Shoreline evolution of the Ebro Delta: seasonal and medium-term evolution

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The Ebro Delta, located in the Spanish Mediterranean coast (fig.1) has experimented during the last decades a change in its evolution trend. Whereas in 1900 it behaved as a progradating coast it is eroding severely at present. This change is linked to a decrease of the solid discharge of the Ebro river while the transport capacity of the waves has remained much the same.

Under these conditions, the behaviour of the Delta can be assumed as independent of the river discharge and fully wave-dominated. This means that marine dynamics is responsible for the short-term and medium-term coastal responses.

The Delta coast has been monitored during the last four years to identify and quantify the processes that control the coastline evolution. From these measurements, two types of changes have been identified: medium-term and seasonal changes. The first ones are associated to longshore transport gradients along the coastline (JIMENEZ *et al.* 1991a, JIMENEZ *et al.*, 1992) while the second ones are due to the quasi-cyclic action of storm and post-storm waves. These changes are overlapped and can be seen in figure 2.

The existing of longshore transport gradients - due to changes in the wave characteristics at breaking and to differences in the shoreline alignment - produce erosive processes in some coastal stretches (figure 1). The main erosive areas are the Buda Island and the Trabucador Bar in the southern hemidelta, and the whole northern hemidelta. Their behaviour can be classified as a medium-term trend because of the time scale of the measurements (several years), but seems to be representative of the longer-term evolution trend (only from the wave action point of view, i.e. not considering other kind of effects like sea level rise or others).

The profile short-term changes are associated to the storm and post-storm wave attack on the coast and they are correlationed with the climatic seasons -heavy storms during the winter and mild waves during summer- (GARCIA *et al.*, 1992). These changes are mainly due to the cross-shore component of the transport and they are not uniform along the coast. The response of each profile depends on the coastal orientation with respect to the wave direction. Coastal stretches with a similar behaviour can be easily identified (JIMENEZ *et al.* 1992).

In the Trabucador Bar the most remarkable short-term changes are associated to storm events during which high waves coexist with an important surge. If overtopping is produced, a remarkable sediment transport towards the Alfacs Bay can exist. This transport can produce the failure of the Bar. The sediment removed from the littoral and deposited it in the Bay, will be no longer available for the littoral transport scheme (JIMENEZ *et al.*, 1991b).

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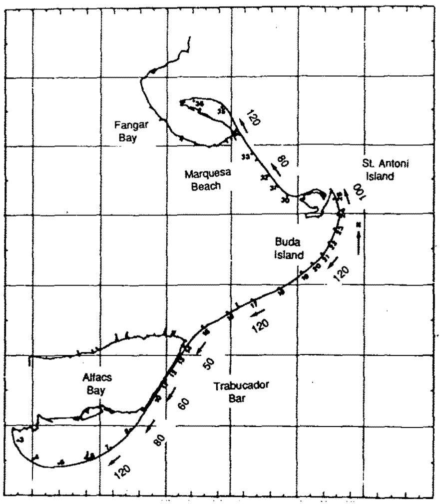

Figure 1. Net longshore transport rates in the Ebro Delta (transport in thousands of cubic meter per year)(modified from Jiménez *et al.* 1992)

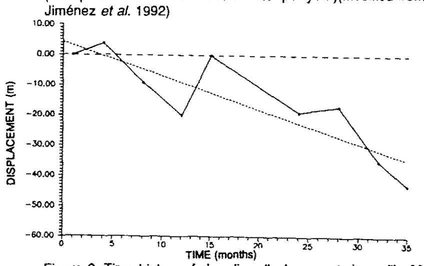

Figure 2. Time history of shoreline displacements in profile 22 (Buda Island).

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Sedimentation in the Rasa River estuary (Istra, Croatia)

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The Rasa River estuary (Istra, Croatia - see: Figure) was chosen as a model of karstic river mouths in studying the land/sea interaction. The principal vehicle of this interaction are suspended mineral particles and consequently their sedimentation. The particles originate from the northern part of the drainage basin, where Eocene flysch sediments are exposed. The southern part of the drainage basin and the whole estuarine system are developed in Cretaceous carbonate rocks.

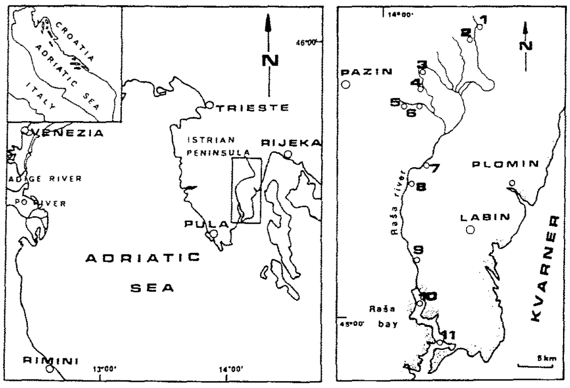

Figure: The Rasa River estuary and the sampling stations

The hydrology of the Rasa River is typically karstic : small flux with high seasonal variations : at sampling station (ST 7) the reported mean flux is 2.3 m^3/s, whereas at the river mouth (ST 10) the corresponding figure is 12 m^3/s.

Sampling in the drainage area includes terrestrial sources (ST 2, 3 and 5), riverine sediments (ST 1,4,6,7,8, and 9), and estuarine (sea) sediments (ST 10 and 11). The results of sedimentological analysis of these samples are presented in the Table.

Standard techniques have been used in producing data shown in the Table: X-ray diffraction for semiquantitative mineral composition ; gas volumetry for carbonate share ; nitrogen adsorption for the BET surface area determination ; standard wet sieving and Coultercounter sizing for granulometry.

TABLE : Characteristics of materials

	Sampling station	Mineral composition*	Carbo-nates %	SSA m^2/g	Mz μm	Rock/soil type
	2A	Ca, Q, F, I, Ch	62	2.6		sandstone
	2B	Ca, Q, I, Ch, S, K, F	46	10.9		marl
	2C	Ca, Q, I, Ch, F	51	12.8		marl
I	3A	Ca, Q, S, I, Ch, F	39	14.6		marl
	3B	Ca, Q, F, I, Ch	52	5.3		sandstone
	5	Ca, Q, I, S, Ch, F	46	8.2		marl
	1	Ca, Q, Ch, I, S, F, K	38	16.2	6.7	clayey silt
	4	Ca, Q, I, Ch, S, F	28	26.5	8.1	clayey silt
	6	Ca, Q, I, Ch, S, F	46	15.0	6.0	silty clay
II	7	Ca, Q, I, S, Ch, K, F	28	25.5	3.5	silty clay
	8	Q, Ca, I, S, Ch, K, F	19	30.5	3.0	silty clay
	9	Ca, Q, I, Ch, S, F	39	8.7	3.6	silty clay
III		Ca, Q, I, Ch, S, F			3.0	silty clay
	10	Ca, Q, I, S, F, Ch	38	10.0	3.7	silty clay
IV	11	Ca, Q, I, Ch, D, F	32	13.3	4.3	silty clay

The mineral composition of the clastic source rocks is predominantly carbonate, but noncarbonate, quartz and clay minerals are present in significant shares. The latter are the minerals found in riverine and estuarine sediments due to its transport from its flisch origin through the carbonate zone into the estuary. The main part of the terrigeneous clastic particles is deposited in the estuary. The Rasa River estuary is an illustrative example of transport of suspended matter and sedimentation under the influence of the Coriolis force, as indicated by the high turbidity of water at the right bank. The main reason for accumulation of terrigeneous material is the estuarine circulation with the ingoing bottom saline water and outgoing surface brackish water. The foregoing is corroborated by studies of BENAC*et al.* (1991) of the Rasa River basin, and by JURACIC and PROHIC (1991) of the Krka River estuary.

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