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Coastal flooding impact evaluation using an INtegrated DisRuption Assessment (INDRA) model for Varna region, Western Black Sea

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The study presents evaluation and comparative analysis of storm induced flooding impacts on different coastal receptors at a scale of Varna region using INtegrated DisRuption Assessment (INDRA) model.
The model was developed within the FP7 RISC-KIT project, as a part of Coastal Risk Assessment Framework (CRAF) consisting of two phases. CRAF Phase 1 is a screening process that evaluates coastal risk at a regional scale by means of coastal indices approach, which helps to identify potentially vulnerable coastal sectors: hot spots (HS). CRAF Phase 2 has the objective to assess and rank identified hotspots by detailed risk analysis done by jointly performing a hazard assessment and an impact evaluation on different categories (population, businesses, ecosystems, transport and utilities) using INDRA model at a regional level. Basically, the model assess the shock of events by estimating the impact on directly exposed to flooding hazard receptors of different vulnerability, as well as the potential ripple effects during an event in order to assess the "indirect" impacts, which occur outside the hazard area and/or continue after the event for all considered categories. The potential impacts are expressed in terms of uniform “Impact Indicators”, which independently score the indirect impacts of these categories assessing disruption and recovery of the receptors. The ultimate hotspot ranking is obtained through the use of a Multi Criteria analysis (MCA) incorporated in the model, considering preferences of stakeholders.
The case study area – Varna regional coast – is located on the western Black Sea, Bulgaria. The coastline, with a length of about 70 km, stretches from cape Ekrene to cape St. Atanas and includes Varna Bay. After application of CRAF Phase 1 three hotspots were selected for further analysis: Kabakum beach (HS1), Varna Central beach plus Port wall (HS2) and Artificial Island (HS3). For first two hotspots beaches and associated infrastructure are the assets that attract holiday-makers and tourists in summer season. For HS3 the exposed area is occupied by storage premises for industrial goods and oil/fuel tanks.
Flooding hazard was assessed through coupled use of XBeach 1D and LISFLOOD 2D inundation models at the selected hotspots. The “response” approach was adopted as 75 extreme storm events were simulated to obtain storm maxima series of overtopping discharges, flood depth, depth-velocity and berm retreat. The selected return periods within the extreme value analysis were 20, 50 and 100 years.
For impact evaluation by INDRA model the categories “Population” and “Business” were considered. Impacts on Population were addressed by 3 impact indicators: “Risk to Life”, “Household Displacement Time” and “Household Financial Recovery”, while for Business category only by “Business Financial Recovery”.
Hotspots ranking was done using MCA by weighting of the evaluated indicators: focused on Risk to Life (F1) and on Business Financial Recovery (F2). MCA scoring focused on Household displacement/recovery was not evaluated because modelling results revealed quite a low number of flooded household receptors. Results show that for both F1 and F2 and for all considered return periods HS2 has the highest scores, which makes it a final hotspot.