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Identifying extent of technogenous impact on the coastline of Bulgaria based on GIS methodology

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The Bulgarian Black Sea coast is about 412 km long, stretching between cape Sivriburun on the North and Rezovska River mouth on the South. At present, coastal erosion is a common process affecting 61% of the Bulgarian coast, while the sandy beaches comprise at least 30 %. Large number of coast-protection measures has been used to solve and manage the erosion/landslide problems, as most of these methods have involved "hard" stabilisation options such as: solid groins, dikes and seawalls. Design and construction of such protection structures has been increased in particular over the last few decades. About 217 technogenous objects have been indicated as port and coastal defence structures that currently constitute 17 % of the whole Bulgarian coastline. As a result, for a 50-year period (1960-2008) the amount of sediment material, incoming from cliff erosion, river solid discharge and wind-blown material has decreased from 4 979 700 Mg/y to 1 221 300 Mg/y. This in turn has provoked a reduction of sediment supply, sandy beach degradation and even occurrence of new erosion spots. Therefore, the major causes for progressive erosion along the Bulgarian coast could be mostly related to expanding human influence in terms of maritime constructions, dredging works and river corrections. The study is designed to trace the important issues of finding the extent of technogenous impact on the coastal zone of Bulgaria in order to delimitate the areas most influenced by coastline armouring.
Topographic maps and GPS field survey data were used for identifying various types of port and coast-protection structures along the coastline. Data processing, mapping and analysis, as well as assessment of technogenous impact on the coastline were methodologically performed with tools of GIS ArcInfo 9.2. To evaluate the extent of anthropogenic influence on the Bulgarian Black Sea coast the coefficient of technogenous impact K was used, which serves for quantitative assessment of the impact of maritime hydraulic structures on the coast. This coefficient represents the ratio between total length of protection structures/objects (groins, moles, seawalls, dikes, navigational channels and permeable bridges) and total length of the coastline. According to this methodology the extent of technogenous impact is considered as minimal at K = 0.0001-0.1; average when K = 0.11-0.5; maximal at K = 0.51-1.0 and extreme if K > 1.0.
The coefficient of technogenous impact on the whole Bulgarian coastline was estimated to be K = 0.17, which determines the extent of coastline armouring with port/coast-protection structures as average. Although this value for K of the entire coast could be acceptable, there are large coastal units, distinguished with significant concentration of maritime structures, and these are the largest bays along the Bulgarian shore: Varna Bay, where K reaches to 0.88 and Bourgas Bay with K = 0.26.
The main findings from the study reveal an increasing human influence due to coastal defence activities at the Bulgarian Black Sea coast particularly expanded over the last few decades. Instead of soft protection alternatives, the construction of hard stabilisation structures, such as groins, dikes and seawalls, have been assumed as a common solution to prevent the coastline. As a result, the sporadic natural erosion in the near past has turned into human-caused and has become critical at many coastal units. The coefficient K could be used as an indicator for the extent of technogenous impact and would allow quantifying coastline modifications related to maritime structures (port and coast-protection).

Keywords: coastal erosion, sediments, human impact, coastal defence, GIS.