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Environmental quality of Sitges beaches during the bathing season



Beach surface has considerably increased since 1956 by the construction of breakwaters and ports, but some beaches are still prone to erosion. An adequate management of the, nowadays fragile, underwater prairies and dune vegetation could increase their coastal protection function and other environmental values. The quality of water and sand is in general excellent, but some of the beaches close to the city center have shown some microbial contamination events. The surface density, distribution and composition of beach litter provides useful information to study visitor behavior. We concluded that, during the bath season, the mean available surface is about $9 \text{ m}^2/\text{user}$, but important differences exist amongst beaches. Beach occupancy increase on factors such as beach length and surface, and decrease with distance to the city center. This multiparametric and integrated approach can be useful to promote strategies for better beach management in Sitges and worldwide.

Coastal areas provide significant resources and are crucial in the food chain. With about 40% of the human population within 100 km of the coast, the anthropogenic impact on the shore is high and management is needed to avoid environmental degradation. Beach cleanliness diminished by overuse or contamination directly affect the tourist industry and can have a strong economic impact.

The aim of this study is to analyze a selection of environmental indicators, that show the evolution and present state of the Sitges beaches. The 5.3 km coastline is mostly occupied by the 13 main beaches that represent 1.5% of the total Catalan beach length. To quantify the variation of the littoral line and surface we compared aerial cartographic data from 1956 (almost unaltered state) to the latest available in 2008. During this period 5 breakwaters and 4 harbors were constructed, affecting the sedimentation, increasing by 64% the total beach surface, although 4 of 13 beaches (with a main southern orientation) reduced its surface and Balmins appeared as a new beach. This sedimentation changes may affect by burial the submarine prairies.

The study of the phyto-quality was based on two indicators, submarine phanerogam prairies (presence, density and cover of mainly *Posidonia oceanica*) these not only offer a base for rich ecosystems but also their presence as fragile sea life is an indicator of good water quality and adequate fishing techniques. In situ studies show a complete lack of prairies on the northern half of Sitges while the Southern half prairies are small and isolated. They occupy 20% of the available surface with a density 50% below the optimal value. We also studied dune vegetation quality, their ecological value is great in comparison to otherwise deserted areas and protect the littoral from erosion. Only in Les Botigues beach can dune vegetation be found (thanks to recovery actions), its present surface of 5.03 Ha could be increased to 7.88 Ha and dune ecosystem could be recovered in Anquines, Terramar and Barra beaches. Several autochthonous species are widely distributed and the exotic invasive genre *Carpobrotus sp.* is colonizing the less developed dunes.

As microbiological pollution indicators we used the evolution of colony forming units concentration (c.f.u. g^{-1} for sand and c.f.u. 100 ml^{-1} for water). In sand, *Staphylococcus aureus* was measured but never detected, faecal contamination indicators such as *Escherichia coli*, *Enterococcus* and *Streptococcus* showed positive results. Periodic microbiological sand analyses during bathing seasons 2008 and 2009 show a general healthy state but with some contamination peaks. *E.coli* was only detected in 3 beaches and only Balmins reached occasionally levels near the quality limit. *Streptococcus* and *Enterococcus* were widely present and in some occasions, exceeded the quality limit value, fourfolding it in Balmins and St. Sebastià beach. In seawater, faecal coliforms (2003-2007) and *E. coli* (2008-2009) showed positive results while intestinal *Enterococcus* was a secondary contamination source. As in sand, levels were usually low, but some contamination peaks were observed, the *E.coli* quality limit was never surpassed during the period of study and intestinal *Enterococcus* limits were not surpassed since 2006. We concluded that the most vulnerable beaches are those close to rainwater urban discharge and water deposits used by beach service facilities that could be improved.

The seasonal visitors cause an economic boost but also a waste increase (monthly non-selected waste goes from 1.100 t in winter up to 1.900 t in August). In order to solve the lack of periodic data on beach litter, we used the daily records of sand cleaning tractors in 12 beaches, obtaining as indicator the total litter weight collected divided by surface of each beach. The mean litter density was clearly beach dependent, ranging from 100 g/m² in Balmins beach to 10 g/m² in Fragata beach. In almost all beaches litter density was about a 10% higher in 2009 than 2008. The weight percentage of plastic litter, was rather constant around 45% (solid municipal waste is close to 3%).

Comparing different data sources, we conclude that the mean beach user in Sitges produces approximately 300 g of waste per day (in total 8.834 visitors per day, while the lodging places in Sitges are 6.500). In average our beach user occupies a mean surface of 9.1 m², although with strong variation between beaches. Beach litter concentrations, and therefore beach user densities are smaller the further from the city center. Surface and shoreline length showed positive correlation to the variation of use.

Alejandro Palomino de Dios

Alejandro.Palomino.deDios@gmail.com

References

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