SAND SIZE VARIABILITY INSIDE THE HOPPER OF A TRAILING SUCTION DREDGER IN REGARDS TO BEACH NOURISHMENT PROJECTS

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INTRODUCTION

Analysis of field data and aerial photographs over the last half century has shown that the coastline has suffered recession at a rate of about 1 m/year in some points of the Gulf of Cadiz (Muñoz-Perez et al., 2001). A protection program based in sand nourishment, therefore, has been performed during the last 25 years (Muñoz-Perez et al., 2014).

Amongst the design parameters for a beach nourishment project, sand size must be highlighted. Sand size is critical not only to compare the suitability of a borrow sand to substitute the eroded native sand, but also to identify the new equilibrium beach profile and to calculate the sediment volume necessary to achieve the projected berm or beach width.

Some researchers have already taken into account the phenomena that change the theoretical volume of sand needed for a beach nourishment project (CUR, 1987; CEM 2002) such as the methodology for the hopper measurements taken on board of the dredger (Muñoz-Perez et al., 2003) or the sand porosity variability (Roman-Sierra et al., 2014). Nevertheless, no investigation has been carried out about the variability of sand size inside the hopper of a trailing suction dredger till nowadays.

There are several reasons to justify this possible heterogeneity of the granulometric parameters inside the hopper. Firstly, there is the intrinsic variability of the sediment characteristics at the sea bottom. On top of that, most of the vessels which dredge nowadays are of the Trailing Suction Hopper Dredgers (TSHD) type and this means that these vessels do not dredge in a stationary way, i.e. at a certain location and vicinity, but along a big stretch of the bottom (Figure 1). Moreover, the fall speed of sand depends directly on the grain diameter (for a given density); i.e. the larger the grain sizes the faster the grain deposits and so, probably, the coarser grains would be at the bottom of the hopper and the finer grains would be at the top. Finally, it is noteworthy a word about the fragments of shells or bioclasts: because of their flat shape, these pieces linger more than the silica grains to decant and, therefore, their percentage will most likely be larger at the surface of the hopper.

METHODOLOGY

During the dredging process, for beach nourishment purpose, a large number of samples were taken by using different methodologies:

- During the dredging, in different moments (therefore, at different depths), at bow and stern.
- At the end of the dredging, in different locations distributed across the surface
    - By using a Van Veen grab sampler.
    - By introducing tube-corers by percussion and/or vibration.

Sand samples were analyzed following the standard procedure explained in Syvitski (1991) and modified by Roman-Sierra et al. (2013).

Figure 1 Data were taken from the Balder R (left) and the Costa Dorada dredgers (right)

RESULTS, DISCUSSION AND CONCLUSIONS

The paper will discuss the data gathered altogether with its importance when designing a beach nourishment project. The methodology used will also be explained in detail in order to let anyone apply it generally. Some interesting practical results drawn from the work carried out will be presented.

REFERENCES

CEM – Coastal Engineering Manual (2002), US Army Corps of Engineers, Part III Coastal Sediment Processes.

CUR (1987), Manual on Artificial Beach Nourishment, Centre for Civil Engineering Research, Codes and Specifications, Report n. 130.

Muñoz-Perez, J.J., Lopez, B., Gutierrez-Mas, J., Moreno, L., and Cuena, G. (2001), Cost of Beach Maintenance in the Gulf of Cadiz (SW Spain), Coastal Engineering 42, pp. 143–153.

Muñoz-Perez, J.J., Gutierrez-Mas, J.M., Moreno, J., Español, L., Moreno, L. and Bernabeu, A. (2003), A Portable Meter System for Dry Weight Control in Dredging Hoppers, Journal of Waterways, Port, Coastal and Ocean Engineering, Vol. 129, No.2, pp. 79–85.

Muñoz-Perez, J.J., Roman-Sierra, J., Navarro-Pons, M., Neves, M.G., and del Campo, J.M. (2014), Comments on “Confirmation of Beach Accretion by Grain-Size Trend Analysis: Camposoto Beach, Cádiz, SW Spain” by E. Poizot et al. (2013), Geo-Marine Letters 34 (1), pp. 75–78.

Roman-Sierra, J., Muñoz-Perez, J.J., Navarro-Pons, M. (2013), Influence of Sieving Time on the Efficiency and Accuracy of Grain-Size Analysis of Beach and Dune Sands, Sedimentology 60, pp. 1484–1497.

Roman-Sierra, J., Muñoz-Perez, J.J., Navarro-Pons, M. (2014), Beach Nourishment Effects on Sand Porosity Variability, Coastal Engineering 83, pp. 221–232.

Syvitski J.P.M. (1991) Principles, Methods, and Application of Particle Size Analysis, Cambridge University Press, New York, 368 pp.