# LONGSHORE SEDIMENT TRANSPORT OF AN ESTUARINE BEACH: NUMERICAL INVESTIGATION

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## 1. INTRODUCTION

Alfeite beach is an estuarine sandy beach submitted to wind wave action generated in an area of restricted fetch, the internal Tagus estuary of main alignment NNE-SSW (Figure 1). The beach is located in the south bank of the internal estuary and is not reached by oceanic waves. It has a main alignment WNW-ESE and is characterized by having a steep upper slope (average 0.15) until mean sea level, followed, seaward, by a low gradient terrace of approximately 800 m width, and a bimodal sediment distribution. The steep upper beach, with coarse sand grains ($D_{50}$ = 1.26 mm, where $D_{50}$ is the mean grain diameter), terminates in its base at a low gradient terrace, with finer grains ($D_{50}$ = 0.33 mm). Both the steep upper beach and the low gradient terrace are engaged in the surf zone at different states of the tide, therefore, the beach responds as a reflective beach and as a dissipative beach. The Tagus estuary is submitted to a semi-diurnal astronomic tidal cycle and a meso-tidal regime, according to the classification established by Davies (1964). At Alfeite beach the average tidal range at spring tide is 3.2 m and at neap tide is 1.5 m. The alongshore extension of the beach is about 2.5 km.


**Figure 1**: Location of the study area.

## 2. WIND WAVE ACTION

A six-year series (1999-2004) of four daily records (every 6 hours) of intensity and direction of the wind registered at the meteorological station Lisboa - Gago Coutinho of the Meteorological Institute, near the estuary, was statistically treated and analyzed. Only 10.8% of the total expected data was either missing or not valid. The distribution of the records per octant of incident direction (Figure 2) shows that there are four predominant directions of incidence: octants NW and N, with about 20% each; and octants NE and SW, with about 15% each. The analysis of the distribution of the intensity of the wind velocity per octant was also performed. The results allowed to establish the representative average annual wind regime, i.e., a set of pairs of velocity parameters, [intensity; direction], considered to generate the average annual wind wave climate in the internal estuary. The numerical model SAWN (vastly divulged and applied, therefore here dismissed description) was applied to simulate the processes of wave generation and propagation in the internal estuary. The wave climate was calculated at different positions in front of the beach. The comparative analysis of the climates revealed uniformity of the wind wave action alongshore (Figure 3). These results were then used as input to estimate the wave induced nearshore currents and the longshore transport.

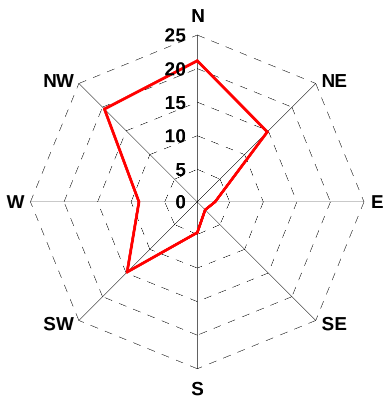


**Figure 2**: Average annual wind occurrence per octant, for the period 1999-2004.

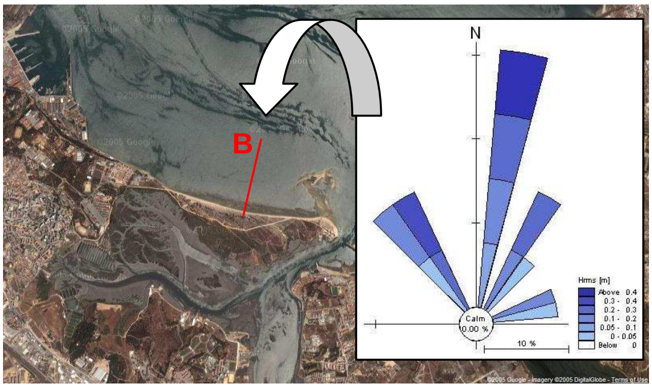


**Figure 3**: Wave climate at the entrance of profile B.

## 3. LONGSHORE SEDIMENT TRANSPORT

The longshore sediment transport was estimated through the application of a process based numerical model, a profile type model, LITDRIFT of the LITPACK package (vastly divulged and applied, therefore here dismissed description).

Topo-hydrographic and sedimentologic (grain size) surveys were performed along several beach profiles. These data were used as input in the model application (Figure 4).

Considering the astronomic tidal cycle correspondent to the average tidal range 2.4 m, the estimated average annual longshore transport in Alfeite beach is $14.5x10^3$ $m^3.year^{-1}$. This volume of sediment is equally distributed in both longshore directions, i.e., the net transport is null.

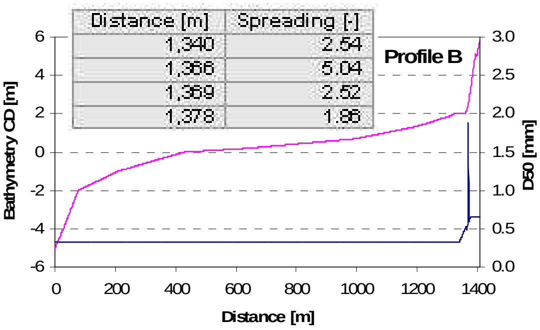


**Figure 4**: Profile B: geometry and grain size distribution ($D_{50}$ and geometrical spreading).

The discretisation of the longshore sediment budget, as function of directional sectors of 10° and classes of root-mean-square wave height, Hrms (Figure 5), shows, when comparing with the wave climate (Figure 3), that the most frequent incident sector, which also contains the highest waves, is not the one with the largest contribution to the transport due to its location (nearly normal) relativity to the shoreline. In opposition, the most western sector of incidence contributes largely to the transport directed to east because, despite it does not contain the highest waves, its direction relatively to the shoreline normal is about 45° (the most effective direction in generating longshore transport).

As described by Freire (1999), the beach profile is only modified when rare storms occur. No inter-annual or seasonal morphological changes have been observed in the last decade, i.e., the beach presents a medium-term permanent profile. This fact validates the numerical results obtained, i.e., that the integrated net transport along the beach profile is null.

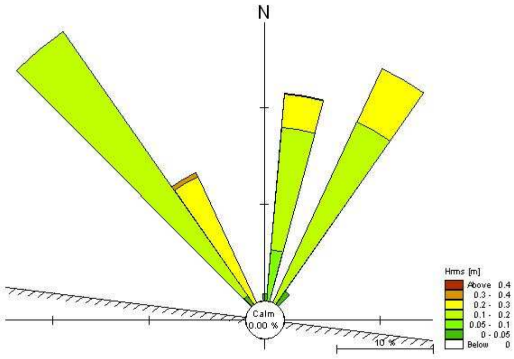


**Figure 5**: Discretisation of the longshore sediment budget at profile B.

## 4. CONCLUSIONS

The medium-term hydrodynamics and longshore sediment transport of a low energy estuarine beach, submitted to wind waves generated in an area of restricted fetch and a semi-diurnal meso-tidal regime, was analyzed based on mathematical modelling. The beach is characterized by having a steep upper slope until mean sea level, followed, seaward, by a low gradient terrace and a bimodal sediment distribution. The methodology applied allowed to conclude: on the characterization of the wave climate in front of the beach; on the magnitude of the average annual longshore sediment budget, $14.5x10^3$ $m^3.year^{-1}$; and on the contribution of each wind wave component to the longshore transport.

## ACKNOWLEDGEMENTS

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