Journal of Coastal Research	SI	85	1421-1425	Coconut Creek, Florida	2018

Management priorities in San Andres Island beaches, Colombia: associated risks

Luana Portz†, Rogério Portantiolo Manzolli† and Nubia Garzon‡

†Department of Civil and Environmental. Universidad De La Costa, Barranquilla, Atlántico, Colombia.

‡Schools of Engineering and Architecture. Universidad Pontificia Bolivariana, Montería, Colombia.

www.cerf-jcr.org

www.JCRonline.org

ABSTRACT

Portz, L.; Manzolli, R.P., and Garzon, N., 2018. Management Priorities in San Andres Island Beaches, Colombia: Associated Risks. *In:* Shim, J.-S.; Chun, I., and Lim, H.S. (eds.), *Proceedings from the International Coastal Symposium (ICS) 2018* (Busan, Republic of Korea). *Journal of Coastal Research*, Special Issue No. 85, pp. 1421-1425. Coconut Creek (Florida), ISSN 0749-0208.

San Andres is a touristic island located in the Seaflower Biosphere Reserve, Colombian Caribbean. The island reflects the current territorial dynamics, and economic development. These create significant changes that have been affecting its natural characteristics. The present study analyses the evolution of the landscape characteristics and beach litter situation at 17 points (sandy beaches/rocky shores). The amount and source of waste are different between the tourist beaches (excellent), non-tourist beaches (poor), and rocky shores (good), and correspond to human activities related to beach use and irregular disposal. Solid waste can be observed on trails, footbridges, vacant lots, and especially on non-tourist beaches. Beaches located farthest away from the island's touristic center are the most affected by litter, which puts tourists seeking beaches with a lower tourist density and local people at risk. These non-tourist beaches are considered improper due to the amount of hazardous solid waste present, including glass, even though they have coastal scenario values that are similar to the popular tourist beaches. The environmental management of the island should prioritize all the island beaches considering the fact that environmental quality reflects the growing social and environmental concerns of tourists when choosing their destinations.

ADDITIONAL INDEX WORDS: *Beach users; preferences; coastal management; tourism.*

INTRODUCTION

The Caribbean is the most tourism dependant region of the world (Kingsbury, 2005, World Travel and Tourism Council, 2014). Most of the islands have cultivated a tourism industry based on the "sun and sea" approach. Several factors define the magnitude of benefits provided by beaches, including width, length, and beach morphology. Natural and anthropogenic factors, however, constantly affect the Caribbean beaches.

The coastal region of the Caribbean has not yet achieved the same pollution levels observed in other areas (Harborne et al., 2001). Even so, during the last 20-30 years, marine pollution and coastal degradation have become a serious problem in this region (Siung-Chang, 1997; Asli et al., 2016; Brown, Takada, 2017). These touristic areas report loss of a esthetical quality of beaches (Araújo and Costa, 2006), which can result in economic losses related to the tourism industry and waste management. The presence of solid waste is one of the five most important factors related with beach quality for Caribbean beach users (Rangel-Buitrago, 2017). From a scientific point of view, the solid waste problem has been treated as one of the main problems related to marine pollution of the last decades, and its consequences have been reported in coastal and marine areas all over the world (Battisti et al., 2016, Williams et al., 2017). Inadequate disposition and management of solid waste on islands and coastal areas, often causes unpleasant odours, leachate, and the presence of disease vectors (INVERMAR, 2012). In addition to these problems, the presence of hazardous wastes (i.e. broken glass, syringes, fishing line and hooks) on the beach has safety implications, as was reported by Williams (2011). The safety of bathers is not yet a priority for beach management, but this wastes is a commonly causes a minor cut, abrasion and stick (needle) injuries (Sheavly and Register, 2007).

STUDY AREA

San Andres is an island with 27 km² (Figure 1), located in the Seaflower Biosphere Reserve, Colombian Caribbean. The island has a population of 67.000 people and receives 400.000 tourists every year (Colombia, 2014).The population, as well as the tourism, is mostly concentrated in the north area of the island (around 7000 people/km²). The center and south regions have a lower population density, still maintaining rural characteristics (INVERMAR, 2012). San Andres Island is the most tourism dependent Colombian region; it has a gross national product (GNP) of 16%, against 5% found in other areas of the country (Cruz, 2013). San Andres has three coastal morphological units (INVERMAR, 2012) (Figure 1): **Beaches:** located in the north and east sector of the island. They present amplitudes varying between 10 and 15 m, with erosion evidence, such as beach scarps, fallen palms, and erosion on the lower portion of the road that encircles the island; **Reef coast:** increased between 4 and 6 m in relation to its level on the western sector, and

DOI: 10.2112/SI85-285.1 received 30 November 2017; accepted in revision 10 February 2018.
*Corresponding author: luanaportz@gmail.com

between 0.5 and 1 m on the eastern sector. It has a flat surface with an average 5 m width, with localized or no vegetation; **Anthropogenic deposits:** occupy a wide area of the northeast sector of the island. Part of the maritime terminal, docks, and access roads were constructed on these deposits.

The island reflects its current territorial dynamics and economic development that has created significant changes, which have been affecting its natural characteristics.

The scope of this paper is to analyze the presence of solid waste on different beaches of San Andres Island, Colombia (which have different typological characteristics), aiming to establish some management perspectives.

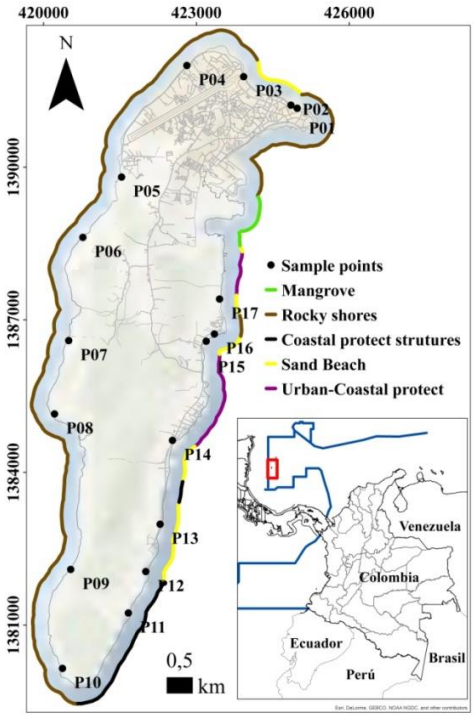

Figure 1. The study area at San Andres Island, Colombia, and the sampled points (UTM-WGS1984-17N).

METHODS

The study area consists of 17 points on San Andres Island, which were analysed between March 1st - March 3rd of 2017 (Figure 1, Table 1).

San Andres has a road that encircles the whole island, facilitating the circulation and access to all the point on the island. The whole shoreline can be easily accessed and, in general, one can observe the main road from the beach. In order to typify the coastal zone, the following geomorphologic characteristics were used: Mangrove, Sandy Beach, Rocky Shore, Coastal Protection Structures, and Urban-Coastal Protection Structures.

Evaluation of the scenery quality was carried out through application of the Coastal Scenery Evaluation System proposed by Ergin et al. (2004). This methodology utilizes fuzzy logic to estimate weights for 26 parameters considered essential for an attractive coastal landscape. The value "D" is the indicator of attractiveness of the evaluated place.

Marine debris were sampled at each point on a 10 m wide transect (parallel to the shoreline). The areas between the shoreline and any urban structures present (streets, sidewalks, etc.) were also sampled, being evaluated only the surface samples. This sampling method allowed the determination of spatial patterns (parallel and perpendicular). Sampled marine debris were then classified into classes of material (plastics, cigarette butts, metal, glass, paper, anthropogenic wood, and others) (Cheshire et al., 2009), and, in the case of plastic items, detailed into specific types (fragments, bags, package, PET bottles, and others).

RESULTS AND DISCUSSION

Figure 2 shows examples of the analysed beaches. The beaches were classified according to use: touristic or local, and according to their configuration of sand and rocks. Due to the island's configuration, the right margin of the island has mostly sandy beaches and the left margin, reefs (P4-P10). In the same way, beaches located in the north region are closer to the urban areas (P1, P2, P3, and P4) (Table 2), with the presence of a touristic accommodation complex (hotels/apartments/resorts), which is utilized by most of the beach users.

The beach scenarios vary from extremely attractive, non-urban touristic beaches, to unattractive beaches with severe human alterations (i.e. large presence of solid waste). Class I includes touristic sandy beaches (P16), and non-touristic rocky beaches (P10). Class II includes touristic sandy beaches (P14, P15), and non-touristic sandy beaches (P13). Class III includes touristic urban (P1, P2) and non-urban (P12) beaches. Class IV includes touristic beaches (P3), and non-touristic beaches with small fishing vessels (P11, P17). Class V includes non-touristic rocky beaches (P5, P6, and P4).

Figure 2. Characteristics of the studied beaches.

Solid waste variability

The amount and sources of solid waste were different among different types of beaches: touristic beaches (excellent), non-tourist (poor), and rocky shores (good), and these characteristics

are related to human activities, such as beach use and irregular disposal. Figures 3 and 4a show the classification and the total amount of the solid waste found on each of the analysed beaches. Plastic (74.1%), cigarettes butts (8.2%), metals (6.9%), and glass (4.9%) were the main types of solid waste found. Plastics such as PET bottles, lids, bags, etc., are predominant among the found solid waste. The same situation happens in other beaches of the world (Xanthos et al., 2017; Pietrelli et al., 2017). These types of plastic waste come from the local population and tourists (Silva et al., 2009).

According to Williams et al. (2016), concern regarding the amount of solid waste accumulated in beaches and seas has been increasing over the past few decades, as well as public awareness (both local and touristic).

In this study, beaches located on points P11, P14, and P17 were the ones that presented the largest volume of plastic items (Table 3). They are non-touristic sandy beaches, with the presence of small fishing vessels (P11, P17). On these beaches, most of the solid waste was from anthropogenic sources, such as food packages, containers, PET bottles, as well as a large volume of plastic fragments (Figure 3). The low degradation rate of most marine litter items, in particular, plastic items (Florian et al., 2015; Lavers, et al., 2016), together with an increasing production of solid waste, has been causing a progressive, and dramatic, increase in the amount of solid waste in ocean and coastal zones around the world. The presence and persistency of plastics on San Andres beaches is evidenced by the large number of small fragments found on touristic beaches (P1, P2, and P3). Kiosk owners do not remove this type of waste from the beaches. This global pattern can be explained by some plastic characteristics such as flexibility, durability (slow natural degradation), low density, and low cost. Therefore, plastics are present in a wide range of products that are easily accessible to consumers.

Table 2. *Characteristics of the study area, coastal scenario, and main types of solid waste observed.*

	Coordinate		Characterization	Cenary	D	Main Litter
P1	424951	1391117	Sand Beach, touristc	0,50	Class III	Cigarette, plastic fragment
P2	424856	1391218	Sand Beach, touristc	0,50	Class III	Cigarette, plastic fragment
P3	423929	1391778	Sand Beach, not tourist	0,22	Class IV	Plastic fragment, plastic fragment, candy and lolly wrappers
P4	422815	1391997	Rocky shores, no touristc	-0,04	Class V	Plastic fragment, glass fragments.
P5	421534	1389805	Rocky shores, no touristc	-0,40	Class V	Plastic fragment, PET caps, glass containers, plastic bags
P6	420774	1388620	Rocky shores, no touristc	-0,08	Class V	Plastic fragment, cup, food packaging, cans
P7	420497	1386590	Rocky shores, no touristc	0,12	Class IV	PET bottles, cans
P8	420219	1385149	Rocky shores, touristc	0,23	Class IV	Big plastic fragments, PET caps/bottle, cans
P9	420536	1382092	Rocky shores, touristc	0,12	Class IV	Plastic fragment, plastic bags, cans
P10	420375	1380148	Rocky shores, no touristc	0,91	Class I	Glass fragments, PET bottles, plastic bags, Cans
P11	421667	1381236	Sand Beach, not tourist, boats	0,37	Class IV	Straws, PET caps/bottle, plastic bags, metal caps
P12	422010	1382051	Sand Beach, not tourist	0,40	Class III	Plastic fragment, Cup
P13	422289	1382980	Sand Beach, not tourist	0,79	Class II	Cans, glass fragments
P14	422533	1384630	Sand Beach, touristc	0,67	Class II	Pots/containers, PET bottles, glass containers and frag, cans
P15	423195	1386578	Sand Beach, touristc	0,74	Class II	Plastic fragment, PET caps, plastic bags
P16	423356	1386720	Sand Beach, touristc	0,85	Class I	Plastic fragment
P17	423458	1387407	Sand Beach, not tourist, boats	0,02	Class IV	Plastic fragment, Pots/containers, PET bottle/caps, straws

Class I (D value > 0.85) - extremely attractive natural. Class II (D value 0.85 – 0.65) - natural, attractive areas with high landscape value. Class III (D value 0.64 – 0.4) - mostly natural areas with low landscape value. Class IV (D value 0.39 – 0) - urban areas, mainly unattractive, with low landscape value. Class V (D value < 0) - unattractive urban areas, with intense development and low landscape value

Table 3. *Total amount of solid waste per category and per sampling point.*

Total by category	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17
Plastic	162	143	114	67	114	54	72	93	62	83	152	52	96	257	62	22	394
Cigarette	141	38	3	15	6	4	0	0	2	0	0	0	2	2	4	0	3
Paper	20	3	4	1	4	2	1	1	4	1	0	0	17	0	12	0	1
Glass	2	4	5	9	18	3	0	3	2	12	0	2	39	4	3	0	7
Fishing material	1	1	0	1	0	2	0	1	1	0	0	0	0	1	2	0	3
Metal	15	3	4	3	28	9	15	11	11	35	18	0	27	0	4	2	0
Other	1	1	11	0	23	3	5	0	3	6	5	1	15	4	0	0	2

Cigarette waste (packages and butts) was found mainly on the sites P1 and P2, beaches with high touristic influence. The occurrence of butts also reflects the lack of knowledge of beach users about the potential risks of this item (such as ingestion by the marine biota, and even children), and its highly persistent characteristics, since butts are made of polymers (Portz, 2011).

Metal waste, represented by beverage lids and cans, was found mainly on the West coast of the island, which is visited mostly by local residents and some tourists (Figure 3B). Williams et al. (2016) studied 35 beaches in the Colombian Caribbean area (continent) and found out that, due to economic conditions and cultural habits, local tourists usually carry their own food (i.e. fried potatoes) to the beach in plastic bags, polystyrene boxes, etc., and beverages (i.e. cans, plastic and glass bottles). After consumption, people leave the waste directly on the beach.

The sampling points located on rocky shores presented the largest concentration of waste by the road that encircles the island, due to irregular disposition by the population. On these

points, there was no solid waste near the sea, indicating that the waste is not coming to shore from the ocean.

This study evidence that tourist beaches, with presence of resort beaches and those with international visitors showed the best litter management, as also observed by Botero, et. al. (2017) on the beaches of Cuba.

The presence of solid waste along the Colombian Caribbean beaches causes deterioration of scenic quality, health hazards for humans and wildlife, the need for financial investments in "cleanups", and has been severely threatening the "sun, sea, and sand" industry (Williams et al., 2016).

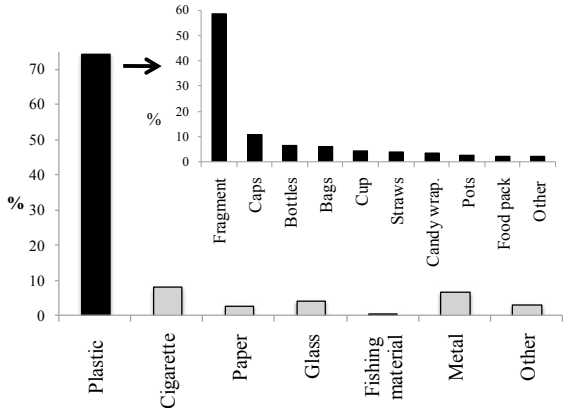

Figure 3. Classes of materials and their respective percentages, identified in all transects.In detail, the types of plastic debris and their percentages.

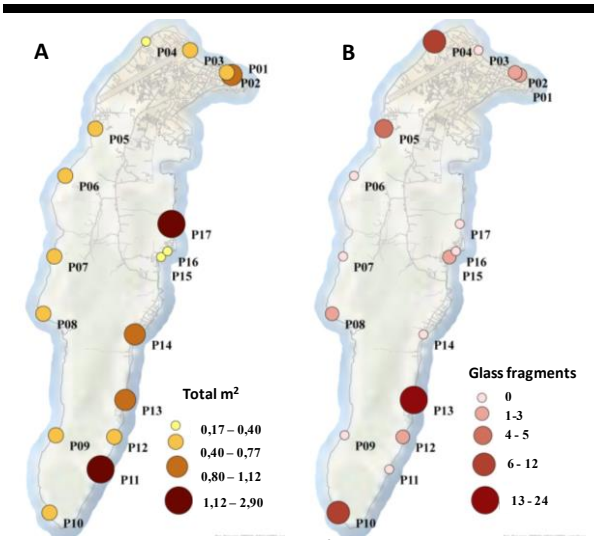

Figure 1. Presence of residues per m^2 on each beach analysed. a) Total amount of residues, b) glass fragments.

The high population density hampers the possibility of effective management and the implantation of a sustainable development model. According to the last census, San Andres Island has 2400 hab./km² (Dane, 2007). The population grew exponentially and the land use was gradually modified (INVERMAR, 2012). Some of the main factors that lead to the high volume of solid waste include irregular disposition by the local population, and the lack of cleaning maintenance on the non-touristic beaches. This fact is evidenced by the large number of anthropogenic litter found between the points P4 and P8, concentrated next to the road that encircles the island. It is also possible to observe garbage cans located on the seaside of the main road. If these garbage cans fall, solid waste ends up accumulating on the beach and/or rocks.

The population of San Andres has increased with little or no territorial management, leading to chaotic coastal development. Solid waste management has become one of the main topics of environmental concern. The island generates an average of 68 tons of solid waste per day; this situation, together with the lack of efficient integral management strategies and guidelines, has become a permanent problem of the island territory (INVERMAR, 2012).

Some measures to revert this condition are being taken. The *Corporación para el Desarrollo Sostenible del Departamento Archipiélago de San Andrés, Providencia y Santa Catalina (*CORALINA), in association with local institutions, has concentrat edits efforts on the development of campaigns to eliminate marine litter and to eradicate illegal disposal areas. Therefore, the active inclusion of the all the different stakeholders involved in the development of this process is extremely important. This will have as an objective the implementation of definitive and effective mechanisms that will provide a continuous solution for this environmental problem.

The sea level rise prognosis is another concern. According to estimates, in the next 50 years, 17% of San Andres Island will be affected by coastal flooding (UNAL, 2005). Flooding could catalyze the solid waste problem on the beaches, since its disposition often occurs close to the shoreline, facilitating its dispersion.

In order to be effective, management plans must consider the tourism model of the region, as well as the increasing impacts of solid waste on the beaches; their characteristics, impacts, and trends are indispensable factors for effective coastal management (Williams et al., 2016). This generates actions that improve the appearance of beaches, which directly influences public acceptance.

CONCLUSIONS

Mass tourism and urban expansion have created new processes and needs, such as waste management. The results of this study show some local sources of litter on the beaches and analysed points. The sources reflect the human actions happening in each sector.

The presence of hazardous waste (e.i. glass fragments) puts beach users at risk, whether on tourist or local beaches. The presence of these residues in greater volume in non-tourist beaches demonstrates the management priorities of the beaches. Places that do not receive constant cleaning are unsuitable for bathing. These beaches present scenarios similar to the other beaches, so it could be stimulated their use by tourists, generating income distribution.

Given that the ecosystems are connected (beaches, mangroves, reefs), the development of a solid waste management program, including constant cleaning actions on all the beaches, will be a determinative factor for the maintenance and conservation of all ecosystems.

These results can be used to create new perspectives, not only in relation to the potential development of coastal tourism of islands, but also, in relation to landscape improvement policies. Improvement of landscapes will help to create more sustainable tourism around the San Andres Island, reducing the touristic concentration on the north region of the island. The aforementioned actions are also indispensable for the maintenance of the local economy. Thus, through the management of the negative anthropogenic factors present on the non-touristic beaches of the island, it will be possible to increase tourism, as well as the use of the beaches by the local population.

The environmental management of the island should prioritize all the island beaches considering the fact that environmental quality reflects the growing social and environmental concerns of tourists when choosing their destinations. A policy for landscape management needs to be created and the loss of desirability and risks associated with the presence of hazardous solid waste on the beaches must be understood.

LITERATURE CITED

Araújo, M.C.B. and Costa, M.F., 2006. The significance of solid wastes with land-based sources for a tourist beach: Pernambuco, Brazil. *Pan-American Journal of Aquatic Sciences*, 1(1), 28-34.

Asli, K., Idil, P.; Tolga, G., and Filiz K., 2016. Marine pollution risk in a coastal city: use of an eco-genotoxic tool as a stress indicator in mussels from the Eastern Aegean Sea. *Environ Sci Pollut Res*. 23, 16067-16078.

Battisti, C.; Poeta, G.; Pietrelli, L., and Acosta, A., 2016 Unexpected Consequence of Plastic Litter Clean-Up on Beaches: Too Much Sand Might Be Removed. *Environmental Practice*. 18(4), 242-246.

Botero, C.M.; Anfuso, G.; Milanes, C.; Cabrera, A.; Casas, G.; Pranzini, E., and Williams, A.T., 2017. Litter assessment on 99 Cuban beaches: A baseline to identify sources of pollution and impacts for tourism and recreation. *Marine Pollution Bulletin*, 118, 437-441.

Brown, T. and Takada, H., 2017. Indicators of Marine Pollution in the North Pacific Ocean. *Archives of Environmental* Contamination & Toxicology. 73(2), 171-175.

Cheshire, A.C. et al., 2009. UNEP/IOC guidelines on survey and monitoring of marine litter. UNEP regional seas reports and studies, No. 186; IOC Technical Series No 83.

Colombia, 2014. Secretaria Departamental de Turismo, Governo do Arquipélago de San Andrés, Providencia e Santa Catalina.

Cruz, J.L.J., 2013. Tourism as an economic development strategy: the case of the islands of San Andres and Providencia. Cuadernos del Caribe 16(1), 37-55.

DANE, 2007. Censo de Población y de Vivienda 2005. Departamento Archipiélago de San Andrés, Providencia y Santa Catalina. Bogotá: Dirección de Censos y Demografía.

Ergin, A.; Karaesmen, E.; Micallef, A., and Williams, A.T., 2004. A new methodology for evaluating coastal scenery: fuzzy logic systems. *Area,* 36, 367-386.

Florian, F.; Colin, D.; Olivier, W.; Manuel, K., and Alencastro L.F., 2015. Plastic pollution in Swiss surface waters: nature and concentrations, interaction with pollutants *Environmental Chemistry,* 12, 582-591.

Gavio, B.; Palmer-Cantillo, S., and Ernesto, M.J., 2010. Historical analysis (2000-2005) of the coastal water quality in San Andrés Island, SeaFlower Biosphere Reserve, Caribbean Colombia. *Marine Pollution Bulletin*, 60, 1018-1030.

INVERMAR, 2012. Atlas de la Reserva de Biósfera Seaflower Archipiélago de San Andrés, Providencia y Santa Catalina. Invemar, Santa Marta, Colombia. 184p.

Kingsbury, P., 2005. Jamaican tourism and the politics of enjoyment. *Geoforum,* 36(1), 113-132.

Lavers, J.L.; Oppel, S., and Bond, A.L., 2016. Factors influencing the detection of beach plastic debris. *Marine Environmental Research*, 119, 245-251.

Marnie, L.C.; Slavin C; Grage, A. and Kinslow, A. 2016. Human health impacts from litter on beaches and associated perceptions: a case study of 'clean' Tasmanian beaches. *Ocean and Coast Management,* 126, 22–30.

Pietrelli, L.; Poeta, G.; Battisti, C. and Sighicelli, M., 2017. Characterization of plastic beach debris finalized to its removal: a proposal for a recycling scheme. *Environmental Science & Pollution Research,* 24(19), 16536-16542.

Portz, L.; Manzolli, R.P., and Ivar do Sul, J.A., 2011. Marine debris on Rio Grande do Sul north coast, Brazil: spatial and temporal patterns. *Journal of Integrated Coastal Zone Management*, 11(1), 41-48.

Rangel-Buitrago, N.; William, A. and Anfuso, G., 2017. Hard protection structures as a principal coastal erosion management strategy along the Caribbean coast of Colombia. *Ocean & Coastal Management*, xx, 1-18.

Sheavly, S.B. and Register, K.M., 2007. Marine debris and plastics: environmental concerns, sources, impacts and solutions. J Polym Environ 15:301–305

Silva, C.; Jacqueline, S., and Araújo, M.C.B., 2009. Plastic litter on an urban beach - a case study in Brazil. *Waste Management & Research,* 27(1), 93-97.

Siung-Chang, A., 1997. A review of marine pollution issues in the Caribbean. *Environmental Geochemistry And Health*, 19(2), 45-55.

UNAL-Universidad Nacional de Colombia, 2005. Elaboración de escenarios de cambio climático para el territorio colombiano. Documento preparado para el IDEAM.

Williams, A.T., 2011. Definitions and typologies of coastal tourism beach destinations. In: Jones AL, Phillips MR (eds) Disappearing destinations: climate change and future challenges for coastal tourism. CABI, Wallingford, 47–66.

Williams A.T.; Rangel-Buitrago N.G.; Anfuso G.; Cervantes O., and Botero C.M., 2016. Litter impacts on scenery and tourism on the Colombian north Caribbean coast. *Tourism Management*, 55, 209-224.

Williams, A.T.; Randerson, P.; Allen, C., and Cooper, J.A.G., 2017. Beach litter sourcing: A trawl along the Northern Ireland coastline. *Marine Pollution Bulletin*, 122, 47-64.

Xanthos, D. and Walker, T.R., 2017. International policies to reduce plastic marine pollution from single-use plastics (plastic bags and microbeads): A review. *Marine Pollution Bulletin,* 118(1/2), 17-26.