

MARINE DEBRIS CONTAMINATION ALONG UNDEVELOPED TROPICAL BEACHES FROM NORTHEAST BRAZIL

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ABSTRACT

We hypothesize that floating debris leaving polluted coastal bays accumulate on nearby pristine beaches. We examined composition, quantities and distribution of marine debris along ~150 km of relatively undeveloped, tropical beaches in Costa do Dendê (Bahia, Brazil). Plastics accounted for 76% of the sampled items, followed by styrofoam. Small plastic fragments resultant from the breakdown of larger items are ubiquitous all over the area. Areas immediately south of the major regional embayments (Camamu and Todos os Santos) were the preferential accumulation sites, indicating that rivers draining populous areas are the major source of debris to the study site. Our results provide baseline information for future assessments. Management actions should focus on input prevention at the hydrographic basin level rather than on cleaning services on beaches.

Keywords: Plastics; coastal pollution; marine litter; Bahia State

INTRODUCTION

The negative effects of anthropogenic contamination in the oceans are related not only to chemical pollutants, but also to marine debris. Marine debris are defined as “any manufactured or processed solid waste material that enters the marine environment from any source”. Many impacts have been related to marine debris. Sea birds, turtles, mammals, and benthic organisms are often affected by plastic ingestion and/or entanglement primarily in fishing-related debris (DERRAIK, 2002; LAIST, 1997). Floating plastics may also act as an artificial substratum for faunal dispersal over large distances. In addition, marine debris negatively affect the scenic potential of tourist beaches, pose a risk to the health of beach users, and damage watercrafts (SANTOS et al., 2005).

The majority of studies about marine debris were conducted along temperate coasts in developed countries. However, the problem seems to be more critical in developing countries where a massive arrival of packaged goods on the market is associated with inefficient waste disposal. In spite of these potential problems and having more than 7,000 km of coastline, systematic studies concerning marine debris on Brazilian beaches are still scarce and limited to restricted sectors of the coastline (IVAR DO SUL and COSTA, 2007). We report the composition, quantities and distribution of marine debris on Costa do Dendê. The most probable sources of debris are also discussed. The area is experiencing accelerated growth, so baseline investigations may provide useful information concerning changes eventually brought by development.

MATERIAL AND METHODS

Despite heavy industrialization in some major coastal cities, most of the northeastern Brazilian coastline is still characterized by low population densities. Costa do Dendê is located south of Salvador City and Todos os Santos Bay (Fig. 1), which can be a significant source of floating debris to its beaches, as the longshore current in Bahia State is predominantly southward (BITTENCOURT et al., 2002). The beaches are usually sandy and separated by estuaries surrounded by mangroves.

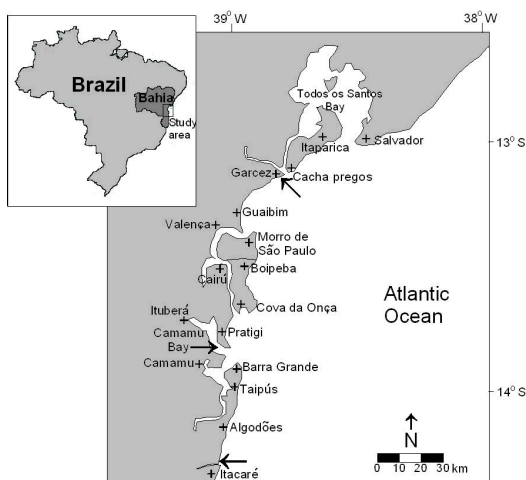


Figure 1: Study area in Bahia State located at northeast Brazil. The survey was conducted in January 2005 between Itacaré City and Garcez Point.

Randomly-selected, 10 m-wide transects were established from the water line to the edge of beach vegetation or dunes. We sampled a total of 79 transects (between 0.5 and 2 km apart) from Itacaré to Garcez Point, along nearly 150 km of shoreline. All debris (> 2 cm) inside each transect were counted and classified into specific categories. In order to investigate the influence of beach typology on debris accumulation we defined four classes of beaches: (1) tourist beaches (n=17), characterized by beach users presence and cleaning services; (2) river-dominated beaches (n=31), characterized by strong fluvial influence, e.g., marked occurrence of riverine natural organic matter; (3) stable beaches (n=20), defined by the presence of dune vegetation and no riverine natural organic matter; and (4) unstable beaches (n=11), with evidence of erosion, e.g., no dune vegetation and/or exposure of back-dune vegetation (coconut trees). To test whether beach typology affects debris accumulation we applied a single-factor analysis of variance (ANOVA) at a level of significance of 95%.

RESULTS AND DISCUSSION

Debris were found on all 79 transects. Higher quantities were observed between Barra Grande and Algodões beaches and on north of Boipeba Island. These segments are located immediately south from Camamu and Todos os Santos Bays, respectively (Figure 1). Plastic (76%) was the main type of material found on beaches, followed by Styrofoam (14%). This is a common pattern of marine debris stranded on beaches (DERRAIK, 2002). The most prevalent plastic item was soft fragments of low density polyethylene bags and other containers (45.7%).

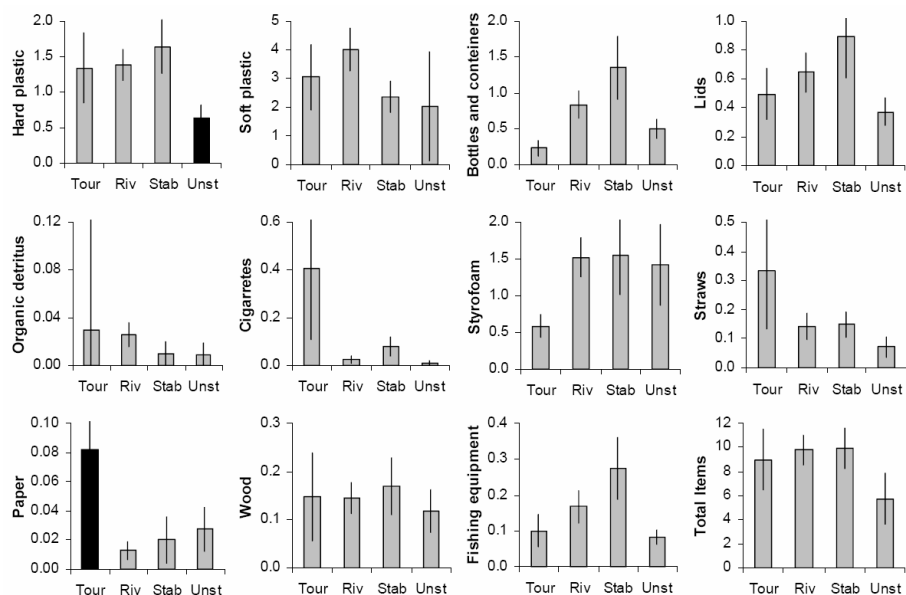


Figure 4: Average (\pm standard error) of selected types of debris (in units of items per m of shoreline) according to beach typology (Tour=tourism beach; Riv=river-dominated beach; Stab=stable beach; Unst=unstable, erosional beaches). Black columns represent treatments with mean significantly different from the other treatments (single-factor ANOVA, $p < 0.05$).

Except for paper items in tourism beaches and hard plastic fragments in unstable beaches, we found no significant evidence ($p < 0.05$) to reject our null hypothesis, i.e., that the four different treatments have the same population mean (Fig. 2). Small and degradable items were more frequent in tourist beaches. Larger items, in turn, are less abundant in tourism beaches. In such areas, the balance between tourism-generated debris and cleaning services changes debris composition, but not total quantities. Marine debris accumulation was higher in areas where dunes develop (stable beaches) and where river organic matter accumulates (river-dominated beaches). Fishing equipment and floating debris were especially higher on stable and river-dominated beaches, reflecting their depositional characteristic. The total quantities of debris were smaller in areas affected by erosion (unstable beaches), where few plastic fragments were found.

Identifying the source of debris polluting beaches is a key step towards the solution of the problem. First of all, our data indicated that the beaches south of the major bays seem to have a higher rate of debris accumulation, suggesting river inputs. We found a negligible amount of fouled

plastics in Costa do Dendê, which implies a short residence time in the ocean and that marine-based sources are unlikely to be dominant in the area. The small percentage of debris typically generated by beach users (7.6%) and fishing activities (15.8%) suggests that urban activities (~80%) are the most important source of beach debris to Costa do Dendê. The control of diffuse land-based sources of marine debris is difficult and actions tend to be palliative (e.g., cleaning of tourism areas) (SANTOS et al., 2005). In order to mitigate the problem, environmental education and pollution prevention at the hydrographic basin level are probably the best alternatives.

CONCLUSION

Plastics, especially soft fragments, dominated the debris composition on Costa do Dendê beaches. Though a few types of debris occurred preferentially in certain types of beaches, all the categories of debris were found all over the study area. This implies alongshore transport from the large human settlements and illustrates how mobile floating debris may be. Beaches south of major embayments were the main accumulation sites. Our results provide background information for future assessments. Management actions should focus on input prevention at the hydrographic basins rather than on cleaning services on beaches.

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