intermingled with tourism facilities targeting almost exclusively the upper economic classes.



Fig. 1. Geographic location and subdivision of Puerto Rico's tourism regions.

The commonwealth of PR has become an interesting case study of tourism and urban development impacts on a tropical island scenario due to its socio-politic relationship with the United States (U.S.), and its advantageous socio-economic position relation to other Caribbean nations. Also, the local governing bodies on the island have largely claimed that current local tourism development trends are sustainable, but this claim is yet to be fairly tested. PR has embraced a globalized non-sustainable approach of coastal tourism and urban development that include unprecedented planning strategies and policy moves, with poorly addressed long-term environmental and socio-economic impacts.

PR is a subtropical island archipelago located in the northeastern boundary of the Caribbean Sea (18°N, 66°W). It is the smallest of the Greater Antilles following Cuba, La Hispaniola

(Dominican Republic and Haiti), and Jamaica (Figure 1). It roughly measures 176 x 62 km, and has about 432 km of coasts. Its population in 2010 was determined at 3.7 millions, a 2.2% reduction in comparison to 2000, which was largely the result of migration of residents to continental U.S. due to the recent economic crisis. The topography of PR can be categorized into three main provinces: the interior-central mountainous region peaking at 1,388 m, the karst province, and the coastal valleys (Monroe, 1977). The continuous influence of the easterly trade winds and the PR's geographic location, and topography, generate a somewhat varied maritime sub-tropical climatological canvas across the island. Monthly minimum and maximum temperatures fluctuate little ($\sim 4^{\circ}\text{C}$) between the relatively cooler months and the warmer summer months, but variations of up to $\sim 9^{\circ}\text{C}$ can be expected at any time between the warmer coastal valleys and the relatively cooler mountainous areas (Colón, 1977). The average annual rainfall is approximately 177 cm, but it may fluctuate from roughly 80 cm in the dry southwestern corner of the island up to about 260 cm in the northeast and western-interior regions (Colón, 1977). The diversity of climatological and topographical conditions have given rise to a six life zones ranging from dry sub-tropical forests in some coastal valleys to rain forests in the higher altitude mountainous areas (Ewel & Whitmore, 1973).

1.2 Information gaps and objectives

Many examples of inadequate approaches implemented by the local tourism and urban development sectors may be cited in PR. These include unprecedented planning strategies and policy changes recently implemented by the local government that may make these practices far from sustainable. Many of these must also be relevant to other tropical island nations and will be discussed in this chapter. We have identified the following: (1) *Old-style, non-participatory, top-down approaches* – tourism and urban housing projects being planned and executed without meaningful participation of local communities (Equations, 2003); (2) *Significant permanent negative environmental impacts* – projects built on top of or immediately adjacent to ecologically sensitive habitats, impacts to threatened or endangered species, destructive activities (i.e., dredging, blasting of coral reefs/seagrasses, wetland filling, deforestation, etc.); (3) *Socio-economic degradation* – globalized, top-down approaches of tourism and urban development has often resulted in social and economic marginalization of base communities, increasing unemployment, crime (Diedrich, 36 2006), drug abuse, prostitution (Cabezas, 2009; Padilla, 2007), child abuse (Equation, 2009), declining quality of life, and impoverished livelihoods; (4) *Lax regulations* – local governments derogate stringent zoning and planning regulations, implement flexible environmental standards and establish fast tracking procedures to facilitate permitting processes without proper evaluation that often favor private interests often over public interests; (5) *Non-sustainable operations* – the only model envisioned by local governments as an expected tool against economic crisis is largely based on a non-sustainable approach (i.e., focused on construction on sensitive sites, rapid revenue often at the expense of the environment, very limited revenue to local communities); (6) *Decision-making processes with significant conflicts of interests and corruption* – in many instances government contracted consultants or regulatory agency key personnel are/were also consultants of project developers, or instances where project developers are also significant economic supporters of political parties; (7) *Revenue leakage* – Large portions of the economic revenue of the massive tourism industry often end up on a large trans-national company far from the local community; (8) *Construction is often envisioned as the*

solution to economic constriction – Construction is often synonymized as progress leading to rapid project approvals without adequate planning and environmental impact evaluations, and to project construction on inadequate sites (i.e., sensitive habitats, soils prone to landslides, lands prone to flooding or vulnerable to coastal flooding or tsunamis); and (9) *Climate change impacts are still largely neglected by many local governments as a significant threat* – many nations, including the Commonwealth of PR, are still yet to adequately accept and much less address the threats faced by increasing climate-related impacts, particularly to coastal habitats where the vast majority of the tourism activities and large housing construction occur. Many of these factors, with very few exceptions, have been poorly addressed in the literature as many could be often considered “taboos” by the tourism and urban construction industries, as well as by local governments that do not want to upset the both industries and risk the possibility of maintaining wealthy revenues, even though the private sector of both industries often obtain the largest economic benefits in comparison to that obtained by local governments.

The main objective of this chapter was to identify most information gaps associated to the above topics in a context of a small over-populated Caribbean island, and in a context of the projected climate change impacts. It was also aimed at reviewing some of the existing literature regarding the impact of tourism and urban development on a tropical coastal scenario and discussing some of the most significant case studies and lesson-learning experiences of the historical non-sustainable approaches used by the tourism and housing construction industry in PR. We also examined some of the current controversies regarding the proposed coastal tourism and housing development expansion strategy in PR, as well as some of the most significant climate-related threats. Finally, we addressed the need to implement an alternative sustainable coastal tourism and housing development model, and made specific recommendations for reviewing and modifying existing strategies in a way that could also be helpful for other tropical countries that share similar situations.

2. Case studies from Puerto Rico: A brief history of coastal tourism and urban development

2.1 The early stages: 1910s to 1960s

Coastal tourism and urban development have represented an important and continuously growing economic activity in PR since the late 1910s. However, agriculture following the U.S. takeover of the island in 1898 was the most significant economic activity during the early 20th century. The expansion of coastal tourism offerings in PR was accompanied by a massive urban expansion as the main economic model of the island switched from an agriculture-based economy during the first half of the XX century to an industrial-based one. In year 1919 the Condado Vanderbilt Hotel was built in the capital city of San Juan right in front of the Condado Beach area, representing the first major turning point in the tourism and urban residential boom that occurred in the island. The second most important turning point was the opening of the San Juan Nautical Club (SJNC) in 1930 in the adjacent San Juan Bay. This was the first private marina in PR. The third major episode in coastal tourism development in PR was the opening of the Escambrón Beach Club during 1932. The Escambrón Beach Club was a private club located right at an important public beach in the metropolitan area of San Juan. It involved the construction of the first known breakwater to protect the shoreline from typical strong wave action of the northern coast of the island. It

also included the construction of a boardwalk on the water and an underwater steel fence to prevent sharks and barracudas to access the public bathing beach. Important social events were celebrated on the area for several decades. Development of the Escambrón Beach Club also triggered further tourism development on adjacent coastal lands. The luxury Normandie Hotel, the first major art-deco style hotel building on the island, was opened in 1939 adjacent to the Escambrón Beach and to the SJNC. Simultaneously, there was also the construction of significant urbanized areas on the metropolitan area of San Juan, as well as an increasing number of secondary beach homes built by wealthy families across different coastal municipalities of the island, such as Dorado, Vega Baja and Arecibo, along the northern coast. What is peculiar was that this occurred during the peak of the Great Depression. By that time agriculture had shut down significantly on the island and there was a lot of social and political turmoil. Hotel construction and tourism-related development slowed down during World War II and remained so while important political and socio-economic transitions that lead to the declaration of PR as a Commonwealth of the U.S. were taking place. Then, the emblematic Caribe Hilton Hotel, one of the most important hotels existing in PR, was opened in 1949. Historical aerial image analysis suggest that its construction involved also for the first time extensive filling of adjacent coral reef and seagrass bottoms to expand the coastal lands and build part of the hotel facilities. It also resulted in the creation of the first private artificial beach in the island.

There was a second boom in the tourism and urban construction industries during the early 1950s, after World War II, when important socio-economic changes occurred in PR from an agricultural to an industrial economy with the establishment by the U.S. Congress of the Commonwealth of PR in 1952 and the establishment of the Operation Bootstrap (*Operación Manos a la Obra*) during the administration of then governor Luis Muñoz-Marín (1948-1964). Operation Bootstrap promoted industrialization through several phases: (1) labor-intensive manufacturing; (2) petro-chemical industrialization; and (3) rapid establishment of pharmaceutical industries protected under now extinct federal tax exemptions (Berman-Santana, 1996). Berman-Santana (1996) also established that “one of PR’s most important industrial recruitment tools was the less stringent enforcement of environmental protection laws than on the U.S. mainland”. According to Dietz (1986), “Operation Bootstrap from its beginning was based, at least implicitly, on the assumption that self-interested behavior does lead to public benefit, and on the further assumption that economic growth benefits all classes and groups – i.e., the ‘trickle-down’ theory that the benefits of a growing output gradually spread throughout the social hierarchy”. Tourism and urban construction impacts on coastal areas in PR have been an expression of this. Benefits have been just measured in terms of economic parameters, while ecological degradation plays an insignificant role and is mostly seen as a deterrent to economic development.

Tourism was kind of mixed during 1950s and 1960s in between booming construction as it was needed to foment these industries by allowing investors to come to the island and be willing to put their money down. As a consequence, several foreign investors acquired extensive coastal lands and initiated the construction of new hotel complexes in Dorado (west of San Juan) and Fajardo (northeast PR). Also, one of the most dramatic coastal development socio-economic, cultural and political controversies initiated during the 1960s with tourism development projects that were proposed for Piñones Ward in the municipality of Loíza, east of San Juan, right in the midst of a traditionally underserved community, a case study discussed below. Then, following the 1970s, there was also a

significant increase in “internal tourism” activities, which refers to tourism activities carried out by island residents within the PR archipelago. One of the key drivers of increasing urban construction along coastal areas in PR mostly represents internal tourism in the form of secondary homes used for short-term vacationing during weekends and special holidays. Coastal towns such as Dorado, Lajas, and Rincón, are an example of this.

2.2 Changes in political and socio-economic models: The first significant turn of events in urban construction

The designation of the Commonwealth status of PR represented significant political changes that impacted the socio-economic development of the island. The economic development plan that followed the Great Depression and World War II had some very important consequences in the spatial distribution of the island’s population and its land use patterns. An often mentioned repercussion of PR’s industrialization program was an abandonment of land for agricultural production and a migration of people from rural areas in the countryside to urban centers (Figure 2a) (Grau et al., 2003). According to the US Census Data, (<http://www.censo.gobierno.pr/>), while 60% of the island’s population lived in rural areas in 1950, these areas came to constitute only 6% of the population in 2000. The proportion of the island’s population that lives in municipalities along the island’s coastline has increased to roughly 70% from 1950 to 2000. Census data shows that most population growth in PR has occurred in urban centers on coastal municipalities (Figure 3). Whereas coastal urban centers contained roughly 34% of the total population in 1950, the proportion of the population in these areas almost doubled to 67% by 2000. The growth of the urban sector of the population in PR is a combined result of actual displacement of the population to pre-existing urban areas and a consequence of the new high density urban development patterns which have turned what were previously considered rural communities into urbanized areas.

The total number of dwellings (housing units or ‘*viviendas*’ in Spanish) in PR showed a net growth of almost 965,000 units between 1950 and 2000. Roughly 71% of this net increase in dwellings occurred in coastal towns (Figure 2b). Coastal towns had a total of 683,600 more units in 2000 than in 1950, while mountain towns showed a net increase of 281,300 units. The island-wide increase in the rate of growth of individual units was roughly 6,840 additional dwellings per year between 1950 and 1960. This rate significantly increased and peaked between 1970 and 1980 at 28,000 units per year. Rates between 1980 and 2000 remained high at values ranging between 19,500 and 23,000 units per year. The rate of growth in dwellings on coastal areas has been consistently higher than in mountainous areas since 1950, where growth rates have remained between 5,870 and 19,550 units per year. Remote sensing analyses conducted in various parts of PR corroborate the increased rate of growth suggested by the housing census data. Island-wide assessments suggest a slight but still significant increase in urban areas from 10.8% to 11.4% between 1991 and 2000 (Helmer et al., 2002; Matinuzzi et al., 2007). Meanwhile, smaller scale but longer-term studies conducted in the northeastern and southwestern portions of the island suggest a consistent increase in urbanized area over the last several decades. These smaller scale studies indicate that by the early to mid-1990’s urbanized zones covered between 3% and 32% of the study areas (Figure 3) (Lugo et al., 1996; Ramos-González, 2001; Ramos-Scharrón et al., in prep.). Studies consistently cite the preferential use of the lowland, low-relief coastal valley areas previously used for agricultural activities and pasture for new urban development (e.g., Helmer, 2004; Torres-Marrero, 2003). In the long run, such trends have also resulted in

increased environmental impacts to adjacent estuarine, coastal and marine habitats (Martinuzi et al, 2009).

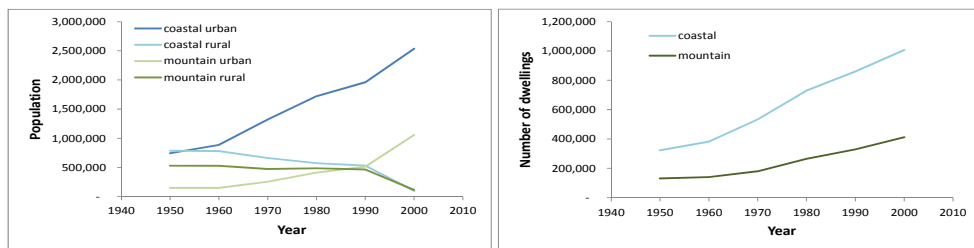


Fig. 2. (A) PR wide trends in population broken down by the number of people living in urban or rural areas and by location relative to the coastline. Population defined as ‘coastal’ refers to that living in a municipality located along the island’s coastline, while those defined as ‘mountain’ are located away from the coast; (B) Time trends in the total number of dwellings in PR from 1950 to 2000. Dwellings defined as ‘coastal’ refer to those built on municipalities with a coastline, while those declared as ‘mountain’ do not.

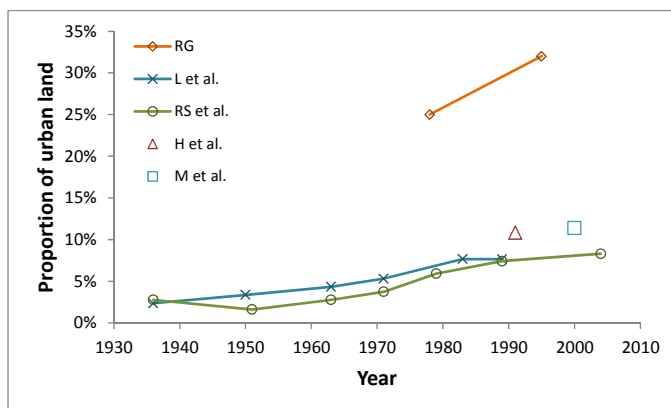


Fig. 3. Time trends in the proportion of urban land in PR. RG: Ramos-González (2001)- Northeastern PR; L et al.: Lugo et al. (1996)-Guánica; RS et al.: Ramos-Scharrón et al (in prep)- Río Fajardo Watershed; H et al.: Helmer et al. (2002)- Island-wide assessment; & M et al.: Martinuzzi et al. (2007)- Island-wide assessment.

While land development on coastal zones is evidently considered to be more prone to induce direct adverse effects on coastal and marine resources, the relatively small size of the watersheds in PR imply that all activities throughout the entire island may indirectly affect downslope marine resources through issues related to water quality. The quality of freshwater that gets eventually delivered to coastal waters is inevitably related to the intensity and extensiveness of land use. Water quality has been found to be inversely correlated with economic development, population density, land use patterns, and other socioeconomic indicators (Biagi, 1965). Therefore, the deterioration of coastal water quality in PR is presumed to have been initiated in the early to mid-1800’s when an island-wide deforestation effort cleared the land for various uses including timber extraction, cattle

grazing, and agricultural production (Birdsey & Weaver, 1987). Change of sovereignty at the turn of the 20th century from Spain to the U.S. favored the extensive use of all available land for massive sugar cane production under a progressively mechanized and more centralized system that favored the use of coastal valleys and wetlands (Dietz, 1986; Labadie-Eurite, 1949; Martinuzzi et al., 2009) and this resulted in its own new set of water pollutants (Biagi, 1968). Assisted by a deliberately deficient enforcement of environmental safeguards, socioeconomic and political development in PR following World War II explicitly encouraged a move towards industrialization at the expense of agricultural production (Dietz, 1986) and environmental deterioration (Berman-Santana, 1996; Concepción, 1988). Even though implementation of this new economic model allowed for the recuperation of an island-wide forest cover (Grau et al., 2003; Rudel et al., 2000), it also introduced its own new set of water quality issues (Hunter & Arbona, 1995) that have established a legacy of documented stress and detrimental effects on marine ecosystems in various parts of the PR archipelago, largely as a result of eutrophication and sedimentation impacts (e.g., Goenaga & Cintrón, 1979; Goenaga, 1991; Hernández-Delgado, 2005; Hernández-Delgado et al., 2010; Hernández-Delgado & Sandoz-Vera, 2011; Larsen & Webb, 2009; Loya, 1976).

Excess sediment delivery to coastal waters is considered one of the most important sources of stress affecting marine resources worldwide (Rogers, 1990). Among the various affected marine ecosystems, coral reefs stand out as they are particularly susceptible to increased sediment delivery rates (Fabricius, 2005; Rogers, 1990). Terrestrial sediments are considered as a major threat to PR's coral reef systems (Hernández-Delgado, 2005; Larsen & Webb, 2009). Land disturbance in PR associated to the deforestation that began in the 1820's and the extensive use of land for agriculture that lasted until the middle of the 20th century was responsible for significantly increasing the rate of soil erosion on the island through the combination of increased landslide activity and surface erosion (Larsen, 1997). The current geomorphic model for PR suggests that while some watersheds had streamflow regimes competent enough to effectively deliver the sediment into the sea, other catchments the stream capacity was insufficient to transport the sediment and this led to sediment aggradation (i.e., deposition) which delayed delivery to watershed outlets. This model suggests that aggraded sediment is still being slowly delivered by the stream through geomorphic processes that include upland channel extension on headwater streams and channel widening and deepening adjustments along the lower elevation valleys (Clark & Wilcock, 2000). Therefore, it is believed that some of the sediment that is currently being delivered to coastal waters from some areas in PR is a legacy of cumulative effects that have continuously affected the behavior of watersheds over the last two centuries.

In addition to the legacy of previous land use practices and geomorphic responses, current land use activities are still responsible for increasing erosion and sediment yields to PR coastal waters. Increased delivery of sediments associated to road construction is a very important component in the sediment budget of mountainous areas of the island as roads tend to increase the propensity for slope failure and landsliding (Larsen & Parks, 1997; Larsen & Torres-Sánchez, 1997). Land clearing trends in support of the little remaining agriculture on the island and construction associated to urban sprawl and tourism stand out as some of the most important active sources of terrestrial sediment on the island. It is important to note that empirical research shows that while agricultural activities may induce a tenfold increase in hillslope-scale erosion rates relative to undisturbed conditions

(Gellis et al., 2006; Smith & Abruña, 1955), erosion rates on barren surfaces typical of construction sites and unpaved roads may represent a one to a four-order magnitude increase relative to background rates (Gellis et al., 2006; Ramos-Scharrón, 2010). Therefore, the combination of a very high road density network that increases the incidence of landslides accompanied by a fast pace of land transformation to urban spaces suggests that current sediment yield rates may be among the highest ever experienced on the island. The manifestation of peak sediment yield rates during a period of fast urban expansion has been documented elsewhere (Wolman, 1967), and it appears to be supported locally by the relatively high suspended sediment yields documented for the island (570–1,900 mg/km²/yr) (Larsen & Webb, 2009) and the marine sedimentation record obtained at specific locations (Ryan et al., 2008). Therefore, the combined impacts of increased construction activities, not only along coastal areas, but also across the entire island, with the lack of implementation of the existing land use plans, and the poor implementation of mandatory erosion-sedimentation control regulations have resulted in long-term water quality degradation by sediments and on declining conditions of coastal ecosystems.

2.3 The Piñones case study: A 45-year struggle against massive tourism

Just minutes away from the San Juan metropolitan area of PR, lies the traditionally underserved community of Piñones with its unique array of cultural, natural, archeological, gastronomic, and recreational resources. With a population of approximately 2,400 residents, Piñones is home to generations of families who have lived in this community for more than 400 years. It extends through 12 km of shoreline and 8,000 acres under the municipality of Loíza. Piñones reflect the richness of the island's Afro-Caribbean culture and traditions, especially in the form of music, food and crafts. It also has an extraordinary diversity of coastal and marine ecosystems, including the largest continuous mangrove forest in PR, estuarine lagoons, channels, swamps and marshes, seasonally bioluminescent waters, native coastal forests, sandy beaches, sand dune formations, coral reefs, and seagrass beds. All these ecosystems serve as habitat for numerous threatened and endangered species. Piñones is also the custodian of more than 120 archeological sites, some of them considered one of PR's oldest archeological remains. The community of Piñones has been historically marginalized by the state and municipal governments through the lack of provision of adequate government services (Guerrero, 2009).

Government land use policies toward Piñones gained a new dimension in the 1950s. The industrialization process fostered by Operation Bootstrap (i.e., 'Operación Manos a la Obra') was combined with an aggressive tourism development strategy, especially in the adjacent San Juan metropolitan area to attend the lodging needs of recently established industrial companies as well as the incipient increase in the number of recreational tourists visiting PR. One of the first impacts was the extraction of the large sand dunes in Piñones during the 1950s to use the material as fill for the wetlands just south of the Piñones' lagoons to build the Luis Muñoz Marín International Airport. The sand extracted from these 10 meter-high sand dunes was also used for the construction of various urbanizations in the metropolitan region adjacent to the coastal zone. This created a permanent problem of shoreline erosion and recurrent coastal flooding (Bush et al., 1995). At that time Piñones became the last frontier to conquer towards the east of the San Juan metropolitan area for residential and tourism purposes. The construction of various residential projects with water-access to the

Piñones lagoons and channels, such as Vistamar Marina in the municipality of Carolina, just east of San Juan, and the establishment of private marinas that required the dredging of La Torrecilla lagoon resulted in significant changes to the lagoon's water circulation, retention, salinity, and sedimentation levels.

During the early 1960s, the government of PR, through the PR Industrial Development Company (PRIDCO), the financial arm of the island's Economic Development Administration, acquired approximately 900 acres in the western part of Piñones to promote the development of massive tourism and recreation projects. Its plans, which included *A General Plan for the Boca de Cangrejos Area* of 1961 and *A Development Plan and Recommended Program for Finca Piñones* of 1968, proposed the construction of thousands of hotel rooms, a convention center, casinos, restaurants, golf courses, tennis courts, and Miami-style marinas throughout Piñones (Adams & Greeley, 1961; OPDAS, Inc., 1968). PRIDCO's investments in western Piñones raised expectations of potential large-scale development in the area fostering other private investors to acquire large tracts of land on the eastern part of Piñones to promote their own tourism and residential projects. As a result, private companies, such as PFZ Properties Inc., acquired more than 1,300 acres on the Monte Grande sector, within the eastern side of Piñones, in 1960. PRIDCO's plans identified Piñones residents as "squatters" and "invaders" that needed to be relocated to San Juan or other parts of the municipality of Loíza. Its plans even established measures to assure that residents were not allowed to construct new houses or conduct renovations within their homes; and were not permitted to inscribe the land title of their property by using the right to *usucapio* (Giusti, 1994).¹ In order to implement its plans, PRIDCO filed an injunction seeking to evict more than 200 families from the western part of Piñones in 1969. The residents responded with a countersuit, aided by the *pro-bono* entity *Servicios Legales de Puerto Rico* (Puerto Rico Legal Services), claiming *usucapio* rights and demanding recognition as formal owners of the land. This lawsuit extended until 1987 when a settlement was reached granting titles to the residents of Piñones through another legal statute that could grant titles to recent squatters, rather than by recognizing the residents' *usucapio* rights. As a result, PRIDCO's plans in western Piñones never materialized or were even implemented. As the community's land title battles with PRIDCO were being solved, PFZ Properties Inc. presented its first development proposal in 1969, *Talega Basin*, which consisted of 8,600 hotel rooms, plus 8,000 residential units in a "concrete city" of seven 30-floor towers with a variety of commercial structures, including a convention center and a large scale marina that required the dredging and filling of most of the property's mangroves and wetlands. The state government did not approve PFZ's first proposal because the proposed construction site did not have the necessary infrastructure (access road, wastewater treatment plant, and flood management controls). However, PFZ resubmitted its proposal for government review in 1973.

The conflicting and contradictory positions in which the government of PR found itself in the Piñones conservation versus development debate were clearly presented in the diverse number of policy determinations, planning exercises, administrative decisions, and research studies conducted by state agencies during the 1970s. While the PR Planning Board (PRPB)

¹ "Under the PR Civil Code and civil law generally, possession for thirty years is enough for a squatter to become full owner even if the titled owner is recorded in the Property Registry. This is the right of *usucapio*, which corresponds to the more vaguely defined "adverse possession" of the common law" (Giusti 1994: 860).

and the Environmental Quality Board (EQB) had approved the sitting permit and the environmental impact statement for PFZ's *Talega Basin* in 1974, the local government also started shifting its perspective towards Piñones by recognizing its ecological singularity. For example, the recently founded Department of Natural Resources published a number of scientific documents that stressed out the uniqueness, extensiveness, and fragility of the Piñones mangrove forest and critiqued the private development proposals that would significantly alter the ecosystem.² In 1978, the PRPB designated Piñones as a Special Planning Area under the 1972 US Coastal Zone Management Act. It also approved other special designations that promoted natural resource conservation within Piñones, such as new areas designated as a Nature Reserve (1979), Critical Wildlife Area (1979), and proposed new areas to be acquired as a future Nature Reserve (1983), including part of the lands that belonged to PFZ Properties Inc.

During the early 1980s, a new series of residential and tourism development projects proposed in eastern Piñones started their permit acquisition processes, such as Proyecto Caribe from the development company Caribe Associates Ltd. In 1985, PFZ Properties Inc. presented a smaller scale version of its previous project with 3,556 residential and tourism units for government approval, as its 1974 project had been halted by a lawsuit that dragged for years with the U.S. Environmental Protection Agency regarding U.S. Clean Water Act violations.³ The tensions that resulted from the 1980s environment versus development debate regarding future land uses in Piñones moved former governor Rafael Hernández-Colón's administration (1984-1992) on February 1988 to conduct a land use planning exercise that would clearly identify the lands that could be developed and those that would be conserved. As such, the PRPB was charged with the responsibility of leading the development of the Piñones Special Planning Area's Land Use Plan. After seven years of public hearings and revisions between two different government administrations, the Piñones Special Planning Area's Land Use Plan was approved in 1995 under the administration of former governor Pedro Rosselló (1992-2000). Without a doubt, the government was expecting too much from a document that merely listed some community, natural resource, and tourism strategies and included as an appendix a land use zoning map. Based on the reality of the Piñones 20-year debate, the government should have promoted a participatory planning process immersed in conflict resolution to try to find true solution to this extensive debate, if one was available. In the end, government ended up doing what it was used to do, "interventions not implementation", claiming it had achieved a solomonic solution towards all stakeholders (Mosse, 2004).

The 1995 Land Use Plan had the goal of "achieving the protection, conservation, and restoration of the different natural systems that compose the Planning Area, and at the same time, promote a limited and ordered ecological-tourism development" (PRPB, 1995: Preface). The state might have claimed this goal, but in essence what it ended up achieving was plotting in a map where hotels could be developed and establishing design and density criteria for constructions. Soon after the approval of the 1995 Land Use Plan and its new permit streamlining process, private companies presented new development proposals

² The Department of Natural Resources' research studies included: Wildlife Management Proposal for the Piñones State Forest (1974); Unit Plan for the Management of the Piñones Forest (1974); The Master Plan for the Commonwealth Forests of Puerto Rico (Division of Forest Planning) (1976); and Puerto Rico's Mangrove Systems (1978).

³ *PFZ Properties Inc. v. Russell E. Train et. al.* [393 F. Supp. 1370 (D.D.C. 1975)]

before the PRPB and the EQB. As a result of this Plan, the following projects were being considered for Piñones by the late 1990s and early 2000s: (1) 1,320 condo-hotel units, 450 tourism villas, and 225,000 m³ of sand extraction (Proyecto Turístico Caribe); (2) 880 condo-hotel units, 42 tourism villas, 1,394 parking spaces, various tennis courts and pools, and retail and commercial areas (Costa Serena); (3) 408 hotel units and 102 villas (PDCM Associates); (4) 290 apartments in 9 buildings (Comunidad Santiago); (5) 122 hotel units, 132 cabins, 27 villas, 5 pools and 40,000 m³ of sand extraction (Vacía Talega Village); and (6) 375 tourism units with 2 golf courses (Casa Grande Resort, Caribbean Links). Together, these projects represented the development of more than 4,000 condo-hotel units, apartments, and villas; sand extractions; a population growth of more than 5,000 residents in a community of 2,400 residents; and an increase in infrastructure pressures for public services that were not optimal for the local community (i.e., water supply, wastewater management and treatment, road capacity, etc.) Public agencies quickly approved the environmental and sitting permits for the PFZ Properties Inc. and the Caribe Associates projects, some without even celebrating public hearings. As a response, community groups, such as the Piñones Residents Association and the *Frente Loiceños Unidos* (FLU), presented several environmental lawsuits against these projects, with the assistance of local universities' law clinics, because of their in compliance with environmental and land use laws and regulations. These community entities constantly prevailed in these lawsuits; cases that ended up establishing important environmental law jurisprudence in PR. After these long-awaited sentences, construction companies desisted in continuing with their development proposals as they were originally conceptualized.

The debate of the future land uses in Piñones continued during the decade of 2000, as the public campaigns and strategies to either promote large scale residential-tourism projects or smaller sustainable tourism development initiatives grew stronger. On March 2007, in a surprising turn of events during the traditional Governor's Message of the State, former governor Aníbal Acevedo-Vilá (2004-2008) announced that he had spoken with Joel Katz, PFZ's President, and that the Government of PR had entered into a collaborative agreement with PFZ Properties Inc. in which the state would acquire his lands at a market price value in order to designate them as a Nature Reserve. With the expropriation of the lands that belonged to PFZ Properties Inc., the 45-year old debate of the future land uses in eastern Piñones was put to a partial end. During the final years of this debate, a broad coalition of community residents, environmental and civic organizations, workers' unions, and academics successfully mobilized public support and influenced national political arenas and decisions in halting the construction of large-scale residential and tourism projects in eastern Piñones. Future sustainable tourism initiatives in Piñones should aim to find a common ground where a vision of the community's future can be delineated through participatory planning mechanisms, deliberative dialogues, and inter-sectorial consensus building.

The Fajardo and Palmas del Mar case studies in a nutshell

The Fajardo story: Displacement of local fishing communities by private marinas

1960s – Construction of Hotel El Conquistador at Fajardo opened the gate of major tourism development across the northeastern PR zone; raw sewage discharged from hotel caused localized coral mortality at Las Croabas fringing coral reefs.

1970s - Construction of two apartment buildings and a private marina at Cayo Obispo, later known as Isleta Marina.

1970s-2000s - Construction of five more large private marinas in Fajardo; physical displacement of residents or displacement from part of their traditional fishing grounds (Miguel "Chan" Dávila, fisher folk and President, *Asociación de Pescadores de Maternillo y Mansión del Sapo*, Fajardo, pers. comm.).

Significant physical alteration of coastal morphology and of adjacent coastal coral reef and seagrass communities due to chronic coastal water quality decline.

Elimination of important essential fish habitats due to dredging, filling, piling, and breakwater construction; changes in littoral drift that caused net increased coastal erosion.

The vast majority of registered recreational vessels in PR (>65,000) are nowadays located within the Fajardo area, which has also created dramatic increases in recreational boating pressure, groundings, anchoring impacts on coral reef and seagrass habitats, oil pollution, illegal garbage dumping, recreational overfishing, and illegal coral collection as souvenirs in the past over the island archipelago across the eastern PR shelf (Hernández-Delgado, 2000, 2005), including Arrecifes La Cordillera Natural Reserve, Culebra Island, Vieques Island, and even up to the U.S. Virgin Islands, and the British Virgin Islands.

The Palmas del Mar story: The first large-scale resort

1970s - construction of Palmas del Mar, the first coastal mega-resort in PR, at the eastern town of Humacao.

1970s - 2000s - Continued expansion of the 1600+ hectare project that include several hotels, some of them right on Candelero Beach, the second largest private marina in PR, and one of the largest of the entire Caribbean region, several apartment walk up buildings, extensive residential areas, many of them as secondary homes, as well as four golf courses and other facilities.

Significant increase in the local demand for freshwater, as well as increases in sewage and solid waste production.

Public access to the coast became severely limited with a complete prohibition of access to some areas, and very limited access to some others due to very stringent rules.

2.4 The Río Grande case study: A dramatic turn of events for the coastal tourism industry

Another major example of unsustainable tourism and residential development was the unprecedented deforestation and filling of continuous mangrove forest, wetlands and other estuarine habitats carried out during the late 1960s by local investment company, *Empresas Díaz*, at Punta Miquillo, Río Grande, in northeastern PR (Figure 1). More than 1,000 hectares of coastal wetlands were eliminated and filled for a proposed large-scale tourist resort and residential development named Coco Beach. This also included a major dredging of a deep

canal across shallow coral reefs and seagrass communities at adjacent Ensenada Comezón for the construction of a private marina. According to local fishermen, these actions caused an irreversible damage to coastal water quality that resulted in continuous sediment resuspension, degradation of seagrasses, and on a massive coral mortality across adjacent reefs, which induced the collapse of the local fisheries. Recent evaluations of Río Grande's coral reefs suggest that no recovery has occurred even four decades after the dredging (Hernández-Delgado, 2005, 2009). Due to major economic constraints, only the first stage of the residential component of the project was built during the 1970s and no resorts were built until 2003. In 1985, and during the administration of then governor Rafael Hernández-Colón (1984-1988) the PR Department of Natural and Environmental Resources (PRDNER) designated the entire zone, as well as its adjacent waters, as the Río Espíritu Santo Estuary Natural Reserve (RESENR), recognizing the critical ecological value of the zone and to counter-balance the proposed tourism development of the area. In spite of the public nature of all beaches in PR, coastal access was already extremely limited across the Punta Miquillo and Punta La Picúas zones at Río Grande due to continuous and increasing coastal construction and land segregation, and very stringent access regulations.

However, during the period of 1992 to 1994, under the administration of former governor Pedro Rosselló (1992-2000), an unprecedented fast tracking permitting system was established across several state government agencies aimed at: (1) establishing a smoother and fastest permitting process in government agencies for developers; (2) fostering a boom in residential and tourism construction activity; and (3) eliminating public participation from planning processes, public hearings, etc. In 1995 and after an unprecedented legal action in PR, the PRDNER eliminated the entire Punta Miquillo zone and the RESENR to facilitate tourism development. Further, during 1996, the Northeast Coastal Tourism Development Conceptual Plan was approved and implemented by the PR Planning Board (PRPB, 1996). This was aimed at establishing more flexible zoning schemes aimed at fostering massive 36 tourism construction across northeastern PR, though this strategy was later expanded to the rest of the island. Following these actions, a dramatic boom in tourism and residential projects occurred in many areas of PR, but mostly across the northeastern coastal zone during the late 1990s and early 2000s. During 2003 two large private resorts, the Meliá and Paradisus hotels, were constructed on Punta Miquillo, with four golf courses across the area, and further restricting public access to the coastal zone and establishing a *de facto* private beach. Current plans include the construction of a high-class resort/residential/golf club developed by multi-millionaire investor Donald Trump which also includes a proposed large private inland marina within the Río Espíritu Santo estuary, as well as two artificial beaches that will require the nearly total elimination of remnant fringing seagrass communities. The entire set of activities that have taken place in the Río Grande area represent one of the most dramatic examples where marginalization of local communities, in combination with unprecedented rapid legal changes in planning, zoning and environmental regulations, resulted in establishing a non-sustainable tourism development model which has had permanent negative irreversible impacts on adjacent coastal communities. According to many local fishers, it has also resulted in permanent impacts on the livelihoods of local communities that historically had depended on the coastal resources as means of recreation and income.

3. Swimming against the current: The still non-sustainable coastal tourism and urban development strategy of Puerto Rico

3.1 Non-sustainable political tactics: Unprecedented changes in land zoning rules, environmental regulations, permitting and decision-making processes to favor tourism and urban expansion plans

The global economic crisis that has characterized the first part of the current century, in combination with the projected impacts associated to climate change, may represent the most critical threats to coastal tourism and urban growth at a global scale. The situation may become more complicated if there is no long-term vision, planning, and a successful implementation of sustainable socio-economic development strategy. In spite of its close political and economic relationship with the U.S., the Commonwealth of PR has been under a constantly changing political atmosphere every four years over the last two decades, but particularly since 1996, when four different administrations alternated between the two main political parties of the island with completely opposite political philosophies have switched power. Though all political administrations have fostered significant tourism and urban development, their plans and strategies have also followed a similarly changing pathway, leading to substantial changes in political tactics which have prevented embracing a sustainable tourism and socio-economic development model. But regardless of their philosophy, all four administrations have managed to maintain a nearly unchanged, non-sustainable approach aimed at rapidly-approving construction activities to sustain the construction sector as one of the principal economic drivers of the island. The most significant changes over the last two decades have included: (1) fast tracking of the government permitting processes, which basically represented the elimination of most steps of the standard bureaucratic burden for developers, particularly those that included public participation through public hearings on regulatory agencies; (2) more flexible state environmental regulations; (3) a massive change of zoning schemes across the coastal zone of the entire island and the island municipalities of Vieques and Culebra; (4) establishment of more flexible uses on each of the existing and new zoning classifications to allow significant construction of tourism and residential projects in areas where previous permitted uses prohibited it; (5) substantial suppression of public participation on planning and decision-making processes; (6) establishment of severe legal limitations through Law 161 of 2009 which created the Office of Permits Management and an Adjudicative Board whose decisions will be considered final to foster permitting fast tracking procedures and halting citizens and communities rights to appeal in court any questionable government decision regarding project approval; (7) adoption and implementation of the regional non-sustainable tourism development plan for the northeast coast as proposed by developers (PRPB, 2006); and (8) the partial elimination of the Río Espíritu Santo Estuary Natural Reserve, Río Grande, to favor tourism and urban construction.

Additional non-sustainable strategies have been also recently implemented in PR, including: (1) inadequate implementation of the highly controversial Ecotourism Law 340 of 1998 that was instead used to foster rapid tourism and urban development on sensitive coastal habitats; (2) inadequate implementation of Sustainable Development Law 267 of 2004 and Law 254 41 of 2006 for the Public Policy for the Sustainable Tourism Development of PR; (3) the most recent change in the political administration resulted in the immediate substitution of the *Master Plan for Tourism and Sustainable Development of PR* by the non-sustainable *PR*

Tourism Strategic Plan 2009-2013; (4) lack of compliance with Law 153 (August 10, 2002) for the Sustainable Development of Vieques and Culebra Islands; (5) elimination of the *Master Plan for the Sustainable Development of Vieques and Culebra Islands*; (6) the elimination of the draft revised and updated version of the *Puerto Rico's Land Use Plan* which proposed the conservation of extensive coastal areas where new large-scale tourism resorts, housing projects, golf courses and/or private marinas are now being either proposed or constructed; (7) the most recent change in the political administration resulted in the immediate elimination of the Climate Change Commission on the House of Representatives (it lasted only about a year and was nearly useless; no public policy was enacted regarding climate change impacts, neither it was replaced with something that might have had better guidelines on which to work on); (8) the failed attempt to enact a proposed new *Coastal Law* that would have allowed extensive tourism and urban construction right on the public domains of the maritime terrestrial zone and on coastal barriers; (9) alteration in the composition of the State Supreme Court to ensure a higher number of judges lined up with the Fortuño's administration philosophy; (10) unprecedented legal decisions at the state court system favoring private constructions on the maritime terrestrial zone, including at public beaches, mangroves and wetland areas; (11) rapid approval of projects mixing urban construction and tourism facilities to foster urbanization across ecologically sensitive coastal areas without full environmental impact evaluation; (12) declaration of tourism emergency in Culebra Island to foster additional construction of hotel rooms under an expedite exception of compliance with existing environmental regulations; (13) the unprecedented total elimination of the Northeastern Corridor Natural Reserve, Luquillo, to favor tourism and urban construction; and (14) According to PR newspaper *Primera Hora* (Justicia-Doll, October 26, 2011), there has been also a dual role of key personnel of several regulatory agencies as government employees and as consultants for private tourism and construction developers.

3.2 The Puerto Rico tourism strategy, 2009-2013: Perpetuation of the non-sustainable model?

The administration of governor Luis Fortuño (2008-2012) implemented the very ambitious PR Tourism Strategic Plan 2009-2013 which fostered tourism expansion by focusing on the construction of large resorts and hotels across the coastal zone of the island. A total of 153 new projects were proposed to be completed between 2010 and 2013. In comparison to the existing number of hotels in 2009, this represents an astonishing 97% increase in the number of lodging facilities within only four years. According to Bauzá-Alvarez of the PRTC (pers. comm., 2011), a total of 27 projects were completed between 2009 and 2011 (17%), while 21 were still under construction (14%), and the remaining 105 (69%) were still in 2011 at some stage of the permitting process. A total of 26% of the lodging facilities were proposed on the metropolitan area of San Juan, followed by the eastern coast (25.5%) and the west coast (19%). Based on the PRTC information (Bauzá-Alvarez, pers. comm.), there would be only a 12% increase in hotel structures in the southern coast and 8% in the central zone. This expansion also included the proposed construction of 18,113 new rooms by 2013. This would elevate the total number of rooms available in the island to 32,189, and represents a 129% increase in relation to rooms available in 2009. Approximately 28% of the proposed rooms will be constructed on the metropolitan area, followed by 27% on the east coast and 22% on the west coast. Only 7% will be built in the southern coast and 2% in the central

zone. Total investment of these efforts were estimated in an unprecedented USD7.89bn, from which 32% will be invested in the eastern coast, 22% in the western coast, 21% in the northern coast, 19% in the metropolitan area, and less than 6% and 0.6% will be spent in the southern coast and central mountain range, respectively. Total investment in recently constructed structures reached USD789 millions. Another USD1.21bn are being invested in projects under construction, while and estimated USD5.89bn will be invested in projects still in the permitting process. According to PRTC (Bauzá-Alvarez, pers. comm.), nearly 70% of the proposed new hotels and other lodging facilities will be constructed adjacent to coastal habitats. As a mean, 57% of the structures already built between 2009 and 2011, as well as 85% of those under construction are located in coastal areas. Another 58% of those still under permitting processes will also be located at coastal habitats. From the geographic perspective, 92% of the proposed hotels for the eastern coast will be located on coastal habitats, as well as 86% of those from the northern coast, 68% of the western coast, 51% of the southern coast and 47% of the metropolitan area of San Juan. The proposed strategy has followed a non-sustainable pattern of further exporting massive tourism to coastal areas, with highly sensitive habitats, lack of adequate public participation in the decision-making and often fast-tracked process, without any guarantee to foster the protection of base-community livelihoods.

3.3 The Northeastern Ecological Corridor case study: Conservation efforts vs. yet another reversal by government in favor of tourism and urban construction

Covering nearly 3,000 acres between the municipalities of Luquillo and Fajardo, in the northeast coast of PR (Figure 1), the Northeastern Ecological Corridor (NEC) has been recognized by Commonwealth and Federal government agencies, as well as local and international conservation organizations, as one of island's most valuable natural areas and one of the Caribbean's great biodiversity hotspots (PRDNER, 2008). According to the U.S. Fish and Wildlife Service (2002), the NEC's beaches are considered the most important nesting site for critically endangered Leatherback sea turtles 30 in all of PR and their second most important nesting site in all U.S. jurisdiction (just after 31 Sandy Point in Saint Croix, USVI). The NEC also supports an extraordinary array of tropical ecosystems, including coastal forests, wetlands, coral communities, and a bioluminescent lagoon. These are home to more than 50 rare, threatened, endangered, and endemic species. Since the late 1970s, local and federal government agencies had proposed that the NEC be designated as a Natural Reserve (PRPB, 1977; US Department of Commerce and PRDNER, 1978). In 1990, a large part of the NEC was designated as a Coastal Barrier under the US Coastal Barrier Act. In 1992, the PRDNER presented an official designation document to the PRPB proposing its designation as a Natural Reserve. Unfortunately, during the election 39 transition process of 1992, the then recently-elected administration of former 40 governor Pedro Rosselló (1992-2000) requested that the PRPB not approve the 41 designation of the NEC Natural Reserve as it wanted to promote tourism development in 42 the area. The Roselló administration's new land use vision for the NEC was approved in the 1996 Northeast Coastal Tourism Development Conceptual Plan, which re-zoned certain parts of the NEC to allow for residential and tourism construction (PRPB, 1996), therefore reverting the historical conservation objectives of previous administrations. After the 1996 Northeast Coast Tourism Development Conceptual Plan was approved, two mega resorts were proposed to be constructed in the NEC: (1) Dos Mares Resort - consisting of 3,450 residential and tourist

units, a 9-hole and an 18-hole golf course, among other related facilities in lands within and adjacent to the NEC; (2) San Miguel Resort - consisting of 1,450 residential and hotel units and two golf courses, of 18-holes and 9 holes each, among other related facilities. Over 80% of the units proposed by both projects were exclusively residential, which seriously undermined the developers' claim that these were tourism projects. If constructed, the Dos Mares Resort and the San Miguel Resort would result in massive deforestation, soil erosion, land movement, filling of wetlands, channelization of rivers, and the removal of coastal vegetation, significantly impacting many of the protected species and other living resources that depend on the NEC. The project's golf course maintenance practices would include the use of toxic substances such as herbicides, which could affect the water quality of surface, underground, and coastal waters, including adjacent coral reefs. In addition, both projects would severely limit public access to the NEC's beaches, public lands and other public natural resources, as would further increase the competition for water supplies needed by local communities, and thus potentially affecting the quality of life of thousands of citizens in the eastern region of PR.

As a response to these threats, a coalition of local community and environmental groups, organized under the NEC Coalition, initiated a public campaign to protect the NEC as a Natural Reserve with the vision to promote its economic development through the sustainable construction of eco-hotels and the operation of small-scale nature tourism amenities, as well as the revitalization of adjacent town centers that could serve as gateways to this natural protected area. After 10 years of public campaign, the Coalition celebrated the decision of former governor Aníbal Acevedo-Vilá (2004-2008) of signing an Executive Order on October 2007 that established as public policy the conservation of the NEC as a Nature Reserve while promoting its sustainable tourism development (Commonwealth of Puerto Rico [CPR], 2007). After the approval of this Executive Order, the NEC was officially designated by the PRPB as a Natural Reserve in April 2008, more than three decades after it was originally proposed by the PR Coastal Zone Management Program in 1978 (CPR, 2008). In addition, local agencies presented a Comprehensive Land Use and Management Plan for the NEC through a participatory planning process with the purpose of establishing clear guidelines for the development of outdoor recreational and ecotourism facilities in the area (PRDNER, 2008). This Comprehensive Plan was endorsed by a wide array of Commonwealth and Federal agencies, academic institutions, local community groups, as well as local and international conservation organizations. The USFWS and the National Oceanic and Atmospheric Administration (NOAA) also supported these efforts by assigning more than \$3 million in funding for the acquisition of private lands in the NEC, as a means of strengthening its conservation as a natural protected area.

In spite of this extraordinary conservation story, in another unprecedented action in the legal history of PR, governor Luis Fortuño (2008-2012) eliminated the NEC designation as a Nature Reserve on October 30, 2009. On June 28, 2011, the Fortuño administration approved the new Great Northeastern Reserve, as well as a new Special Land Use Plan that promoted the fragmentation and urban development of the Corridor by allowing the construction of residential-tourism projects within 450 acres of the former Natural Reserve (PRPB and PRDNER, 2011). Coincidentally, these 450 acres coincide perfectly with the urban development footprint of former residential and tourism projects proposed at the NEC, such as the San Miguel Resort, the Dos Mares Resort, Paradise Found Villas, and Seven Seas

Resort, among others. The direct, indirect, and cumulative threats of this new special zoning plan are significant: heavy human use, artificial light and noise, increased run-off, and downstream pollution of future developments will vastly change the character of the undeveloped forests and beaches of the Corridor, will permanently and unavoidably damage important ecosystems and its related species, and will eliminate the NEC's extraordinary recreational, tourism, and economic development potential as a regional, low-impact ecotourism attraction. The NEC Coalition is currently engaged in continuing its campaign in favor of the NEC, specifically urging the government of PR to reinstate the designation the NEC as a Natural Reserve in its totality and reverse its decision to open this extraordinary ecological area to residential and tourism construction.

3.4 The Dorado-Arecibo northern PR segment: Non-sustainable urban and tourism expansion threaten several natural reserves, coral reefs, and access to the coastal zone

The coastal segment that lies between the municipalities of Dorado and Arecibo along the northern coast of PR (Figure 1) has sustained a dramatic increase in urban development over the last decade, particularly following the completion of highway PR-22, the main transportation artery connecting San Juan with the northern and western portions of the island. In particular, the municipalities of Dorado and Barceloneta experienced a 12.2% and 11.2% population increase during 2010 in relation to 2000 (U.S. Census Bureau, 2010). Also the adjacent town of Toa Alta showed a 15.9% population increase. These figures contrast with the mean 2.2% population loss of the entire island during the same period and suggest the rapid urban expansion trend of the zone. In the case of Dorado and Vega Alta, there has been a boom in urban sprawling (horizontal construction) across the coastal alluvial plain. But most of the recently proposed projects are focused in the construction of tourism resorts with mixed residential components along the shoreline. Examples of these include a failed 300 acre resort named Playa Hermosa at Cibuco Ward, Vega Baja, which would have directly impacted the Cibuco River Swamp and Mangrove Natural Reserve, as well as several traditionally underserved communities and the Maisabel archeological site. During 2002 a very large apartment complex named Chalets de la Playa was built right on the Vega Baja beach named Tractores, with buildings constructed between 70 and only 45 meters from the shoreline. Some of these structures are in open violation of the existing maritime terrestrial zone restrictions for constructing permanent structures within 50 meters off the shoreline. Tractores Beach still supports the largest and more dense thickets of threatened Elkhorn coral, *Acropora palmata* across the northeastern Caribbean (Hernández-Delgado et al., 2011). The apartment complex was built right behind a remnant sand dune, with its concrete fence right on the maritime terrestrial zone, less than 20 m off the shoreline, impeding beach access, and causing recurrent turbid runoff of storm waters from a retention pond located just 28 meters off the shoreline that reach the adjacent Acroporid reefs and cause recurrent coral and benthic invertebrate mortalities. The original project included a proposal to construct an artificial beach that would have included blasting of existing beach rock and rocky bottoms along the shore, the total elimination seagrasses, partial elimination of reef habitats, the construction of several breakwaters and massive sand filling of the area. Even without completing a full environmental impact analysis and completing its permitting process, this proposal even went to the stage of permit application at the U.S. Corps of Engineers, but local communities got organized, strongly opposed, and defeated it.

Local insults along Vega Baja beach continued during 2011 when an illegal gas station constructed at only 150 meters from the maritime terrestrial zone, and adjacent to Chalets de la Playa in 2008 was opened after three years of struggle with opposing local communities due to the direct intervention of the PRPB which modified an existing rule that prohibited the construction of gas stations within a given distance from another one. This project never had an environmental impact analysis and originally was constructing a 60 cm wide pipe to discharge oil-polluted storm waters directly atop an *Acropora palmata* reef known as El Eco, but was stopped again by the community organized under non-governmental organization *Vegabajeros Impulsando Desarrollo Ambiental Sustentable (VIDAS)* when the pipe was only about 30 meters from the shoreline. The pipeline was removed and substituted by an underground tank which is presumed to leak towards the water table. Due to the porous nature of the underlying rocks, water-borne pollutants are expected to have access to adjacent reefs. Due to the karstic nature of the soils, pollutants should be easily reaching the adjacent reefs. No actions from regulatory agencies have been taken to prevent pollution. In addition, another apartment complex called Vegamar Apartments was proposed right across the maritime terrestrial zone of Sarapa Beach, Vega Baja. In this particular case, *VIDAS*, in collaboration with other representatives from the local communities, took legal action to stop the project which would have impacted about 8 acres of coastal lands and beach access to the most significant surfing beach of the zone, which also harbors important remnant patches of Elkhorn corals. Although the community has prevailed in their legal action, the case was appealed by the developer and is still under review by the PR Supreme Court. For the record, former Vega Baja mayor Edgar Santana (2004-2011) was sentenced to 18 years in prison in 2011 for extortion and bribing several local developers, some of which were associated to several tourism and urban projects across the northern PR region. Also, the municipal government of Manatí was recently proposing the construction of a tourism resort right at the public beach of Los Tubos. These are not only public lands, but also part of the legally-defined buffer zone of Tortuguero Lagoon Natural Reserve. The project did not even make it out to the permitting processes due to the strong opposition of organized local communities and *VIDAS*. As an alternative, the municipal government is currently considering low-impact tourism development alternatives proposed by local residents.

There was also a recent dramatic case of a forced expropriation and destruction of many houses of residents of the traditionally underserved coastal communities of La Boca, Palmas Altas, and Isla del Roque, in Barceloneta, earlier in 2011. The dramatic part of the history is that there was no previous negotiation, administrative or legal actions in the process, and the forced action was ordered by the own mayor of Barceloneta, Sol Luis Fontánez (1986-2012), who was promoting the privatization of these lands for the construction of tourism resorts and apartment buildings by several private investors. Base communities got eventually organized and took legal action against the municipality to stop further structure demolitions, a process that is still in court. Further, Mayor Fontánez was put into jail in February 2012 with Federal charges of corruption and bribery in agreement with private developers. He is currently waiting full trial. Also, state road PR-681, which runs parallel to the shoreline from Barceloneta to Arecibo, has also become another hot spot for a variety of proposed projects. A very large urbanization was recently approved at flooding and tsunami-prone lands right adjacent to the protected wetlands of Caño Tiburones Natural Reserve, Arecibo. Also another apartment complex has been proposed right adjacent to the beach at Cueva del Indio Natural Reserve, which also harbors one of the most significant

archeological sites in PR. Another mega-resort named Island Cove has been proposed for construction along the beach adjacent to this Natural Reserve, while an apartment complex has been proposed right within the maritime terrestrial zone at Peñón de Mera, Arecibo, just off the Arecibo lighthouse, and eight apartment buildings have been also proposed right in front of the local beach called Caza y Pesca, at Arecibo. The northern coastal area of PR has become a very threatening and dangerous example of the consistent, negligent, corrupt, unscrupulous, and often illegal pattern of tourism and residential construction that is being forced in conjunction by private investors, as well as state and municipal governments, even in open violation of existing state and federal regulations, and under an absolute negation of the potential risks of constructing permanent structures along the shoreline in a time of unequivocal climate change and rapid sea level rise (see Titus et al. 2009). Though most, if not all of these approaches have faced strong grassroot and often legal opposition by traditionally underserved communities. However, these actions have not been enough to stop the massive assault to natural coastal resources and to base communities that have existed for generations on these areas.

Culebra Island in a nutshell

A history of bombs, land abuse, and environmental corruption in paradise

Culebra is an archipelago composed of 23 islands or cays, located equidistant between the island of PR and the island of St. Thomas, USVI (Figure 1). The main island of Culebra measures about 11 x 7 km, and has roughly 2,000 residents. It was inhabited by pre-Columbian Taíno indians, colonized by Spain in 1880, and then moved under U.S. jurisdiction as spoils of the Spanish-American war in 1898 (Feliciano, 1976). By virtue of a presidential decree, vast extensions of Culebra became property of the U.S. Navy in 1901, becoming a military training facility for nearly eight decades (Delgado-Cintrón, 1989). The U.S. government deprived locals entry for swimming or fishing of much of their own waters because of the military target maneuvers (Feliciano, 1976). The original old town of San Ildefonso de la Culebra was destroyed and wiped out by the U.S. Navy and residents were relocated to different areas of the island. A concerted effort was made by the military to drive residents completely off the island (Feliciano-Encarnación, 2009). For decades, the Culebrenses lived under the constant harassment of restless ship to ground and air to ground bombing activities and artillery practices at any time, women were harassed or sexually abused by military personnel, navigation, fishing and beach recreation were prohibited, and no forms of tourism or urban development existed in the island until the late 1970s. Under the strong leadership of former mayor, the Honorable Don Ramon Feliciano-Encarnación (1958-1980), who was also a fisherman, and with the legal assistance from a young, idealistic Harvard educated lawyer, Richard Copaken, 750 local families in both non-violent and physical protest managed to end the over 70 years of abuse of their islands for international military target practice in 1975 (Copaken, 2009; Feliciano-Encarnación, 2009).

With strong financial incentives provided by the US Coastal Zone Management Act, the Culebra Segment of the Coastal Zone Management Plan (1976) was created with emphasis to protecting Culebra's stellar coral reefs. In order to receive the Federal funding associated with the coastal zone management plan, the Government of PR agreed to put into place Law 66, 1975 - unprecedented environmental legislation that sought to balance

development to conservation. The plan was based on a low density zoning for Culebra. Law 66, 1975 also created the Culebra Conservation and Development Authority – a board comprised of Federal and local government officials intended to ensure Culebra's future development was locally controlled and sustainable. Culebra Island also got its own Land Use Plan in 1977. Therefore, the island rapidly got unique unprecedented land planning and regulatory tools. By the mid-1980s, and only a decade after the military abuse ended, and under the administration of former mayor Anastacio Soto-Ayala (1980-1996), Culebra enjoyed a steady unemployment rate of only 2%, with 0% involuntary unemployment. A high caliber repeat tourist visited the island specifically to enjoy nature, peace and tranquility, and the unique island culture. While project proposals increased in late 1980s to late 1990s, local government leadership staved off development pressures until the administration changed in 1996. At this time, the local administration of the late mayor, Abraham Peña-Nieves (1996-2000; 2004-2011*died in October 2011), and under former governor Pedro Rosselló administration (1992-2000), shifted toward a fast tracked project approval and construction, compromising meaningful public participation and the island began feeling the irreparable harm of unplanned coastal tourism development.

The first visible large-scale resorts, Costa Bonita (now Sea Breeze Hotel after the latest of five bankruptcies) and Bahía Marina seeped onto the island without previous meaningful public participation. The area proposed for Costa Bonita was a hillside peninsula bordered by USFWS National Refuge mangrove wetlands, the outskirts of which were being considered for protection as a Federal Bird Sanctuary - Canal de Bruly. All neighboring property owners opposed the change in the protective zoning needed for the project to proceed, but the developer partnered with the PRTC and declared a state of "tourism" emergency. The emergency proclamation declared that Culebra needed more hotel rooms. This allowed a rule of exception to variance, and the protective zoning was eliminated despite public opposition, soil constraints and proximity to Federal Refuge. Coastal mangroves were removed and swimming pools were built inside the salt flats of the project, within the public domains of the maritime terrestrial zone. More significantly, this resort was built on areas considered as having a medium risk for unexploded ordnance (UXO), adjacent to an area investigated for chemical clean up - in an area formerly used as NAVY training grounds. In addition, this development was located on an apparent former Taíno indian village, still lacking an adequate archaeological evaluation.. Over the past decade overall tourism and housing construction on Culebra has largely represented a snake eating its own tail. While the delayed development on the island offered some hope of the incorporation of lessons learned from other islands, lack of municipal leadership and the failure of both local and federal agencies to implement their non-jurisdictional duties of oversight seem to have doomed the future of Culebra to the same short-sighted fate of unsustainable tourism development that harms the coastal resources of other Caribbean islands, including the main island of PR. Further large-scale housing projects, which are hidden under the eco-tourism umbrella, are under different stages in the permitting process. These include the 100 acre resort Villa Mi Terruño, villas at Posada del Coronel, the small resort Villas de Andrades, and the large-scale resort Villas de Carenero, which has also proposed the construction of the first large-scale private marina in Culebra.

In spite of being proposed as "sustainable" and "green", the project called Villa Mi Terruño

("Villas of My Native Land") proposed the first access-controlled urbanization for the island and included 110 luxury residences, two hotels and commercial space on less than 94 acres. But in early March 2012, the PR Appeals Court resolved in a lawsuit initiated by local non-governmental organization Coralations that the Planning Board approved the project without complying with the density parameters established for Culebra. These special, low-density zoning parameters were implemented to protect the ecological integrity of the island and her beautiful coral reefs. Therefore, this stopped the project at least as it was originally proposed. There have also been several recurrent attempts to block historical public beach accesses by private owners at Bahía Mosquito, Playa Manzanillo, and the emblematic Playa Flamenco, some of which have resulted in futile legal actions against local residents for alleged trespassing. Further, state and federal regulatory agencies have issued illegal permits for construction in highly sensitive watersheds and steep slopes that have resulted in dramatic impacts from erosion and sedimentation on adjacent coral reefs, seagrass communities and turtle nesting beaches (Ramos-Scharrón et al., 2012). In addition, Cayo Norte, a small private key located north of Culebra, was recently sold in a bid to millionaire investor, Daniel Shelley, who also owns the largest marina in the Caribbean, Marina Puerto del Rey, located in Fajardo, PR. There are already permits approved to initiate development of the cay and to construct a pier. There is fear in the community that a large-scale resort and marina will be constructed on the cay. There certainly will be no hope for Culebra unless meaningful public participation in planning and responsible local and federal agency oversight is restored. Today Culebra has lost much of the natural value it possessed during the past decade, some via direct impacts to coastal resources, to climate change, and other due to lack of meaningful oversight or direct corruption of a legitimate planning process. The island serves as another example in the data base of islands that demonstrate sustainable tourism development fallen prey to short sighted corruption.

4. The rapid-growing cruise ship industry: Increasing revenues, but for who?

According to Murray (2005), cruise tourism has been the fastest growing sector of the tourist industry for the past decades. Since 1980, the industry has had an average annual passenger growth rate of 8.1% (Dowling, 2006). Cruise tourism has exploded around the Caribbean during the last two decades (Brida & Zapata-Aguirre, 2008). This growth is expected to continue into the future (CLIA, 2005; Dowling, 2006). However, the economic bonanza attributed to the cruise ship industry can be misleading because they are not corrected for leakage—the occurrence of tourist revenue flowing out of the country in which it was spent, a particular problem for many small islands (Loper, 2005; Squillante et al., 2004). One of the most critical concerns by residents from small island nations is the final destiny of economic revenues associated to the cruise tourism industry. According to Brida and Zapata-Aguirre (2008), more than 50% of land-based activities are sold on board by the own cruise ships. From the value paid by cruisers for on shore activities, the local tour operator is left with a level of only 50% to 25% of that value. Tourism service providers who want to appear in advertisements delivered on board (videos, brochures, etc.) have to pay significant amounts for it. Others incomes provide from private "dream islands", privatized islands property of each cruise line, most often within the territorial waters of developing island nations. This clearly reduces or eliminates the economic benefit to communities not to disembark at the

destination. As a result, unequal revenue distribution has been associated with social and environmental costs to local people (Diedrich, 2006, Diedrich & Buades, 2009), which have also to absorb the socio-economic and environmental burden of massive pulses of visitors to locations which often lack most of the necessary infrastructure to support such level of visitors. Such a wrong economic model drives even some of the alleged green tourism far from sustainability, often creating a situation of environmental injustice. There are also issues of tourist pack behavior. A key impact of cruise tourism is the delivery of substantial numbers of tourists to remote destinations (Davenport & Davenport, 2006), and its consequent localized pollution pulses on port cities that may often lack adequate infrastructure to cope with a high density of people, pollution, etc. Overcrowding caused by this behavior can inconvenience and annoy local residents, causing the locals to alter their daily behavior to avoid the central business district while cruise ships are in port (Loper, 2005). Also, local residents from port cities have complained about deriving little economic benefits but feeling a loss of quality of life on the other (London, 2005). Thus, socio-economic benefits vs. the cost of impacts need to be weighted in the formula, besides considering only the economic revenues, when strategies for expanding the tourism industry are considered by local governments.

Cruise ships operations also generate significant environmental pollution. This results in direct discharges to the marine environment, including sewage, gray waters, hazardous wastes, oily bilge water, ballast water, and solid waste (Brida & Zapata-Aguirre, 2008). Cruise ships often dump this waste, legally or illegally, into international waters, which are carried by currents throughout the Caribbean and Antilles. They also emit air pollutants to the air and water. The environmental costs of the sector are incalculable given that the cruise ship industry is unregulated and impacts are difficult to gauge. Even small-scale incidents such as propeller wash (i.e., Cozumel Island, México, 2005) and anchoring can produce substantial physical damage on coral reefs habitats (Dinsdale & Harriott, 2004; Rogers & Garrison, 2001). This represents an extremely high environmental and socio-economic cost for an operation which is still too far from sustainable. Further, local governments in many small island nations have recently invested large amounts of money in high quality infrastructures to attend the new lines of colossal ships and thousands passengers arrivals but without any assurance that the benefits of attracting cruises to a tourism destination are higher than the costs (Brida & Zapata-Aguirre, 2008). Therefore, the rapidly growing cruise tourism industry is actually forcing local governments from poor small nations to invest money on building new infrastructure to prevent large cruise lines from abandoning the destination.

5. The tourism trade-off in small tropical islands under climate change

5.1 The globalized tourism industry: Is the enemy within?

Tourism has irrevocably altered tropical islands in many ways. It is impossible to keep an island completely untouched, but in many cases the coastal tourism and urban development industries have done irreparable harm to fragile natural resources, which often have long-term socio-economic consequences and alter the livelihood of local communities (Diedrich, 2006). Globalized large-scale tourism operations (i.e., cruise ships, hotels, shore-based excursions) affect tropical islands culturally, economically, and environmentally. It may

often treat local cultures as spectacles for visitors. Ethnic groups are often viewed as a major “exotic” asset in attracting visitors (Pleumarom, 1995). That type of exploitation often generates more revenue to the tourism companies than to local communities (Diedrich, 2006, 2010), and according to McDaniel (2008), “tourism development can become the worst enemy of tourism development: The concept of tourism development being hijacked by for-profit developers without any interest in the conservation of natural resources, in sustainable practices or in fostering community development and integration into the tourism development model”. Under such globalized increasing economic pressure, local island governments often feel charged with promoting and further developing their island's tourism industry and infrastructure because of massive tourism's dominance in the economies.

Coastal habitat destruction for the construction of tourism facilities and urban development, dredging, filling, shoreline modification (i.e., beach renourishment, artificial beach and breakwater construction), urban pollution (i.e., stormwaters, sewage, oil), heavy boating, recreational misuse, and overfishing can cause irrevocable damage to the delicate ecosystems of the islands and always contribute to permanent water quality degradation, which in turn cause a aesthetical value decline of local coastal resources for tourism (Goenaga, 1991; Hernández-Delgado, 2005; Hernández-Delgado & Sandoz, 2011). Tourism can harm wildlife endemic to the islands via the indirect introduction of alien invasive species throughout habitat fragmentation, deforestation, and other forms of alterations of native flora and fauna. Alien species can threaten endemic species by competing for habitat space, disrupting the community trophic chain, or introducing foreign disease. Also, tourism pressure can result in significant land degradation. Important land resources include minerals, fossil fuels, fertile soil, forests, wetlands and wildlife. Increased construction of tourism and recreational facilities, as well as residential projects, has increased the pressure on these resources and on scenic landscapes. Direct impact on natural resources, both renewable and nonrenewable, in the provision of tourist facilities can be caused by the use of land for accommodation and other infrastructure provision, and the use of building materials. Forests often suffer negative impacts of tourism due to deforestation caused by fuel wood collection and land clearing for construction of infrastructure. More recently, off-road vehicles have become extremely popular during the recent decade in PR, resulting in localized increases in habitat fragmentation, increased erosion of steep slopes, sedimentation of watersheds, filling of critical habitats for riverine fauna, and oil pollution of nearly pristine rivers. Even the PRDNER approved in December 2011 a private concession to operate off-road “eco-vehicles” to an unexperienced company within the Guánica State Forest, which was also designated in 1982 as a Biosphere Reserve by UNESCO. Permit was issued without public hearings and without environmental impact assessments. But strong opposition by adjacent communities, environmental organizations and academics stopped the proposal in January 2012.

Construction of coastal tourism and urban infrastructure in small islands can also exacerbate problems of space, resource availability, and coastal access for local residents to live on, and as well as taking away from the natural beauty of the island itself. The millions of tourists and travelers annually consume local resources such as energy, water and food, which have a significant impact on the local environment and ecosystems. Tourists consume exorbitant amounts of water, electricity, seafood, as well as many imported goods. Under very high consumption rates it may cause shortages and price fluctuations in many resources on small

islands. Most islands with excessive water consumption often lack significant surface or underground sources of water to meet local pulse demands. Many large tourist resorts can potentially use on average five to ten times more water than residential areas in the Caribbean, and though many have resorted to expensive reverse osmosis to desalinate seawater, many local governments, such as in PR, have given high priority and supply water to tourism facilities and adjacent wealthy residential areas instead of securing a permanent water supply to local traditionally underserved communities. The tourism industry generally overuses water resources for hotels, swimming pools, golf courses and personal use of water by tourists. This can result in water shortages and degradation of water supplies, as well as generating a greater volume of wastewater, particularly, where water-consuming facilities have been established (i.e., golf courses). Golf course maintenance can deplete fresh water resources (Warnken et al., 2001). In recent years golf tourism has increased in popularity and the number of golf courses has grown rapidly, including PR, where there are already 20 golf courses. From these, 50% are located on the northern coast, 25% in the east, 10% in the west and south, respectively, and 5% in the central area. The largest concentration of golf courses is located in the coastal municipality of Dorado, with 5, followed by Río Grande with 4, Humacao with 3, and Fajardo with 2. In addition, at least 4 golf courses have been proposed for the NEC area in Luquillo. If approved, it will result in having a total of 10 golf courses in a 20 km stretch of coastline in northeastern PR. Golf courses require an enormous amount of water every day and, as with other causes of excessive extraction of water, this can result in water scarcity, as well as in significant impacts on adjacent wetlands, mangroves, rivers and coastal waters associated to habitat destruction, water diversification and the use of pesticides and fertilizers (McLean, 1993; Pleumarom, 1992). If the water comes from wells, overpumping can cause saline intrusion into groundwater. Golf resorts are also more and more often situated in or near protected areas or areas where resources are limited, exacerbating their impacts. Snow (1993) estimated that golf courses in humid areas across eastern U.S. may use between 10 and 20 MGY of water to maintain, while those across the arid southwest may require up to 500 MGY, amounts substantially larger than any regular community.

Tourist facilities, as well as large-scale urban development along coastal areas also increase pollution levels. Though many resorts have significantly improved their sewage treatment facilities, often using reclaimed water for irrigation purposes, there are still many areas where sewage is being emptied on adjacent beaches creating a significant threat to swimmers and to adjacent ecosystems from high fecal pollution (Kocasoy, 1995; Bonkosky et al., 2009). Also, ballast water from cruise ships can become a source of microbial contaminants. Many islands still lack adequate sewage treatment facilities, landfills, functional waste recycling programs, efficient sources of energy production or adequate massive transportation infrastructure. Therefore, waste minimization, improved energy efficiency, conservation and management of natural resources, including freshwater resources, wastewater management, hazardous substances transport, land-use planning and integrated coastal and tourism development management (with the integrated participation of local communities in planning and decision-making processes), design for sustainability, and partnerships for sustainable development are critical elements that are still largely lacking in the tourism industry across many small islands, including PR. Failing to recognize these elements will perpetuate the “enemy within” syndrome in the tourism industry.

5.2 Can sustainability be reached in a non-participatory globalized model?

The usual rapid economic revenue of non-sustainable, massive tourism activities is often one of the preferred tools for poverty reduction in developing countries, including many small island nations. But massive tourism often involves a chain of socio-cultural, economic, logistic and environmental problems. When nations consider tourism development, the potential for negative consequences is often overshadowed by the lure of economic benefits (Diedrich, 2006). When tourism development gets out of control, negative impacts are most likely to occur. In spite of the substantial economic benefits of the tourism industry, it can have three main types of effects, according to Gormsen (1997): (1) the development of seaside tourism including the changes of socio-economic and settlement patterns; (2) its cultural impact on the local population; and (3) its environmental aspects. Massive tourism may result detrimental on local water supplies, sensitive coastal landscapes, and socio-cultural identity. In many cases, tourism has often had significant permanent negative environmental impacts on nearly pristine natural environments, particularly when construction and operation impacts where dismissed by regulatory government officials as non-significant (Equation, 2009). Burak et al. (2004) have documented negative impacts of rapid tourism expansion in coastal habitats that include loss of aesthetic value, rapid population densification, increased construction of multistory buildings adjacent to coastal areas, pollution, and the permanent loss of adjacent fertile agricultural lands. Sewage pollution has been a concern regarding long-term degradation of coral reefs (Hernández-Delgado et al., 2010, 2011; Pastorok & Bilyard, 1985), and regarding risks to recreational users (Bonkosky et al., 2009; Kocasoy, 1989). The construction of coastal resorts and roads, marinas, jetties and other infrastructure often result in significant coastal habitat fragmentation and reduced biodiversity (M'Rabet et al., 2009). There is also increased literature documenting adverse impacts from infilling, sedimentation and over-fishing for marine curios (Hawkins & Roberts, 1994), intertidal trampling on shallow-water coastal habitats (Davenport & Davenport, 2006; Hawkins & Roberts, 1993), and from snorkeling and SCUBA diving on coral reefs (Davenport & Davenport, 2006; Harriott et al., 1997; Hawkins & Roberts, 1992; Hawkins et al., 1999). Davenport and Davenport (2006) also documented the negative impacts of recurrent mechanical beach 'cleaning' (i.e., removal of natural strandlines as well as litter) that is practiced throughout the world's sandy beach resorts, a practice which is also carried out across many known turtle nestling beaches adjacent to hotels and urban zones in PR (Hernández-Delgado, pers. obs.). Further, under extremely high exploitation by massive tourism at some sites, these authors also documented negative impacts from relatively innocuous activities such as swimming, surfing, sailboarding, dinghy sailing and 'extreme sports' (e.g., 'coasteering', kitesurfing), which are marketed for its environmentally-friendly nature, yet causes measurable deterioration in many shallow coral reef ecosystems despite good management practices.

In many instances, tourism can also result in socio-cultural and economic impacts which may involve the physical displacement of traditionally underserved small communities, shifting livelihoods and population increases from immigration or, less tangible in the form of changes in morals and traditions, and local increases in crime (Diedrich, 2006) and prostitution (Cabezas, 2009; Padilla, 2007). In some particular places, dramatic social impacts have included child exploitation (Equation, 2009). According to Bruyere et al. (2009), many communities perceive that local base communities receive the least benefits from tourism revenues, and that there is also a lack of representation of local communities in the tourism

sector employment. There are also substantial issues of carrying capacity and ecological sensitivity which need to be also kept in mind if tourism is going to become sustainable (Equations, 2009). Most often decisions regarding setting up a tourism strategy, selecting sites for projects, or establishing a carrying capacity or a limit of acceptable change for some tourism activities are often driven by a purely economic decision by private interests, instead of being based on empiric scientific-based and participatory processes. Even worst, planning and decision-making often lack a community-based participatory process. Community-based participation should be fundamental to integrate local stakeholder's vision, interests, perceptions, fears, livelihood, cultural, religious and heritage values in the tourism strategies decision-making processes. Community participation and integration with local government in the planning and decision-making processes has been shown to be paramount to foster compliance and to advance conservation and management of marine protected areas (Appeldoorn & Lindeman, 2003; McConney & Pomeroy, 2003). Perceptions of environmental resources determine not only how a resource is utilized and managed, but also its relative value to the community (Pollnac & Crawford, 2000). The value that a community places on natural resources can have significant implications on how those resources are used and managed. For projects that seek to use coastal resources (i.e., hotels, private marinas, pier development, etc.) it is important to primarily understand which resources a community places values on and which they do not. But local resident perceptions of factors influencing the status of coastal resources are rarely taken into consideration by the tourism industry prior to the construction of any project, particularly in small island scenarios. Cinner & Pollnac (2004) showed that wealthier residents have demonstrated a better understanding of the indirect activities that affect coastal resources while poorer residents were more concerned with meeting basic needs and, thus, may not be able to be concerned with aspects of conservation. Tourism can alter the way local residents or even the government value and use marine ecosystems. According to Diedrich (2006), before tourists discovered Belize, many coastal communities were primarily dependent on fishing and farming for survival. Nowadays, many of these are becoming increasingly dependent on tourism. Local communities subjected to massive tourism have shifted their historical perspectives and values of coral reefs from subsistence to rapid economic revenue from tourism. But there are increasing concerns regarding the impacts of tourism fishing in many areas (Gartside, 2001), as well as regarding the impacts of tourism in free-ranging marine wildlife, including cetaceans, dolphins, turtles, sharks, rays, etc. (Birtles et al., 2001). In addition, there is frequent political sensitivity and security issues linked to many tourism development activities. In many instances, decisions regarding the approval of tourism projects might be more linked to political influences and politically-driven decisions instead of sound tourism development strategies implemented through participatory processes. The lack of clear local-based tourism strategies and lack of data and data-based analysis (economic, tourist profile and arrivals, employment and revenues based data) on which such plans and recommendations are made may usually lead to wrong decisions (Equations, 1999) when only globalized approaches are followed.

5.3 Current trends and impacts of climate change in Caribbean tropical islands

Climate change has become a major concern to humankind, particularly for small island nations. According to the Intergovernmental Panel on Climate Change (IPCC, 2007), due to the weaknesses of islands (geographical isolation, reduced territory and limited natural

resources) these territories are extremely vulnerable to changes and variations in climate, especially precipitation and sea level rise. Although a significant number of island nations across the Caribbean have made substantial advances in terms of adaptive planning strategies to face problems associated to climate change, PR is still way behind on that regards with a government administration that is still in some kind of denial stage of potential threats that the island might face in the near future. The most likely impacts of climate change across the Caribbean may largely affect the coastal tourism and residential construction industries, and may include: (1) increased beach erosion rates and coastal property loss; (2) saline intrusion into coastal aquifers; (3) increased frequency of extreme weather events (i.e., droughts, flash floods and landslides); (4) altered freshwater availability; (5) recurrent massive coral bleaching events and mass coral mortalities similar to those witnessed during 2005 (Hernández-Pacheco et al., 2011; Miller et al. 2006, 2009); (6) less productive agricultural systems and fisheries; (7) changes to biological systems/reduction in biodiversity as it has been already modeled to occur at least for Caribbean coral reefs (Hoegh-Guldberg, 1999); (8) irreversible damage to coastal amenities and infrastructure; (9) reduction in long-haul passengers due to ethical concerns associated to carbon footprint, regulatory taxes, etc.; (10) changes in preferences of the tourism market; (11) declining aesthetical value of coastal areas as a result of coastal erosion and water quality decline; (12) increased costs of mitigating sea level rise for beachfront properties; (13) increased vulnerability of beachfront properties and public infrastructure to hurricanes; and (14) increased cost of insurance for beachfront properties, a trend that has already occurred in the U.S. (Mills, 2005).

Climate variability particularly affects rainfall patterns (González-Hidalgo et al. 2002; Peterson et al. 2002) and is an important feature for water resources in the tropics. In the actual debate about climate change, water has become more prominent at the regional and global scale. At the present time, water heads most global political and scientific debates that usually tackle the conflicts about this resource (water geopolitics), its management (man as a hyper-consumer, and the right to have access to water), and water pollution (human activities that may put this resource at risk). Climate change may cause significant fluctuations in the distribution of wind and humidity patterns that may also influence known diurnal rainfall patterns across islands (Roy & Balling, 2005), therefore, producing long-term changes in surface and groundwater availability for local communities as well as for tourist facilities. Méndez-Lázaro (2010) analyzed rainfall trends in PR in the context of climate change, and its relationship with regional and global climate variation in recent decades (1955-2007). The analysis indicated that the precipitation of the island does not show a unique spatio-temporal pattern. However, a slight increase was detected in the southern region, while a decrease was observed in the western region. Overall, regressive tendencies in the wet summer months and increases in the historically drier winter months were more commonly observed. These observations are consistent with those of Neelin et al. (2006) and of Sanderson et al. (2011) which using climate modeling approaches showed that there will be a significant decline in total rainfall across the wider Caribbean.

We have also to pay attention to the different phenomena that control climate at the wider Caribbean regional scale. Large-scale atmospheric events such as the North Atlantic Oscillation (NAO), *El Niño* Southern Oscillation (ENSO), and *La Niña* can have paramount influences in the precipitation patterns on regional and sub-regional scales, which may make difficult the interpretations of climate variability across the Caribbean and South

America (Giannini et al. 2000; Liang, 2004; Ropelewski & Halpert, 1987). Giannini et al. (2000) found that declining sea surface atmospheric pressure in the North Atlantic result in increasing rainfall patterns across the Caribbean by affecting wind patterns across the region, and also indirectly affecting sea surface temperature (SST). This can result in doldrum oceanographic conditions (low winds, slower currents, increased SST) that may further result in significant coral bleaching events and coral mortality events (Eakin et al., 2010; Hernández-Pacheco et al., 2011; Miller et al., 2006, 2009). Giannini et al. (2000) also demonstrated that high pressure positive anomalies across the North Atlantic can cause stronger trade winds, which make the SST get fresher, and produce less rainfall in the Caribbean. However, as soon as the atmospheric conditions are getting back to normal, there is an increase in convection and, at the beginning of the rainy season, precipitation events are getting stronger, especially across the Greater Antilles. Flooding has become more likely during May and June of the first year of the warm-phase, whereas excessive rainfall was also observed in Cuba during the last winter (January-March) of the first year of the ENSO (Giannini et al. 2000). In Costa Rica, the intensification of the Caribbean Trade Winds registered during the summer of the ENSO, as well as the topography, are fundamental factors that increase the precipitation in the Caribbean coast, reducing simultaneously in the Pacific coast (Giannini et al. 2000). Similar to the results and patterns found in PR according to Centella et al. (1999), the annual precipitation in Cuba did not show significant changes in a long period of time, though a slight change was noted in both islands in the precipitation annual behavior, presenting an increase in the winter months and a decrease in the summer months. On the contrary, an important increase of the winter precipitation was registered, and a slight decrease was noted in the summer precipitation. There is also some evidence suggesting that climate change may result in an increased frequency and/or intensity across the Atlantic, particularly following the current increasing SST trends (Mann & Emanuel, 2006; Shapiro & Goldenberg, 1998). There has been an increasing trend in hurricane frequency since 1995 (Nyberg et al., 2007). The combination of strong hurricanes, high SST, and massive coral bleaching has been shown to be detrimental for coral reefs across the Caribbean (Gardner et al., 2005; Wilkinson & Souter, 2008) and given current climate change projections, these combined factors might be detrimental for the Caribbean coastal and marine biodiversity as well (Cambers et al., 2008). Losing coral reefs due to increased environmental degradation, in combination with recurrent massive coral bleaching and mass mortality events may represent losing its tourism and aesthetic value, its food production sustainability, its role as a buffer against greenhouse gas emissions, as a source of natural products with pharmacological value, as well as its role as a natural buffer against wave action and coastal erosion, particularly under current sea level rise trends (Veron et al., 2009). This would imply an increasingly negative economic impact to the tourism industry as there would be an increasing need to establish physical protective measures against coastal erosion (i.e., breakwaters) and to renourish eroding beaches adjacent to hotels. There will also be an increased risk of coastal flooding during hurricanes, which would in turn increase insurance expenses for beachfront properties (Mills, 2005).

6. A sustainable alternative model of tourism development for tropical islands

Tourism and urban development across coastal areas in PR have followed a non-sustainable model that have caused irreversible negative impacts on a variety of natural resources, and

have largely degraded coastal habitats, and caused often unaccounted socio-economic impacts, including the loss of traditional underserved community livelihoods. Experiences throughout the world show that poorly planned and managed tourism that fails to support its environment base will eventually be economically unsustainable. With the potential for self-destruction, achieving a more sustainable tourism option is the most important issue facing tourism (Whitmore & De Lacy, 2004). Also, if tourism is to sustain itself in the coming years, its best bet would be to address climate change through responsible tourism, encompassing all economic, social and environmental aspects. Pleumarom (1995) suggested that responsible tourism is holistic and it requires commitment to economic, social and environmental principles that reflect the following: (1) a commitment to foster local employment and sourcing (this would help reducing revenue leakage from the community); (2) respect for local cultures and support for community-based development (view local culture as an integrated attraction for visitors and not as a marketing product); (3) protection of natural resources (prevent sacrificing natural resources at the expense of tourism exploitation and urban construction); (4) efficient use of resources (establish limits of acceptable change); (5) responsible waste management (minimize waste production through prevention, reuse and recycling programs); and (6) a commitment to continued improvement (foster base-community integration and participation). Considering the combination of long-term cumulative impacts along coastal areas and the threats associated to current climate change trends, there is an imperative need to foster the establishment of an alternative sustainable development model. But according to Hall (2001), sustainable development of coastal tourism, as well as urban development, should be dependent on: (1) good coastal management practices (particularly regarding proper siting of tourism and urban infrastructure, and the provision of public access); (2) clean water and air, and healthy coastal ecosystems; (3) maintaining a safe and secure recreational environment through the management of coastal hazards (such as erosion, storms, floods), and the provision of adequate levels of safety for boaters, swimmers, and other water users; (4) beach restoration efforts that maintain the recreational and amenity values of beaches; and (5) sound policies for wildlife and habitat protection.

Increasing evidence shows that an integrated approach to tourism and urban planning and management should be necessary to achieve sustainable tourism. It is only recently that there has been a growing recognition of the importance of combining the needs of traditional urban management (transportation, land use planning, economic development, etc.) with the need to plan for tourism. Any sustainable approach for development must involve six integrated elements: (1) economic efficiency (tourism and urban construction should be viable, viability of enterprises, satisfaction of demand for product and services); (2) social equity (benefits for local communities, increased local employment, improved life quality, improved local revenue, public participation, respect socio-cultural values, quality employment for the community, establish linkages between local businesses and tourism); (3) environmental conservation (biodiversity conservation and/or preservation, rational use of natural resources, natural resource conservation from an inter-generational perspective); (4) meaningful community-based participation (planning and decision-making processes should be completely participatory in order to be democratic, improved community-based participation on business, co-management of protected areas, stronger community presence and control in tourism/urban development and decision-making rather than having decisions

being imposed by external forces); (5) stand by accepted international standards (tourism and urban construction should follow accepted international practices, such as setting setbacks of at least 200 meters from the shoreline to buffer for increasing sea level rise due to climate change; guidelines for tourism and urban development, tourism operations, environmental impact assessment, monitoring of cumulative impacts, and establishing limits to acceptable change should be uniformed); and (6) deal cautiously with risk and uncertainty (in situations where environmental impacts of activities are not known, the preferred option should be to proceed cautiously or not at all, until the likely impacts can be determined and minimized).

Diedrich (2006) made also important recommendations to foster the development of alternative approaches on the tourism industry, where many of them also apply to the urban construction industry. Many of these are very pertinent to PR and include: (1) continue to encourage and facilitate local entrepreneurship and small business development (sustainable tourism can only be achieved in healthy, prospering communities); (2) continue to involve local communities in all stages of tourism planning and development (local resentment towards tourism, which may result from not being involved in the development process can have a negative effect on the experience of the tourist and decrease the competitiveness of the tourism market); (3) increase public infrastructure and pollution mitigation capacity in communities to accommodate growth in tourism and associated coastal development (it is essential that increases in tourism and urban development be accompanied by a growth in amenities and infrastructure necessary to accommodate the additional tourists/residents and the associated waste); (4) establish initiatives to improve environmental standards and develop Best Practices for hotels, tour operators, and land developers (take the appropriate measures to reduce ecological footprint of projects); (5) implement stronger regulations for the sailboat charter industry relating to environmental conduct (minimize recreational impacts on coral reefs and other related habitats); (6) embrace cruise tourism as a real and significant component of the tourism market that, if properly managed, should provide more revenue to local businesses and communities (it is important to take action now to ensure that this type of tourism has minimal negative impacts and generates maximum benefits to PR by minimizing revenue leakage and protecting local businesses); (7) continue to develop and improve conservation and education programs at local and national levels, particularly in relation to Natural Protected Areas (conservation, education and alternative livelihood programs are important for the continued success of sustainable ecotourism); and (8) establish and enforce limits of acceptable change in all Natural Protected Areas (these are important tourism attractions so their effectiveness is not only crucial to preserving their natural resources, but to PR's success as a tourism destination).

We also strongly suggest to recognize that PR is in a critical stage of coastal and urban development where actions today will govern the future of the country as a tourism destination (tourism and urban development has been envisioned as one of the principal solutions to the actual economic crisis, but the proposed model is still far from sustainable; actions being planned and implemented may have a very high cost unless a more sustainable approach is considered). Further, there is still a nearly complete lack of basic scientific research of impacts of the tourism and urban construction industry in PR (most of the information available can be found on contracted environmental impact documents paid by the industry itself, where most of the documents find no significant impacts of projects; there is no evidence of long-term monitoring of impacts; PR should take advantage of its

strong academic institutions and research institutes to foster the development of sound scientific research of long-term impacts). Finally, climate change impacts must be integrated into all viability analysis of any future coastal tourism and urban development project (there is a strong need to address what would be the long-term impacts of climate change for coastal areas, as well as to develop and implement a national climate change adaptation plan).

7. Conclusions

Coastal tourism and urban development in PR have become a paramount motor of the island's economy. Most of this development during the last two decades has largely relied on a variety of changes in local environmental, planning and zoning regulations which have reduced the burden of permitting processes to developers, but that have also resulted in a dramatic increase in construction in ecologically-sensitive areas, in significantly reduced community participation, and in the creation of a false sense that only through enhanced construction on ecologically-sensitive sites PR will only remain as a competitive tourism destiny. There are significant case studies of how much have inadequately planned tourism and urban construction impacted local coastal communities in PR. In spite of that, the long-term environmental impacts of most tourism and urban construction projects on coastal habitats have still remained largely undocumented. Current construction trends are still following a completely non-sustainable approach, without meaningful community-based participation and integration, and without meaningful revenue retribution to local communities. Further, climate change has already had recent dramatic and irreversible impacts on local coral reefs, and in beachfront property loss due to beach erosion as a result of increased sea level rise. Therefore, it is critical to consider a precautionary alternative approach for future coastal tourism and urban development on the island. We demand the state government of PR enforce their regulatory role by considering the negative and destructive impacts of coastal tourism and urban construction on the environment and local communities. Further, we strongly encourage the government to incorporate local communities in tourism policies and land use planning frameworks, as well as in the implementation of long-term monitoring of coastal tourism and urban construction impacts.

There is also a need to set up mechanisms to establish ecological and social carrying capacity, or limits of acceptable change on different locations. We strongly encourage the formulation of policies geared to conserving the natural environment rather than opening them up for relentless exploitation by development tourism or urban construction activities. We strongly recommend the government of PR a moratorium in further fostering non-sustainable coastal construction until an environmentally- and socio-economically sustainable strategy is implemented. All recently approved permits, as well as permit applications still under consideration, should be reanalyzed under more strict parameters to ensure sustainability, as well as meaningful community-based participation. We also demand the immediate adoption of adaptation policies to climate change impacts, particularly of initiatives and measures to reduce the vulnerability of coastal natural and human systems against actual or expected climate change effects. There is still an opportunity to ensure that today's investment in coastal tourism and urban development will not compromise the availability and quality of resources for future generations. Further, there is still a chance to use a precautionary approach in our investment in coastal development to minimize the risk and vulnerability against climate change-related impacts.

But the costs of our errors now will certainly be prohibitive for future generations to mitigate, and it would only be a matter of common sense and political will of present generations to prevent such a risk. After all, the long-term cumulative impact of our wrong decisions would probably result in affecting the tourism value of the island and that would be a very high price for future generations that will also have to cope with increasing pressure from climate change.

8. Acknowledgments

This publication was possible thanks to partial funding to E.A. Hernández-Delgado provided by the National Science Foundation through grant NSF HRD 0734826 to the Center for Applied Tropical Ecology and Conservation (CATEC) at UPR Río Piedras. We thank Michelle Bauzá-Álvarez and Henry Neumann of the PRTC for providing important updated statistical data from PR.

9. References

- Adams, H. and Greeley, A. (1961). A general plan for the Boca de Cangrejos Area. Prepared for the Puerto Rico Industrial Development Company. February 1961.
- Berman-Santana, D. (1996). *Kicking Off the Bootstraps- Environment, Development, and Community Power in Puerto Rico*, The University of Arizona Press, ISBN 0-8165-1590-5, Tucson, AZ
- Biagi, N. (1965). Puerto Rico's water pollution image. *Water Pollution Federation Journal*, Vol. 37, No. 3, pp. 381-391
- Biagi, N. (1968). The sugar industry in Puerto Rico and its relation to the industrial waste problem. *Water Pollution Federation Journal*, Vol. 40, No. 8, Part I, pp. 1423-1433.
- Birdsey, R.A., and Weaver, P.L. (1987). Forest area trends in Puerto Rico. USDA-US Forest Service, Research Note SO-331, New Orleans, LA, pp. 1-5
- Birtles, A., Valentine, P., and Curnock, M. (2001) Tourism based on free-ranging marine wildlife : Opportunities and responsibilities. Wildlife Tourism Research Report Series No. 11, Status Assessment in Wildlife Tourism in Australia Series, pp. 1-65
- Bonkosky, M., Hernández-Delgado, E.A., Sandoz, B., Robledo, I.E., Norat-Ramírez, J., and Mattei, H. (2009). Detection of spatial fluctuations of non-point source fecal pollution in coral reef surrounding waters in southwestern Puerto Rico using PCR-based assays. *Marine Pollution Bulletin*, Vol. 58, No. 1, pp. 45-54
- Brida, J.G., and Zapata-Aguirre, S. (2008). The impacts of the cruise industry on tourism destinations. Sustainable tourism as a factor of local development. GRISS Research Unit on Sustainable Development, University of Milano Bicocca, Monza, Italy, 7-9/11/2008, pp. 1-4
- Bruyere, B.L., Beh, A.W., and Lelengula, G. (2009). Differences in perceptions of communication, tourism benefits, and management issues in a protected area of rural Kenya. *Environmental Management*, Vol. 43, pp. 49-59
- Burak, S., Doğan, E, and Gazioğlu, C. (2004). Impact of urbanization and tourism on coastal environment. *Ocean and Coastal Management*, Vol. 47, pp. 515-527
- Bush, D.M., Webb, R.M.T., Hyman, L., González-Liboy, J., and Neal, W.J. (1995). *Living with the Puerto Rico Shore*. Editorial Universidad de Puerto Rico, San Juan, Puerto Rico.

- Cabezas, A.L. (2009). *Economies of Desire- Sex and Tourism in Cuba and the Dominican Republic*. Temple University Press, Philadelphia, PA, pp. 1-218
- Cambers, G., Claro, R., Juman, R., Scott, S. (2008). Climate change impacts on coastal and marine biodiversity in the insular Caribbean. Report of Working Group II, Climate Change and Biodiversity in the Insular Caribbean. CANARI Technical Report 382, pp. 1-88
- Cenacchi, N. (2010). Coastal areas assessing the environmental impact of development policy lending on coastal areas : a World Bank tool kit.
- Centella, A., Gutiérrez, T., Limia, M., and Rivero-Jaspe, R. (1999). Climate change scenarios for impact assessment in Cuba. *Climate Research*, Vol. 12, pp. 223-230
- Centella, A., Llanes, J., Paz, L., López, C., and Limia, M. (eds.). (2000). *Primera Comunicación Nacional a la Convención Marco de las Naciones Unidas sobre el Cambio Climático*. República de Cuba, pp. 1-166
- Cinner, J.E., and Pollnac, R.B. (2004). Poverty, perceptions and planning : Why socioeconomics matter in the management of Mexican reefs. *Ocean and Coastal Management*, Vol. 47, pp. 479-493
- Clark, J.J., and Wilcock, P.R. (2000). Effects of land-use change on channel morphology in northeastern Puerto Rico. *Geological Society of America Bulletin*, Vol. 112, pp. 1763-1777
- Colón, J.A. (1977). Climatología. In: De Galiñanes, M.T.B. (Ed.), *Geovisión de Puerto Rico- Aportaciones Recientes al Estudio de la Geografía*. Editorial Universitaria, Universidad de Puerto Rico, Río Piedras, PR, pp 45-119
- Copakén, R.D. (2009). *Target Culebra. How 743 Islanders Took on the Entire U.S. Navy and Won*. La Editorial de la Universidad de Puerto Rico, San Juan, Puerto Rico, ISBN 978-0-8477-3375-0, pp. 1-480
- Commonwealth of Puerto Rico [CPR]. (2007). Orden Ejecutiva del Gobernador del Estado Libre Asociado de Puerto Rico para Ordenar a la Junta de Planificación de Puerto Rico a Establecer la Reserva Natural del Corredor Ecológico del Noreste y Ordenar al Departamento de Recursos Naturales y Ambientales Adquirir los Terrenos en ella Comprendidos y para Otros Fines y Propósitos Relacionados. San Juan, PR: Boletín Administrativo Núm. OE-2007-37
- Commonwealth of Puerto Rico [CPR]. (2008). Orden Ejecutiva del Gobernador del Estado Libre Asociado de Puerto Rico para Crear, Declarar, Designar y Delimitar la Reserva Natural del Corredor Ecológico del Noreste. San Juan, PR: Boletín Administrativo Núm. OE-20087-22.
- Concepción, C.M. (1988). El conflicto ambiental y su potencial hacia un desarrollo alternativo: el caso de Puerto Rico. *Ambiente y Desarrollo*, Vol. IV, No. 1 y 2, pp. 125-135
- Creel, L. (2003). Ripple effects: Population and coastal regions. Making the Link, Population Reference Bureau, Washington, DC, pp. 1-8
- Cruise Lines International Association [CLIA]. (2005). Industry predicts cruising will be vacation choice in 2005. *Cruise Lines International Association News Release*, 19 January, <http://www.cruising.org>

- Davenport, J., and Davenport, J.L. (2006). The impact of tourism and personal leisure transport on coastal environments: A review. *Estuarine, Coastal and Shelf Science*, Vol. 67, No. 1-2, pp. 280-292
- Delgado-Cintrón, C. (1989). *Culebra y la Marina de Estados Unidos*, Editorial EDIL, Río Piedras, Puerto Rico, ISBN :968-6308-16-4, pp. 1-346
- Departamento de Recursos Naturales y Ambientales. (2008). Plan Integral de Usos de Terrenos y Manejo de la Reserva Natural Corredor Ecológico del Noreste. Borrador para Vistas Públicas, julio 2008
- Diedrich, A. (2006). Assessment of the impacts of tourism in coastal communities in Belize. Ph.D. Dissertation, Marine Affairs, University of Rhode Island, pp. 1-297
- Diedrich, A. (2010). Cruise ship tourism in Belize: The implications of developing cruise ship tourism in an ecotourism destination. *Ocean and Coastal Management*, 53, pp. 234-244
- Diedrich, A., and García-Buades, E. (2009). Local perceptions of tourism as indicators of destination decline. *Tourism Management*, Vol. 30, pp. 512-521
- Dietz, J.L. (1986). *Economic History of Puerto Rico: Institutional Change and Capitalist Development*, Princeton University Press, ISBN 0-691-07716-9, Princeton, NJ, pp. 1-337
- Dinsdale, E.A., and Harriott, V. (2004). Assessing anchor damage on coral reefs: A case study in selection of environmental indicators. *Environmental Management*, Vol. 33, No. 1, pp. 126-130
- Dowling, R.K. (2006). The cruising industry. In *Cruise Ship Tourism*, Dowling, R.K. (ed.), CAB International, Oxfordshire, U.K., pp. 3-17
- Eakin, C.M., Morgan, J.A., Smith, T.B., Liu, G., Alvarez-Filip, L., Baca, B., Bouchon, C., Brandt, M., Bruckner, A., Cameron, A., Carr, L., Chiappone, M., James, M., Crabbe, C., Day, O., de la Guardia-Llanso, E., DiResta, D., Gilliam, D., Ginsburg, R., Gore, S., Guzmán, H., Hernández-Delgado, E.A., Husain, E., Jeffrey, C., Jones, R., Jordán-Dahlgren, E., Kramer, P., Lang, J., Lirman, D., Mallela, J., Manfrino, C., Maréchal, J.P., Mihaly, J., Miller, J., Mueller, E., Muller, E., Noorderloos, M., Oxenford, H., Ponce-Taylor, D., Quinn, N., Ritchie, K., Rodríguez, S., Rodríguez-Ramírez, A., Romano, S., Samhuri, J., Schmahl, G., Steiner, S., Taylor, M., Walsh, S., Weil, E., and Williams, E. 2010. Caribbean corals in crisis: Record thermal stress, bleaching and mortality in 2005. *Plos One*, Vol. 5, No. 11: e13969. doi:10.1371/journal.pone.0013969, pp. 1-10
- Equations. (2003). Tourism and displacement: Karnataka's "model" tourism project - Pilikula, Investigation Report (Final Draft), Equitable Tourism Options, Bangalore, India, pp. 1-20
- Equations. (2009). Who really benefits from tourism? Equations Critiques on Tourism Development, Equitable Tourism Options, Bangalore, India, pp. 1-75
- Ewel, J.J., and Whitmore J.L. (1973). The ecological life zones of Puerto Rico and the U.S. Virgin Islands. U.S. Forest Service Research Paper ITF-18.
- Fabricius, K.E. (2005). Effects of terrestrial runoff on the ecology of corals and coral reefs: review and synthesis. *Marine Pollution Bulletin*, Vol. 50, pp. 125-146
- Feliciano, C.C. (1976). *Apuntes y Comentarios de la Colonización y Liberación de la Isla de Culebra*. Fundación de Culebra, Culebra, PR, pp. 1-278

- Feliciano-Encarnación, R. (2009). *La Victoria de Monchín: Memorias de la Expulsión de la Marina de Culebra*. Fundación La Voz del Centro, San Juan, Puerto Rico, ISBN10: 1-933545-12-7, pp. 1-206
- Gardner, T.A., I.M. Côté, J.A. Gill, A. Grant, & A.R. Watkinson. (2005). Hurricanes and Caribbean coral reefs: Impacts, recovery patterns, and role in long-term decline. *Ecology*, Vol. 86, No. 1, pp. 174-184
- Gartside, D. (2001) Fishing tourism : Charter boat fishing. Wildlife Tourism Research Report Series No. 12, Status Assessment in Wildlife Tourism in Australia Series, pp. 1-25
- Gellis, A.C., Webb, R.M.T., and McIntyre, S.C. (2006). Land-use effects on erosion, sediment yields, and reservoir sedimentation: A case study in the Lago Loíza Basin, Puerto Rico. *Physical Geography*, Vol. 27, No. 1, pp. 39-69
- Giannini, A., Kushnir, Y., and Cane, M.A. (2000). Interannual variability of Caribbean rainfall, ENSO, and the Atlantic Ocean. *Journal of Climate*, Vol. 13, pp. 297-311
- Giusti-Cordero, J. (1994). Labor, Ecology and History in a Caribbean Sugar Plantation Region: Piñones (Loíza), Puerto Rico 1770-1950. Ph.D. Dissertation, University of Puerto Rico
- Goenaga, C. (1991). The state of Puerto Rican corals: An aid to managers. Technical report submitted to the Caribbean Fishery Management Council, San Juan, PR., pp. 1-71
- Goenaga, C., and Cintrón, G. (1979). Inventory of the Puerto Rican coral reefs. Report submitted to the Department of the Department of Natural Resources, San Juan, PR., pp. 1-190
- Gormsen, E. (1997). The impact of tourism on coastal areas. *GeoJournal*, Vol. 42, No. 1, pp. 39-54
- González-Hidalgo, J.C., Vicente, S.M., De Luis, M., Štěpánek, P., Cuadrat, J.M., and Raventós, J. (2002). Reconstrucción estabilidad y Proceso de homogeneizado de series de precipitación en ambientes de elevada variabilidad pluvial. *VII Reunión Nacional de Climatología. Grupo de Clima de la Asociación de Geógrafos Españoles*. Albarracín, España, pp. 1-11
- Grau, H.R., Aide, T.M., Zimmerman, J.K., Thomlinson, J.R., Helmer, E., and Zou X. (2003). The ecological consequences of socioeconomic and land-use changes in postagriculture Puerto Rico. *BioScience*, Vol. 53, No. 12, pp. 1159-1168
- Guerrero-Pérez, C. (2009). The Transformation of Environmental and Social Discourses Through Time: A Look at the 45-year Struggle of the Community of Piñones in Puerto Rico, Fall 2009
- Hall, C.M. (2001). Trends in ocean and coastal tourism: the end of the last frontier? *Ocean and Coastal Management*, Vol. 44, pp. 601-618
- Harriot, V.J., Davis, D., and Banks, S.A. (1997). Recreational diving and its impact in marine protected areas in Eastern Australia. *Ambio*, Vol. 26, No. 3, pp. 173-179
- Hawkins, J.P., and Roberts, C.M. (1992). Effects of recreational SCUBA diving on fore-reef slope communities of coral reefs. *Biological Conservation*, Vol. 62, pp. 171-178
- Hawkins, J.P., and Roberts, C.M. (1993). Effects of recreational scuba diving on coral reefs : trampling on reef-flat communities. *Journal of Applied Ecology*, Vol. 30, pp. 25-30

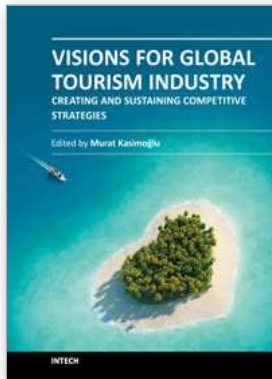
- Hawkins, J.P., Roberts, C.M., Van't Hof, T., De Meyer, K., Tratalos, J., and Aldam, C. (1999) Effects of recreational scuba diving on Caribbean coral and fish communities. *Conservation Biology*, Vol. 13, No. 4, pp. 888-897
- Hawkins, J.P., and Roberts, C.M. (1994). The growth of coastal tourism in the Red Sea: Present and future effects on coral reefs. *Ambio*, Vol. 23, No. 8, pp. 503-508
- Helmer, E.H. (2004). Forest conservation and land development in Puerto Rico. *Landscape Ecology*, Vol. 19, pp. 29-40
- Helmer, E.H., Ramos, O., López, T.D.M., Quiñones, M., and Díaz, W. (2002). Mapping the forest type and land cover of Puerto Rico, a component of the Caribbean Biodiversity Hotspot. *Caribbean Journal of Science*, Vol. 38, No. 3-4, pp. 165-183
- Hernández-Delgado, E.A. (2005). Historia natural, caracterización, distribución y estado actual de los arrecifes de coral Puerto Rico. In, R.L. Joglar (Ed.), *Biodiversidad de Puerto Rico: Vertebrados Terrestres y Ecosistemas. Serie Historia Natural*. Editorial Instituto de Cultura Puertorriqueña, San Juan, PR. pp. 281-356
- Hernández-Delgado, E.A.; Sandoz, B.; Bonkosky, M.; Norat-Ramírez, J. and Mattei, H. (2010). Impacts of non-point source sewage pollution on Elkhorn coral, *Acropora palmata* (Lamarck), assemblages of the southwestern Puerto Rico shelf. *Proceedings of the 11th International Coral Reef Symposium*, pp. 747-751
- Hernández-Delgado, E.A., and Sandoz-Vera, B. (2011). Impactos antropogénicos en los arrecifes de coral. In, J. Seguinot-Barbosa (ed.), *Islas en Extinción: Impactos Ambientales en las Islas de Puerto Rico*. Ediciones SM, Cataño, pp. 62-72
- Hernández-Delgado, E.A., Hutchinson-Delgado, Y.M., Laureano, R., Hernández-Pacheco, R., Ruiz-Maldonado, T.M., Oms, J., and Díaz, P.L. (2011). Sediment stress, water turbidity and sewage impacts on threatened Elkhorn coral (*Acropora palmata*) stands at Vega Baja, Puerto Rico. *Proceedings of the Gulf and Caribbean Fisheries Institute*, Vol. 63, pp. 83-92
- Hernández-Pacheco, R., Hernández-Delgado, E.A., and Sabat, A.M. (2011). Demographics of bleaching in the Caribbean reef-building coral *Montastraea annularis*. *Ecosphere*, Vol. 2, No. 1):art9. 1-13. doi:10.1890/ES10-00065.1, pp. 1-13
- Hinrichsen, D. (1998). The coastal population explosion. *Trends and Future Challenges of U.S. National Ocean and Coastal Policies*, NOAA, pp. 27-29
- Hoegh-Guldberg, O. (1999). Climate change, coral bleaching and the future of the world's coral reefs. *Marine and Freshwater Research*, Vol 50, pp. 839-866
- Hunter, J.M., and Arbona, S.I. (1995). Paradise lost: An introduction to the geography of water pollution in Puerto Rico. *Social Science and Medicine*, Vol. 40, No. 10, pp. 1331-1355
- Intergovernmental Panel on Climate Change (IPCC). (2007). Climate Change 2007. Working Group I Report. "The Physical Science Basis" 978 0521 70596-7 Paperback. Edited By: Solomon, S., Qin, D., Manning, M., Marquis, M., Averyt, K., Tignor, M., Miller, L., and Chen, Z., pp. 1-996
- Justicia-Doll, S. (2011). Denuncian conflicto de interés detrás del Corredor Ecológico del Noreste, *Primera Hora*, October 26, 2011, <http://www.primerahora.com/denuncianconflictodeinteresdetrasdeldorredorecologicodelnoreste-571156.html>

- Kocasoy, G. (1989). The relationship between coastal tourism, sea pollution and public health : A case study from Turkey. *The Environmentalist*, Vol. 9, No. 4, pp. 245-251
- Kocasoy, G. (1995). Effects of tourist population pressure on pollution of coastal seas. *Environmental Management*, Vol. 19, No. 1, pp. 75-79
- Labadie-Eurite, J. (1949). La mecanización agrícola en Puerto Rico. Departamento de Instrucción, San Juan, PR, pp. 1-31
- Larsen, M.C. (1997). Tropical geomorphology and geomorphic work: A study of geomorphic processes and sediment and water budgets in montane humid-tropical forested and developed watersheds, Puerto Rico. Ph.D. Dissertation, Geography Department, University of Colorado, Boulder, CO.
- Larsen, M.C., and Parks, J.E. (1997). How wide is a road? The association of road and mass wasting in a forested montane environment. *Earth Surface Processes and Landforms*, Vol. 22, pp. 835-848
- Larsen, M.C., and Torres-Sánchez AJ. (1998). The frequency and distribution of recent landslides in three montane tropical regions of Puerto Rico. *Geomorphology*, Vol. 24, pp. 309-331
- Larsen, M.C., and Webb, R.M.T. (2009). Potential effects of runoff, fluvial sediments, and nutrient discharges on the coral reefs of Puerto Rico. *Journal of Coastal Research*, Vol. 25, No. 1, pp. 189-208
- Liang, A.G. (2004). Cases of heavy precipitation and flash floods in the Caribbean during El Niño winters. *Journal of Hydrometeorology*, Vol. 5, pp. 577-594
- London, J.B. (2005), Public perception and impacts of cruise ship tourism : Key West. *Proceedings of the 14th Biennial Coastal Zone Conference, New Orleans, Louisiana, July 17 to 21, 2005*, p. 4-5
- Loper, C. (2005), Overview of the socioeconomic impacts of cruise tourism. *Proceedings of the 14th Biennial Coastal Zone Conference, New Orleans, Louisiana, July 17 to 21, 2005*, p. 2-3
- Loya, Y. (1976). Effects of water turbidity and sedimentation on the community structure of Puerto Rican corals. *Bulletin of Marine Science*, Vol. 26, No. 4, pp. 450-466.
- Lugo AE, Ramos O, Molina S, Scatena FN. 1996. A fifty-three year record of land use change in the Guánica Forest Biosphere Reserve and its vicinity. International Institute of Tropical Forestry, USDA Forest Service, Río Piedras, PR, pp. 1-13
- Mann, M.E., and Emanuel, K.A. (2006). Atlantic hurricane trends linked to climate change. *Eos* Vol. 87, pp. 233-241
- Martinuzzi, S., Gould, W.A., and Ramos-González, O.M.(2007). Land development, land use, and urban sprawl in Puerto Rico-Integrating remote sensing and population census data. *Landscape and Urban Planning*, Vol. 79, pp. 288-297
- Martinuzzi, S., Gould, W.A., Lugo, A.E., and Medina, E.(2009). Conversion and recovery of Puerto Rican mangroves: 200 years of change. *Forest Ecology and Management*, Vol. 257, pp. 75-84
- McDaniel, P. (2008). The impacts of tourism on the Caribbean,
http://www.ehow.com/facts_5561618_effects-tourism-caribbean.html
- Méndez-Lázaro, P. (2010). Análisis de tendencias hidroclimáticas recientes y transformación del paisaje en la isla de Puerto Rico. Disertación Doctoral. Universidad de Salamanca, España
- Mills, E. (2005). Insurance in a climate of change. *Science*, Vol. 309, pp. 1040-1044

- Monroe W. (1977). Las divisiones geomórficas de Puerto Rico. In: De Galiñanes, M.T.B. (Ed.), *Geovisión de Puerto Rico- Aportaciones Recientes al Estudio de la Geografía*. Editorial Universitaria, Universidad de Puerto Rico, Río Piedras, PR, pp 1-43
- Mosse, D. (2004). Is good policy unimplementable? Reflections on the ethnography of aid policy and practice. *Development and Change*, Vol. 35, No. 4, pp. 639-671
- Murray, T.J. (2005). The impact of cruise ship tourism on local economies. *Proceedings of the 14th Biennial Coastal Zone Conference, New Orleans, Louisiana, July 17 to 21, 2005*, p. 1
- Neelin, J.D., Münnich, M., Su, H., Meyerson, E, and Holloway, C.E. (2006). Tropical drying trends in global models and observations. *Proceedings of the National Academy of Science USA*, Vol. 103, pp. 6110-6115
- Nyberg, J., Malmgren, B.A., Winter, A., Jury, M.A., Kilbourne, K.H, and Quinn, T.M. (2007). Low Atlantic hurricane activity in the 1970s and 1980s compared to the past 270 years. *Nature*, Vol. 447, pp. 698-702
- OPDAS, Inc. (1968). A development plan and recommended program for Finca Piñones. Preparado para la Compañía de Fomento Industrial. 18 de julio de 1968
- Padilla, M. (2007). Caribbean Pleasure Industry- Tourism, Sexuality, and AIDS in the Dominican Republic. The University of Chicago Press, Chicago, IL, pp. 1-294
- Pérez, M. (2002). The place of abandonment: Geography, race, and nature in Puerto Rico. Ph.D. Dissertation, University of California, Berkeley.
- Peterson, T.C., Taylor, M.A., Demeritte, R., Duncombe, D.L., Burton, S., Thompson, F., Porter, A., Mercedes, M., Villegas, E., Semexant-Fils, R., Klein-Tank, A., Martis, A., Warner, R., Joyette, A., Mills, W., Alexander, L. and Gleason, B. (2002). Recent changes in climate extreme in the Caribbean region. *Journal of Geophysical Research*, Vol. 107, No. D21, p. 4106
- Pleumarom, A. (1992). Course and effect: Golf tourism in Thailand. *The Ecologist*, Vol. 22, No. 3, pp. 104-110
- Pleumarom, A. (1995). Eco-tourism or eco-terrorism? Briefing paper presented to the German Association for Political Economy, April 1995. *Justice Networker*, No. 6, Winter 1995.
- Pollnac, R.B., & Crawford, B. (2000). Assessing behavioral aspects of coastal resource use. Report 2226, Coastal Resources Center, University of Rhode Island
- Puerto Rico Planning Board [PRPB]. (1977). Áreas Naturales de Puerto Rico. San Juan, Puerto Rico.
- Puerto Rico Planning Board [PRPB]. (1995). Plan de Usos de Terrenos para el Área de Planificación Especial de Piñones. Negociado de Planes de Usos de Terrenos, 14 de junio de 1995.
- Puerto Rico Planning Board [PRPB]. (1996). Plan Conceptual de Desarrollo Turístico de la Costa Nordeste de Puerto Rico. San Juan, Puerto Rico.
- Puerto Rico Planning Board [PRPB], and Puerto Rico Department of Natural and Environmental Resources [PRDNER]. (2011). Plan y Reglamento de Calificación Especial Área de Planificación Especial de la Gran Reserva del Noreste (APEGRN).
- Puerto Rico Tourism Company [PRTC]. (2008). Plan Maestro para el Desarrollo Turístico Sostenible de Puerto Rico, Compañía de Turismo de Puerto Rico, pp. 1-191 + App
- Puerto Rico Tourism Company [PRTC]. (2009). Puerto Rico Tourism Strategic Plan : 2009-2013, Compañía de Turismo de Puerto Rico, pp. 1-62

- Ramos-González, O. (2001). Assessing vegetation and land cover changes in northeastern Puerto Rico: 1978-1995. *Caribbean Journal of Science*, Vol. 37, No. 1-2, pp. 95-106
- Ramos-Scharrón, C.E. (2010). Sediment production from unpaved roads in a sub-tropical dry setting – Southwestern Puerto Rico. *Catena*, Vol. 82, pp. 146-158
- Ramos-Scharrón, C.E., J.M. Amador, & E.A. Hernández-Delgado. 2012. An Interdisciplinary Erosion Mitigation Approach for Coral Reef Protection – A Case Study from the Eastern Caribbean. 127-160. In, A. Cruzado (Ed.), *Marine Ecosystems*, ISBN: 978-953-51-0176-5, InTech, Available from:
<http://www.intechopen.com/articles/show/title/an-interdisciplinary-erosion-mitigation-approach-for-coral-reef-protection-a-case-study-from-the-eas>
- Ramos-Scharrón, C.E., Hernández-Delgado, E.A, and Torres-Pulliza, D. in prep. Land use changes in the Río Fajardo watershed in Northeastern Puerto Rico: 1936-2004.
- Rogers, C.S. (1990). Responses of coral reefs and reef organisms to sedimentation. *Marine Ecology Progress Series*, Vol. 62, pp. 185-202
- Rogers, C.S., and Garrison, V.H. (2001). Ten years after the crime : Lasting effects of damage from a cruise ship anchor on a coral reef in St. John, U.S. Virgin Islands. *Bulletin of Marine Science*, Vol. 69, No. 2, pp. 793-803
- Ropelewski, C.F., and Halpert, M.S. (1987). Global and regional scale precipitation patterns associated with the El Niño/Southern Oscillation. *Monthly Weather Review*, Vol. 115, pp. 1606-1626
- Roy, S.S., and Balling, Jr., R.C. (2005). Harmonic and simple kriging analyses of diurnal precipitation patterns in Puerto Rico. *Caribbean Journal of Science*, Vol. 41, No. 2, pp. 181-188
- Rudel, T.K.; Perez-Lugo, M. and Zichal, H. (2000). When fields revert to forest: Development and spontaneous reforestation in post-war Puerto Rico. *Professional Geographer*, Vol. 52, No. 3, pp. 386-397
- Ryan, K.E., Walsh, J.P., Corbett, D.R., Winter, A. (2008). A record of recent change in terrestrial sedimentation in a coral-reef environment, La Parguera, Puerto Rico: A response to coastal development? *Marine Pollution Bulletin*, Vol. 56, pp. 1177-1183
- Sanderson, M.G., Hemming, D.L., and Betts, R.A. (2011). Regional temperature and precipitation changes under high-end ($\geq 4^{\circ}\text{C}$) global warming. *Philosophical Transactions of the Royal Society A*, Vol. 369, pp. 85-98
- Shapiro, L.J., and Goldenberg, S.B. (1998). Atlantic sea surface temperature and tropical cyclone formation. *Journal of Climatology* Vol. 11, pp. 578-590
- Smith, R.M., and Abruña, F. 1955. Soil and water conservation research in Puerto Rico, 1938 to 1947. UPR Agricultural Experiment Station, Bulletin No. 124, Río Piedras, Puerto Rico
- Snow, J.T. (1993). Dealing with golf's environmental issues. *Wetlands Watch*, Vol. 2, No. 2, pp. 1-5, 10
- Squillante L.J., Torell, E.C, and Diamond N.K (eds.). (2004). Counting on people? Then who counts? Teaching cases: The population and gender dimensions of coastal management. Coastal Management Report 2247, Coastal Resources Center, University of Rhode Island, pp. 1-183
- Titus, J.G., Anderson, K.E., Cahoon, D.R., Gesch, D.B., Gill, S.K., Gutiérrez, B.T., Thieler, E.R., & Williams, S.J. (2009). Coastal elevations and sensitivity to sea-level rise: A focus

- on the Mid-Atlantic region. Synthesis and Assessment Product 4.1, Report by the U.S. Climate Change Science Program and the Subcommittee on Global Climate Change Research, pp. 1-298
- US Fish and Wildlife Service. (2002). Comentarios a Declaración de Impacto Ambiental Preliminar San Miguel-Four Seasons Resort. Sometidots ante la Junta de Calidad Ambiental. 30 de enero de 2002.
- Veron, J.E.N., Hoegh-Guldberg, O., Lenton, T.M., Lough, J.M., Obura, D.O., Pearce-Kelly, P., Sheppard, C.R.C., Spalding, M., Stafford-Smith, M.G., and Rogers, A.D. (2009). The coral reef crisis : The critical importance of <350 ppm CO₂. *Marine Pollution Bulletin*, Vol. 58, pp. 1428-1436
- Warnken, J., and Thompson, D. (2001). Golf course development in a major tourist destination: Implications for planning and management. *Environmental Management*, Vol. 27, No. 5, pp. 681-696
- Whitmore, M, and De Lacy, T. (2004). Sustainable development and management of tourism in Moreton Bay: Executive Summary. Sustainable Tourism CRC, Brisbane, Australia, pp. 1-23
- Wilkinson, C., and Souter, D. (2008). Status of Caribbean coral reefs after bleaching and hurricanes in 2005. Global Coral Reefs Monitoring Network, and Reef and Rainforest Research Centre, Townsville, Australia, pp. 1-152
- Wolman, M.G. (1967). A cycle of sedimentation and erosion in urban river channels. *Geografiska Annaler, Series A, Physical Geography*, Vol. 49, No. 2/4, pp. 385-395
- World Travel and Tourism Council [WTTC]. (2005). Trinidad and Tobago : The impact of travel and tourism on jobs and the economy. pp. 1-49
- World Travel and Tourism Council [WTTC]. (2011). Travel and tourism economic impact 2011 : Caribbean. pp. 1-17
- U.S. Census Bureau. (2010). Data for Puerto Rico., U.S. Census Bureau
- U.S. Climate Change Science Program. (2008). The Effects of Climate Change on Agriculture, Land Resources, Water Resources, and Biodiversity in the United States, Synthesis and Assessment Product 4.3 ('Effects of Climate Change on Biodiversity').
- U.S. Department of Commerce and Puerto Rico Department of Natural Resources. (1978). Puerto Rico Coastal Management Program and Final Environmental Impact Statement.



Visions for Global Tourism Industry - Creating and Sustaining Competitive Strategies

Edited by Dr. Murat Kasimoglu

ISBN 978-953-51-0520-6

Hard cover, 478 pages

Publisher InTech

Published online 18, April, 2012

Published in print edition April, 2012

We have been witnessing huge competition among the organisations in the business world. Companies, NGO's and governments are looking for innovative ways to compete in the global tourism market. In the classical literature of business the main purpose is to make a profit. However, if purpose only focus on the profit it will not be easy for them to achieve. Nowadays, it is more important for organisations to discover how to create a strong strategy in order to be more competitive in the marketplace. Increasingly, organisations have been using innovative approaches to strengthen their position. Innovative working enables organisations to make their position much more competitive and being much more value-orientated in the global tourism industry. In this book, we are pleased to present many papers from all over the world that discuss the impact of tourism business strategies from innovative perspectives. This book also will help practitioners and academicians to extend their vision in the light of scientific approaches.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Edwin A. Hernández- Delgado, Carlos E. Ramos-Scharrón, Carmen R. Guerrero-Pérez, Mary Ann Lucking, Ricardo Laureano, Pablo A. Méndez-Lázaro and Joel O. Meléndez-Díaz (2012). Long-Term Impacts of Non-Sustainable Tourism and Urban Development in Small Tropical Islands Coastal Habitats in a Changing Climate: Lessons Learned from Puerto Rico, Visions for Global Tourism Industry - Creating and Sustaining Competitive Strategies, Dr. Murat Kasimoglu (Ed.), ISBN: 978-953-51-0520-6, InTech, Available from: <http://www.intechopen.com/books/visions-for-global-tourism-industry-creating-and-sustaining-competitive-strategies/long-term-impacts-of-non-sustainable-tourism-and-urban-development-in-tropical-coastal-habitats-in-a>

INTECH
open science | open minds

InTech Europe

University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

© 2012 The Author(s). Licensee IntechOpen. This is an open access article distributed under the terms of the [Creative Commons Attribution 3.0 License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.