

# Sediment characterization of Tagus estuarine beaches (Portugal)

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**Introduction:** Estuarine sediments have different sources and their distribution in natural systems is controlled by the interaction between the available sediment and the hydrodynamic processes. Typically, muddy sediments accumulate in tidal flats and salt marshes along the margins and sand and gravel are present in areas of high energy, as deeper tidal channels and estuary mouth. Sand beaches can also be present in inner areas without influence of ocean waves, resulting of locally generated waves sediment reworking. Estuarine beaches have lower energy than ocean beaches and their morphodynamics is controlled by site specific factors as fetch distance, tidal range and bottom morphology [1,2]. The purpose of this study is to characterize the sediments from estuarine beaches of Tagus estuary, located in the Portuguese west coast near the city of Lisbon, and investigate the relation between sediment characteristics and the forcing factors. This mesotidal estuary presents a complex morphology with a narrow fault-controlled inlet channel that separates the outer estuarine domain from the broad and shallow inner domain (Fig. 1). The inner estuary, elongated towards north, is characterised by extensive mudflats and salt marshes nourished by fluvial inputs of fine sediments [3]. Sand beaches are present at the mouth of the estuary, exposed to refracted ocean waves, and within the inner estuary along the southern margin, associated to locally generated wind waves.



**Fig. 1:** Tagus estuary (Landsat 5 TM, 1997, IGeoE).

**Methods:** The beaches were identified through aerial photographs analysis and field surveys. Surface sediment samples were collected and sand grain size analysis was performed by dry sieving. Statistical parameters of grain size distributions were obtained using moments method according to [4]. It is well known that anthropic activity has had an increasing influence on estuarine dynamics. In order to evaluate the extent of these effects, multi-temporal aerial photography and map analysis was performed; this study focused in coastline occupation and evolution, particularly at Alfeite beach (Fig. 1).

**Results:** Tagus estuarine beaches are reflective showing a steep beach face and an adjacent extensive low-sloped tidal flat. Beach sediments are predominately quartzic well sorted sand with a median diameter of 0.2-0.3 mm, at the beaches in the outer domain, and moderated to poor sorted of 0.4-1.0 mm, at the inner domain. Exception is observed at Base Aérea sector (Fig. 1), the more extent and less intervened estuarine beach, with well sorted sand. Results from aerial photograph and map comparison show that human occupation has greatly increased during the last century with noticeable consequences on coastline evolution. For example, in Alfeite beach the human intervention is related with the construction harbour infrastructures that reduce beach sediment supply, the sand dredging disposal in beach vicinity and waste disposal in upper beach.

**Discussion and conclusions:** Sediment textural characteristics of Tagus estuarine beaches reflect the differences in the forcing mechanism and anthropic interventions. While exposed beaches exhibit well sorted fine sand, inner estuary beaches, sheltered from ocean wave influence, are composed by moderate to poor sorted sands, with a negative skew distribution (phi scale). These textural differences can be related to differences in: 1) forcing mechanism; the higher energy levels at outer estuarine beaches promotes a better sand calibration; 2) sediment supply; inner beaches are supplied from local sources and therefore have a wide range of grain-size distribution; 3) anthropic intervention; the disposal of allocthonous particles decreases sediment sorting and as these particles are in general coarser than the local ones, it induces a negative skew distribution. Coastline evolution results suggests that human influence on sediment budget has surpassed natural forcing mechanisms, so the interpretation of sedimentary dynamics should consider these aspects which, at present, are very difficult to quantify since there is no detailed information on this matter. From the above considerations it is clear that the analysis of these systems faces new challenges, with the need of development innovative methods for the quantification of the anthropic intervention effects in the sedimentary record.

## References:

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- [2] Jackson & Nordstrom (1992) *J Coastal Research* 8: 88-98;
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- [4] Friedman (1979) *Sedimentology* 26: 3-32.