

Image analysis applied to the textural variability of sandy beaches

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ABSTRACT: Regarding the importance of sediment textural analysis to understand beach dynamics, image analysis emerged in the last years as an innovative tool able to accomplish this task expeditiously. Thus, this work aims to improve and simplify both image acquisition (in situ) and processing techniques of beach textural data, to validate the method and to apply it to sandy beaches along the Portuguese west coast.

Firstly, research efforts were focused on the development of a simplified lightweight hardware (SAND BOX©) and on the adaptation of an autocorrelation-based software algorithm to quickly process a large set of sediment images. The developed methodology consists on a standard procedure that can be done using a common digital camera that provides the sediment median grain size directly from the acquired images without any type of calibration. In order to validate the method, about 170 sediment samples were both photographed and sieved. The validation process shows that the median grain sizes obtained from image analysis are highly correlated with the sieving results ($R^2=0.89$).

Once the method's reliability was attested, two case studies were carried out at Lagoa de Albufeira and Salgado beaches. The work has focused on the horizontal textural variability of surficial and subsurficial sediments, where the last one corresponds to the layer situated 1 cm below the surface. For obtaining complementary data, topographic surveys were also performed along the studied areas.

Results show that on both beaches, the surficial sediments are always coarser than the subsurficial ones. Empirical models explain it as a consequence of significative water infiltration that reduces the water volume and consequently the backwash transport capacity when compared to the swash, leaving coarser sediments on the top of the active layer. This situation often happens during ebb tide as a result of the last swash on the beach face. In terms of individual results the Lagoa de Albufeira's beach textural analysis revealed a cross-shore pattern where sediments became coarser in offshore direction. When crossing these results with the topographic survey, it was observed an inverse relation between median grain size and elevation, which is a common behavior in high-energy beaches ($H_s \geq 2$ m). At Salgado beach, the textural distribution observed indicates a grain size increase in onshore direction. However, the most striking pattern is in the longshore direction where the textural variability seems to follow the dominating morphological feature, the beach cusps. In this case, the crests contain coarser sediments and the troughs the finer ones, conferring the longshore pattern on the grain size distribution.

The image analysis method developed in this work for determining median grain size of beach sediments revealed an excellent reliability. Later, it was successfully performed on two beaches on the west coast of Portugal. In conclusion and based on these experiences, the image analysis system was effective and sensitive to the scales of grain size variations on the studied areas.

KEYWORDS: AUTOCORRELATION, GRAIN SIZE