

APPLICATION OF METHODS FOR CHANGE DETECTION TO IDENTIFY GEOMORPHOLOGICAL CHANGES. CASE STUDY: MOUTH OF THE EBRO DELTA

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Abstract

This work shows an evolutionary analysis of the different geomorphological units present in the mouth of the Ebro delta in order to evaluate, through methods for change detection, the most significant changes taking place in that area. The period 1957-1984 was much more dynamic and intense than the period 1984-2009. It also found that the most important processes that take place are coastal erosion and anthropogenic expansion.

Key words: Geomorphology, change analysis, geomorphological units, Ebro delta.

1. Introduction

The coastal area is subject to different, and sometimes strong, derivative impacts of natural and anthropogenic processes which concur therein. Its current state is the result of the combined action of physical agents and human agents (Rodríguez et al., 2009). Any variation in these combination results geomorphological changes in relatively short periods of time and, in many cases, can constitute a risk to human activities. The main risks in the coastal zone are coastal erosion, changes in sea level and storm sea (Andrew and Grace, 2002). There are many studies of coastal dynamics, but few of them (Ramírez-Cuesta et al., 2011) have focused on the geomorphological evolution in detail, despite being a key element in such important areas as coastal risks.

Therefore, the aim of this study is to analyze the changes of different geomorphological units of the Ebro river mouth.

2. Study Area

The Ebro Delta, located in the NE of the Iberian Peninsula, south of Tarragona, is one of the major Mediterranean deltas. The selected area is the last section of the mouth of the river Ebro, because it is the place where geomorphological changes have been most evident because the waves impact more strongly than in the rest of the delta. This area has a very flat profile and a low slope, which assists the development of sandbars. The selected area has a total extension of 70.36km².

3. Methodology

To determine the geomorphological evolution, georeferenced images of the years 1957, 1984 and 2009 were selected, which were photo-interpreted in the different geomorphological units, and later this were digitized.

Finally, a change analysis was carried out using a transition matrix or cross tabulation because it is a methodology that has certain characteristics that make it capable of being used in such studies, despite being used primarily on issues of land use (Pontius Jr. et al., 2004). This process identifies the most significant transitions in order to detect the processes that generate these transitions.

4. Results and discussion

As a result of the photo-interpretation, geomorphological maps were obtained for the three dates of interest (Fig. 1), and the area occupied by each geomorphological unit in the different years was calculated. Thus, it was observed that the larger units in the total period studied are wetlands, as befits the typical environment of deltaic areas, and anthropic areas, which shows the great importance of agriculture, mainly rice, in the study area.

Then it proceeded to perform the analysis of changes in order to identify the most significant transitions between different geomorphological units (Fig. 2). Thus, significant transitions found for the period 1957-1984 reflect processes of sedimentation, erosion, sand dunes stabilization, anthropic advance and level variations of wetlands and coastal lagoons. Sedimentation is reflected in the increased size of the bars present in the mouth of the delta in 1957, which defend a large wetland behind them. Regarding erosion, it concentrates on the beach, the unit more exposed to waves causing the beach moves inland.

Much of the sedimentary deposits located at the mouth of the river Ebro disappeared as a result of the construction of Riumar urbanization in the 60s. This is not the only progress of human activity. The expansion experienced by rice was also very marked, mainly affecting the surface devastated by the waves flooding, concentrating this transition in the region north and south of the study area.

Variations of level of wetlands and coastal lagoons are caused by the needs of irrigation in rice cultivation, so the water level of these lakes is higher during the months of May to December than during the rest of the year. Furthermore, due to the expansion of farming plots, mostly in the southernmost lagoon, these ponds and wetlands experienced a great loss of surface during this period.

Transitions identified for the period 1984-2009 show that coastal erosion is concentrated in the beach surface. In this period there is also an increase of the barrier islands of the area N of the mouth due to coastal aeolian transport of sediment by prevailing winds from the NW-SE and also due to the accretion process in the northern coast of Riumar urbanization.

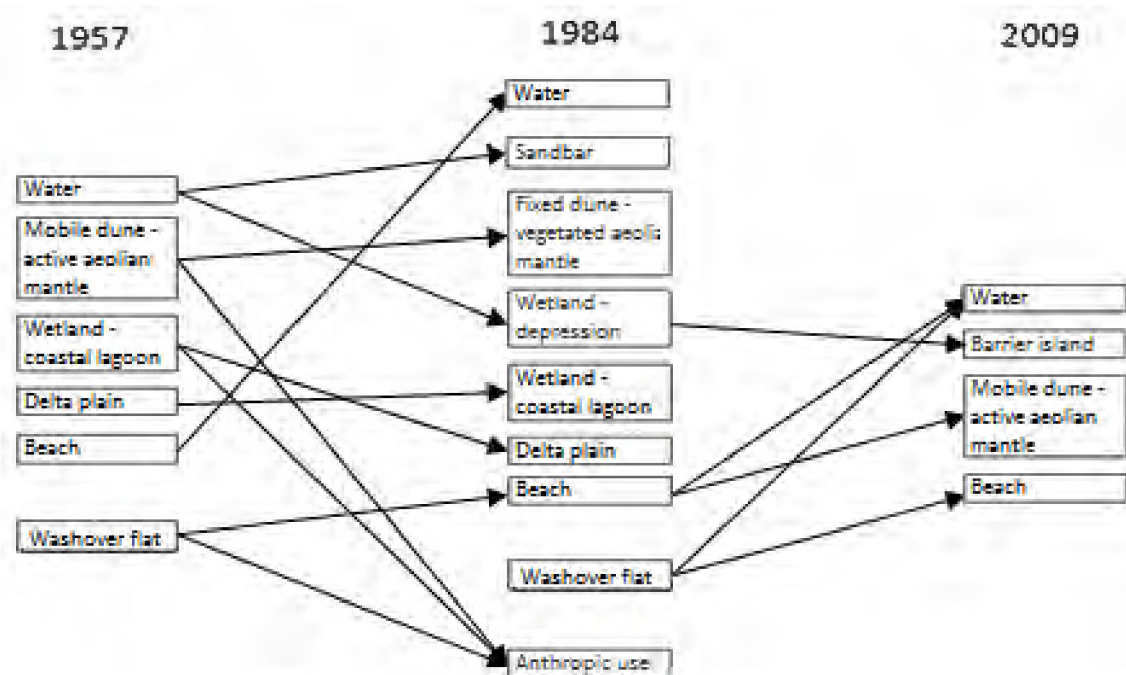


Fig. 1. Significant transitions identified for the entire 1957-2009 period.

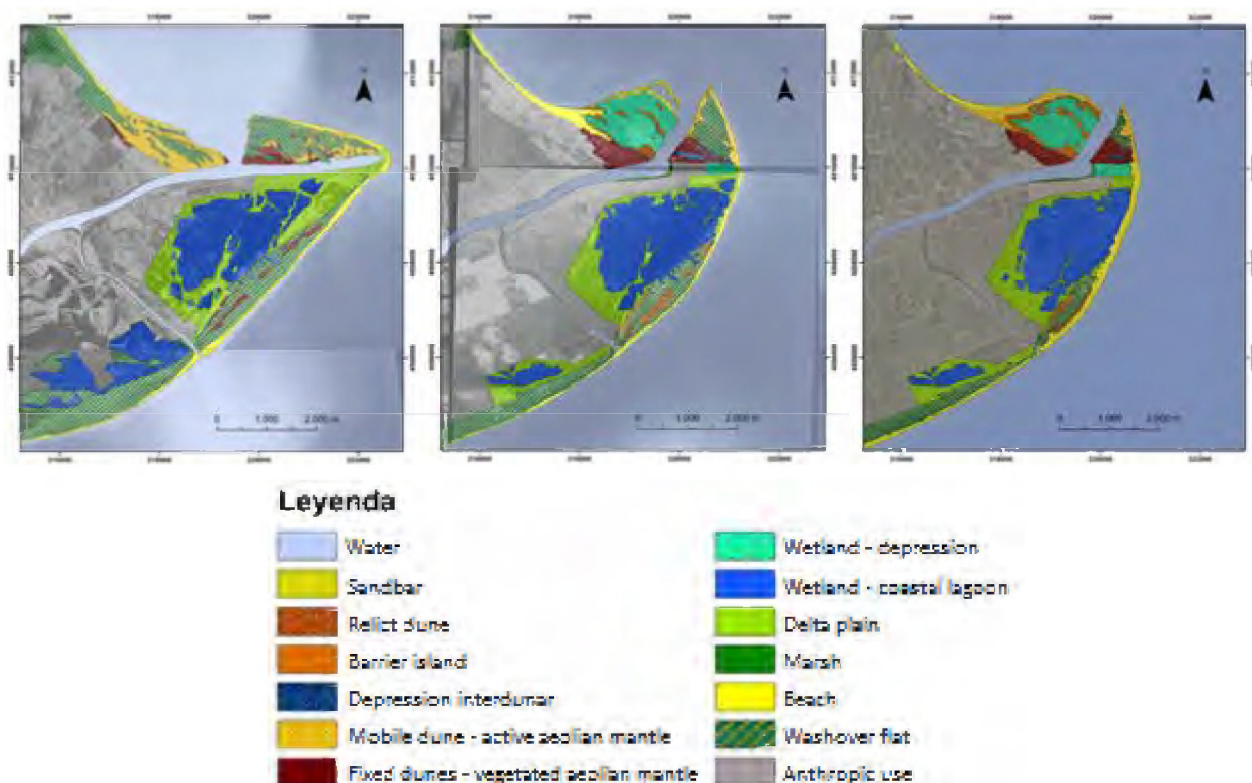


Fig. 2. Geomorphological maps obtained for the three dates of interest obtained by photo-interpretation

5. Conclusions

Change detection methodology is applicable to the field of coastal geomorphology, allowing identification and characterization of the major transitions between geomorphological units identified.

The main processes taking place in the area of the mouth of the Ebro Delta are coastal erosion processes and agricultural expansion.

The period 1957-1984 was more active in terms of geomorphological changes than the period 1984-2009. This suggests that the Ebro Delta is becoming a form that allows cushion the variations mainly by coastal erosion.

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