

## **CLIMATE CHANGE ADAPTATION STRATEGIES IN THE SPANISH COAST: EBRO DELTA CASE STUDY**

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**KEYWORDS:** climate change, strategies, delta, adaptation, flooding, erosion, sea level rise, retreat

A strategy of adaptation to climate change in coastal shores areas, such as deltas and estuaries, needs a very important effort. Integrated Coastal Zone Management allows working with several critical elements, such fragility, interface, demand, and scarcity affecting those areas so it's going to be one of the main tools for developing climate change adaptation strategies.

The presentation will be based on the following sequences: coastal zone significance, climate change threats, existing data, effects on the Spanish coast, plans and measures, and Ebro delta case study.

Coastal zone significance is based on the values of the coast as a receiver and generator of goods and services as: agriculture, harbours, industries, cities, leisure, tourism, etc. According IPCC 50% of population is living on coastal zone. EUROSION program from European Union reached several interesting conclusions: 70 millions of European citizens are living on coastal municipalities and 1 billion of €in goods and services are located on the 500 m of coastal strip.

Coastal zone threats are basically: flooding and erosion. The cost of protection against erosion and flooding effects in Europe during 2001 was 3.200 millions €and induced cost on human activities due to the same phenomena was 5.400 €per year.

The climate change effects on coastal zones are the consequence of: sea level, wind, atmospheric pressure, wave height and wave direction. The analysis of instrumental and retro-analysis from atmospheric maps data during the period 1958-2001 applied to these consequences was developed by Spanish Ministry of Environment and applied to the Spanish coast. Several tendencies were found. From these tendencies the effects of climate change on the Spanish coast were analyzed taking account: flooding level, shoreline retreat, overtopping on maritime works and increasing of block weight on maritime works.

As a conclusion of this analysis several strategies were defined that can be summarized on: retreat, adaptation, and protection, all of these were considered

on the Spanish coast. Retreat strategies were applied in the Ebro delta as a case study.

The Ebro delta is located on the north east part of Spain in the Mediterranean sea. The Ebro delta is an alluvial borrowed sedimentary area with a plain of 325 km<sup>2</sup>. It can be divided in a central area, Ebro river floods the internal area reaching the river mouth, and the coastal area. The last one, that includes the coastal zone, is a sandy stretch of 50 km. of shoreline in front of the open sea and 35 km. of shoreline in internal bays. A practical proposal for this case study will be shown based on beach-dune-wetland-dune scheme. The objectives of this scheme are: to make a wider beach, to obtain a buffer system to storm attacks, ecosystem of flora and fauna, and sea level rise protection. All these aspects are related directly or partially to climate change phenomena.

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