VULNERABILITY OF A RIVER DELTA COAST TO THE IMPACTS OF CLIMATE CHANGE

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INTRODUCTION

The global projections on the concept of climate change mainly indicate global warming, sea level rise and increases in climatic extremes. The main drivers of coastal morphology evolution related to climate change are wave characteristics, storm frequency/intensity and watershed runoff. Estuaries and deltaic plains, strongly affected by the sea-level change, are highly vulnerable to future climate change impacts (Wong et al., 2014). Karasu Beach, located in the southwestern Black Sea, Turkey, is impacted by the Sakarya River plume (Figure 1). The shoreline stretches approximately 30 km to the west and 50 km to the east sides of the Sakarya River mouth. River discharge and energetic wind and wave climate are among the major physical processes that control the sediment transport pattern along the shoreline and cause the formation of natural beach areas with dunes behind. Due to the decrease of sediment runoff to the coast related to the construction of large volume reservoirs along the Sakarya River stream, and construction of a harbor at the west side of the river mouth, significant erosion occurred at the east side of the river, with a 7.5 m/year retreat of the coastal line (Yuksel et al., 2013). A series of dunes protect the Acarlar floodplain forest at the western side of the river that serves as a confined refuge for some fish species and aquatic organisms. The erosion problem threatens the coastal area as well as the deep spot.

Figure 1 – Sakarya River mouth, Harbor and Acarlar deep spot

METHOD

Wave, current, and sediment dynamics along the Karasu coastline are investigated using field observations and numerical model results. Three shipboard surveys (in February, July and October 2019) were conducted in the vicinity of the Sakarya River region of influence, covering different meteorological and hydrological conditions, and therefore allow for observations under different forcing conditions. Measurements of waves, vertical structures of currents, turbidity, temperature, and salinity were collected. Waves, hydrodynamics, and sediment processes in the study area were modeled using the MIKE modeling suite. Waves between 1979 and 2018 were modeled with MIKE 21 Spectral Wave (SW) over the closed Black Sea basin, by using the wind fields obtained from the ECMWF and calibrating with the measured wave conditions. Mike 3 Flow Model FM and Mike 21 ST coupled model were used for modeling the hydrodynamics and sediment processes along the Karasu coastline. A higher-resolution grid that covers the nearshore region was nested in this Black Sea grid and forced with waves at its boundaries, and calibrated using the in-situ measurements of hydrodynamics and sediment processes.

RESULTS

The modeled significant wave height in the last 40 years indicates a variation compatible with the potential impacts of climate change. While the annual mean H_s shows a slightly decreasing behavior with time, the intensity and frequency of extreme events tend to increase significantly (Figure 2). The hydrodynamics and sediment processes model is being run over decadal scales for evaluating the long-term sediment transport patterns of the region. The results will be used to investigate the respective impacts of climate-change associated and the anthropogenic influences.

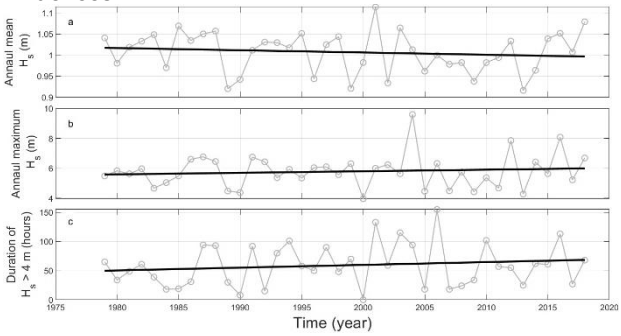

Figure 2 – Evolution of a) annual mean and b) annual maximum wave height, c) occurrence of waves of H_s >4m.

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