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Baseline

Troubles in the paradise: Litter and its scenic impact on the North Santa Catarina island beaches, Brazil

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ABSTRACT

Eight touristic beaches along the north coast of Santa Catarina Island, Brazil were assessed to determine litter influence on scenic quality. The application of the Coastal Scenic Evaluation System (CSES) categorized these beaches into four of the five available classes. Six of the investigated beaches belong to Class III (n = 3) and V (n = 3), while two beaches correspond to Class II and Class IV. Class I beaches were not found. A total amount of 4291 litter items weighing 29 kg were collected with average abundances of 0.29 items m^2. Beach user's habits as well bad management practices along the adjoining river basins play an essential role on litter source, and are directly responsible for the decline of scenic quality of Santa Catarina Island Beaches. In fact, litter has a direct relation with the low scenic scores determined in the surveyed beaches.

For most people Brazil evokes a generalized amalgam of palm-fringed, white sand beaches washed by clear blue waters, exotic flowers and fruits; all under excellent weather conditions and music. This image is promoted by the tourism industry of this country, especially the denominated “Sun, Sand and Sea Tourism” (3S).

Tourism in Brazil is a significant growing sector, and the key to the economy of several regions of the country. According to UNTWO (2017), Brazil had 6.6 million visitors in 2016, ranking the international tourist arrivals as the leading destination in South America, and second in Latin America after Mexico with revenues from foreign visiting tourists totaling US$6 billion in 2016.

This economic sector is founded on the specific resource conjunction along the interface between sea and land (bathing area) where beach users are primarily interested in five aspects: Scenery, Litter, Safety, Facilities and Water Quality (Williams and Micallef, 2009; Williams, 2011; Rangel-Buitrago et al., 2013, 2017). These factors are closely linked with natural resource exploitation, with scenery and the litter being perhaps the most important because these two directly determine conditions for 3S tourism development.

Tudor and Williams (2001) and Rangel-Buitrago et al. (2013) have shown that the loss of tourism potential of a beach is closely related to loss of scenery and/or an increase in litter. Windom (1992) has suggested that the greatest impact associated with marine litter is not on organisms but is one of simple economics re the location's amenities. A country like Brazil that heavily relies on tourism for its economy can have the associated income severely depleted by such problems.

Several studies exist regarding magnitudes, composition, distribution, and sources of litter along Brazilian coastlines (Bugoni et al., 2001; Santos et al., 2005; Leite et al., 2014; Viera da Silva et al., 2016; Neffa et al., 2017; Krelling et al., 2017, among others). However, litter impacts over the scenic quality of beaches is still a topic to explore, especially if one considers its substantial influence over an important economic sector of the country such as the 3S tourism.

In this work, eight village and urban beaches located on the north side of Santa Catarina Island (Brazil) were assessed and rated according to their Scenic Quality as defined by Ergin et al. (2004), and Litter Magnitude Grading methods (EA/NALG, 2000). The scope is to analyze these two variables as indicators from a pollution management point of view, opening opportunities for the optimal development of coastal tourism. Results provide the baseline data necessary to adopt reasoned management decisions over this issue.

Santa Catarina Island belongs to Santa Catarina State and is located on the southern coast of Brazil (Fig. 1). This island, hosts the capital of the state: Florianópolis, and is a developing area with 421,240 inhabitants that corresponds to 0.22% of the total national. The area lies in a warm, humid subtropical climate with a mean temperature of 24.2C° and maximum precipitation values of 1519 mm yr^{-1}, making the coastal environment ideal for 3S tourism development.

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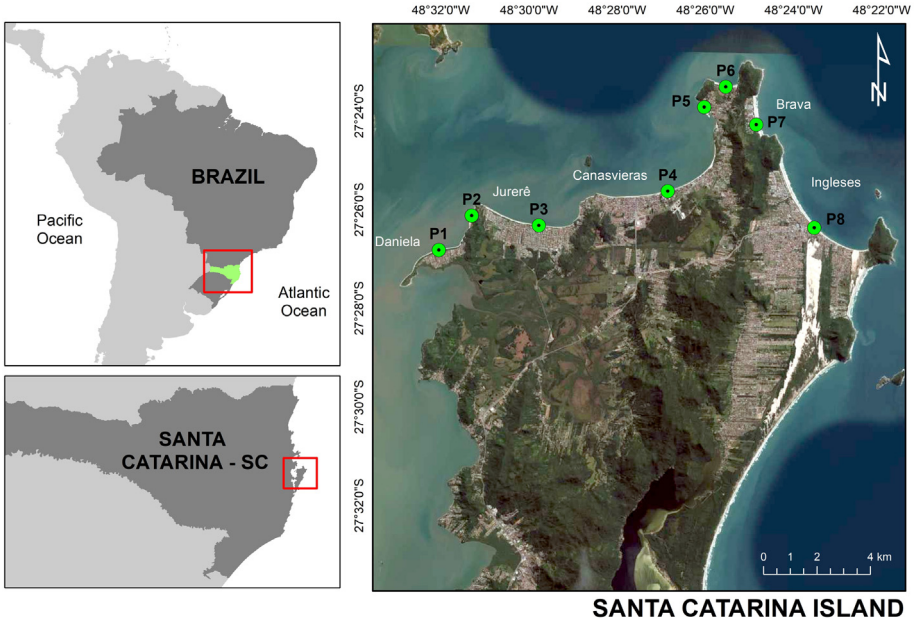

Fig. 1. Study area with indication of beach locations surveyed.

Table 1
Location and main characteristics of the investigated beaches.

ID	Name	Type	Exposure
P1	Daniela	Village	Sheltered
P2	Forte	Village	Sheltered
P3	Jurerê	Urban	Semi-sheltered
P4	Canasvieiras	Urban	Semi-sheltered
P5	Ponta das Canas	Village	Sheltered
P6	Lagoinha do Norte	Village	Semi-sheltered
P7	Brava	Village	Exposed
P8	Ingleses	Urban	Exposed

The study area, located on north side of the Santa Catarina Island, encompasses eight beaches composed of light tan, medium sands separated by headlands (Fig. 1 and Table 1). Along these beaches, waves arrive predominantly from the south with periods of 12 s, followed by waves from the east with periods of 8 s, while > 30% of the time bimodal (south and east) sea conditions occur. Wave height averages 1 to 1.5 m with the highest waves arriving from south and southeast, with H_o (deep water wave height) > 4 m and periods above 12 s (Araújo et al., 2003; Viera da Silva et al., 2016). The average tidal range is 0.8 m with peaks up to 1 m above sea level due to meteorological effects (Truccolo and Schettini, 2009).

Due to its dynamic landscape, diversity of natural environments and popularity for the practice of adventure sports (surfing, sailing, trekking, paragliding), the area is one of the most important places for international tourism in all of Brazil, and has developed an extensive infrastructure to welcome visitors along its entire coast (Santos et al., 2005).

In each of the eight visited beaches a checklist was applied (Coastal Scenery Evaluation System – CSES, Ergin et al., 2004) which evaluates 26 coastal weighted parameters. The checklist is composed of 18 physical and 8 human coastal descriptors (Table 2). By means of fuzzy logic analysis and weighted matrices a final grade "D" was calculated, grouping sites into five distinct scenic classes:

- Class I: Extremely attractive natural sites with D values ≥ 0.85.
- Class II: Attractive natural sites, D = 0.85 to 0.65.
- Class III: Mainly natural sites with little outstanding landscape features, D = 0.65 to 0.4.
- Class IV: Mainly unattractive sites, with low landscape values, D = 0.4 to 0.
- Class V: Very unattractive intensively developed urban beaches with D values below 0.

Further details about this methodology can be found in Ergin et al. (2004, 2010), Rangel-Buitrago et al. (2013) and Rangel-Buitrago (2018).In the same sites, beach surface litter was sampled along a unit area of 100 m long x the beach width (m). Within each sampling unit, all available litter was collected, categorized, counted and weighed in order to compare litter amounts each beach. Results were presented as quantity and weight of litter items and associated densities per square meter. In a second step, beach litter grade was determined by counting the number and type of items recollected along the sampling unit according to the EA/NALG (2000) methodology. This method classifies a beach on a scale from "excellent" (A) to "poor" (D, Table 3). The final grade is the worst result of the individual classes for each parameter surveyed. Litter items were classified on the total numbers counted in each category. Oil was assessed on an estimate of its presence or absence while accumulations were classified according to the number of occurrences.

Once the Scenic Quality and Litter Grading is determined, it is integrated through Sector Analysis (SA - see Williams et al., 2016 and Rangel-Buitrago et al., 2017). SA is a table constructed for each coastal site, with scenic class in rows (5) and litter grades in columns (4). This table is divided into three sectors:

- The upper left quadrant (green) is comprised of four cells and represents sites with good litter grades and scenic classes.
- The lower right quadrant (red), which also has four cells, describes areas having low litter grades and poor scenic classes.
- Along the other two corners and middle cells (yellow) are located sites with contrasting results.

The SA is an efficient tool for use in litter management because it allows identifying those sites where scenic quality is affected by litter issues.

Litter was found along the entire North coast of the Santa Catarina Island. A total of 4291 items weighing 29 kg were collected from the eight surveyed beaches. The average abundance of litter along the study area was 0.29 items m^2. Weight densities ranged from 1.27 to 4.8 g m^2