

RISK OF INUNDATION CAUSED BY SEA LEVEL RISE ALONG THE BULGARIAN BLACK SEA COAST

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Abstract

Over recent decades the increased frequency of natural hazards resulting from global climate change has become one of the most severe problems affecting the sustainability of the coastal zone. In particular, low-lying areas which are strongly affected by flooding pose the most serious consequences for the functions of coastal systems and public safety. Such areas are also most attractive and productive environments both for settlements and human activities because they offer great variety of possibilities for better livelihoods, easy access to the sea, and wide and vast beaches. These settings make even more important the efforts to identify coastal areas with high priority of risks to sea flooding.

Keywords: Black Sea, Coastal Processes, Sea Level

Introduction

The Bulgarian Black Sea coast has a length of 412 km, as 58% of it is exposed to progressive coastal erosion and landslide processes [1,2]. Such natural hazards have been aggravated by increasing anthropogenic impacts associated with accelerated urbanisation and human influence along the coast. There are 14 Bulgarian Black Sea coastal municipalities which embrace about 5.21 % from the entire territory of the country and hosted about 8.85 % of the national population. Coastal units potentially vulnerable to sea level rise along the Bulgarian coast are firths, lagoons, sandy beaches and dunes often being also under subsidence processes. Firths and lagoons are typical of the Bulgarian coastal zone. Firth configuration almost repeats the contours of old river valleys drowned during the Holocene. The number of firths and lagoons are 26 and 5 respectively [3]. Long-term sea level changes along the Bulgarian Black Sea coast have been traced for more than 100-year period. Based on the records of two sea level gauges, located at towns of Varna and Burgas, a continuous sea level increase has been found, particularly over the last few decades. Natural and anthropogenic factors are pointed out as the main causes for accelerated sea-level rise. The natural factors involved include changing river discharge into the Black Sea, rainfall-evaporation balance and water exchange through the straights linking the Black Sea to the Mediterranean [3]. The mean values of average sea level rise for the Western part of the Black Sea vary between 1.5 mm/y and 3 mm/y [4]. Although such rates are not dramatic for the Bulgarian coast there would be a case of sudden sea level rise under certain meteorological conditions. In contrast to climate change-induced sea level rise, which can be predicted over a middle-time scale, the extreme sea level increase associated with storm surges, tsunamis and rain-storms could have a short, but particular devastating impact on coastal areas. Significant coastal changes typically occur during such extreme events. As a consequence, functions and values of the coastal systems could be degraded, and public safety and economy could be affected [5]. Coastal storms are extreme meteorological events that mainly occur along the Bulgarian Black Sea coast in winter with the strongest N and NE winds. There are some examples of extreme events along the Bulgarian coast: the storm happened in February 1979 accompanied by sea level increase; and the storm in June 2006, also combined with pour rains. Extreme wind waves are the main cause of flooding in low-lying coastal territories.

Analysis

To indicate low-lying territories potentially vulnerable to flooding due to extreme sea level rise along the Bulgarian coast, medium scale 1:50 000 topographic maps were used [6]. Maps processing includes a series of steps: scanning, geo-referencing and digitizing with help of Geographic Information System (GIS) ArcInfo 9.2. The following approach was accepted: sea level rise scenarios from 1 to 5 m with interval of 1 m were assumed on the basis of historical background and data collected over a 100-year period (Fig. 1). The performed analysis shows that 14 towns, 17 villages, 13 sea resorts and 7 small campsites would be potentially flooded by extreme sea level rise of 5 m. Number of affected coastal population counts almost 100 000 from all 549 765 residents at these sites, according to last Census data [7]. Low-lying areas around Varna Bay, Kamchia River resort, Burgas town, Sunny beach resort, Pomorie town and coastal section between Albena resort and Kranevo village were identified as most vulnerable to inundation (Table 1). The risk to flooding is higher in summer presumably due to greater numbers of tourists having their rest at the sea coast. In summary, about 20% (83 km) of the entire 412 km long Bulgarian coast are indicated as flood-prone territories or these are coastal units most vulnerable to inundation due to extreme sea level rise of 5 m. Total number of local coastal residents at these sites constitutes 6.93% of country's population.

Conclusions

Sea level rise along the Bulgarian Black Sea coast up to 1 m could cause damages on 7% of the territory and population of the coastal settlements. Sea level rise up to 5 m could cause damages on 21% of the territory and 16% of the population of the coastal settlements. Expected damages in residential area caused by inundation of 1 m would amount to 33% of territory and 42% of population from those affected by inundation of 5 m. As the most risks zones are defined the territories around of the towns of Varna, Burgas, Balchik, Pomorie and Nessebar, Kamchia river region, Sunny beach and Albena resorts. Totally, between 40 and 97 thousand local residence could be affected and between 9 and 27 square km of settlements inundated in case of different scenarios. Although the probability of casualties due to extreme storms is quite high, in actual fact the economic losses in terms of hotel, transport and other infrastructure damages are predominant. As a result of such events the economy of a small municipality like Nessebar will be greatly affected due to its high dependence on the tourist industry. Therefore, many potential users and institutions interested in sustainable development, including local government, civil protection authorities, stakeholders, coastal decision makers and community would benefit from the results obtained for coastal hazards to elaborate appropriate mitigation measures and adaptation policies.

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