

# Beach Nourishment on the Tróia Peninsula, Portugal

Tanya M. Silveira<sup>1</sup>, Nicholas C. Kraus<sup>2</sup> and Norbert P. Psuty<sup>1</sup>

<sup>1</sup> Institute of Marine and Coastal Sciences, Rutgers, The State University of New Jersey, New Brunswick, New Jersey  
<sup>2</sup> U.S. Army Engineer Research & Development Center, Coastal & Hydraulics Laboratory, Vicksburg, Mississippi.



**Introduction:** The Tróia peninsula, in Portugal (Fig. 1), is undergoing tourism development, including the construction of a marina. The marina basin was created by dredging a portion of northern terminus of the peninsula, supplying beach-quality sediment for nourishment. A study identified potential applications and opportunities to place the dredged sand in a beneficial manner. Many variables were taken into consideration, incorporating pre-project beach profile surveys and sediment sampling. Beach-fill design and placement procedures were proposed that recognize the implications of the dredging and nourishment in the regional sediment management. A monitoring program was applied to assess project performance, evaluate project impacts on adjacent areas, and identify problems and their causes.

**Procedure:** Our study recommended that sand dredged during marina construction be placed as nourishment to maintain transport pathways, restore dimensions of impacted beaches and dunes, and provide increased buffering capacity in areas of damage to cultural resources. Between October 2006 and March 2007, 286 000 m<sup>3</sup> of sand from the marina basin and local excavations were placed in four sectors in the vicinity of the new marina and at the Tróia Roman ruins site (Table 1 and Fig. 5).

Table 1. Sites of sediment placement

Location	Amount (m <sup>3</sup> )	Alongshore extension (m)	Nourishment design	Berm width increase (m)	Constraints	Purpose
1. Ocean margin	200 000	600	Beach berm	100	No constraints	Recreation
2. Dune and upper beach	5 000	-	Foredune / berm reinforcement	-	Zostera beds	Prevent overtopping
3. Estuarine margin	55 000	400 east marina 200 west marina	Beach berm	30	Marina basin Zostera beds	Slow erosion rates
4. Roman ruins	26 000	400	Beach berm	30	Caldeira lagoon	Create buffer to erosion



Figure 1. Tróia Peninsula, Portugal.



Figure 2. Estuarine margin east, during and after the fill.

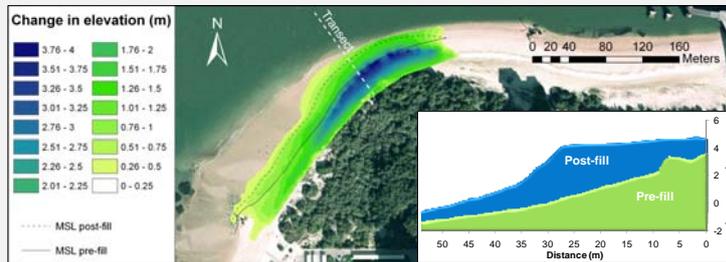


Figure 3. Estuarine margin west, change in elevation map and transects for pre- and post-nourishment.



Figure 4. Ocean margin, and dune and upper beach fill actions.



Figure 5. Location of the marina basin (source of the nourishment material) and the four sectors that received beach nourishment.



Figure 6. The Tróia Roman ruins archeological site. Erosion of the structures that were submerged during high tide, and beach fill procedures.



Figure 7. Change in elevation between May and August 2007 for the estuarine margin, east of the Marina.

**Findings:** Monitoring indicates that by August 2007 most of the emplaced sand was mobilized alongshore promoting the spreading of the fill material to down-drift areas while inducing a general reduction in the beach face slope, and attaining a more natural beach profile (Fig. 7 – example from the estuarine margin nourishment). Pioneer vegetation started to expand onto the newly-constructed berm.

**Conclusions:** This study attempted to arrive at optimal solutions for beach nourishment design for Tróia peninsula by making use of the local beach-quality material made available by the dredging for a new marina basin. A comprehensive study of the local physical setting and a regional sediment management approach formed a basis for recommendation of one-time placement of fill to increase the level of protection of vulnerable coastal areas along the peninsula, and to increase the area of the recreational beach.

**Acknowledgements:** Data were obtained through the "Environmental monitoring program for the marina and new ferry dock of the Troiaresort", and provided by the Institute of Marine Research and SONAE turismo. Tanya Silveira was funded by the Luso-American Foundation /Institute of Marine Research in Portugal.