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Using Bayesian Network as a tool for coastal storm flood impact prediction at Varna Bay (Bulgaria, Western Black Sea)

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Coastal zone is among the fastest evolving areas worldwide. Ever increasing population inhabiting coastal settlements develops often conflicting economic and societal activities. The existing imbalance between the expansion of these activities, on one hand, and the potential to accommodate them in a sustainable manner, on the other, becomes a critical problem. Concurrently, coasts are affected by various hydro-meteorological phenomena such as storm surges, heavy seas, strong winds and flash floods, which intensities and occurrence frequency is likely to increase due to the climate change. This implies elaboration of tools capable of quick prediction of impact of those phenomena on the coast and providing solutions in terms of disaster risk reduction measures. One such tool is Bayesian network. Proposed paper describes the set-up of such network for Varna Bay (Bulgaria, Western Black Sea). It relates near-shore storm conditions to their onshore flood potential and ultimately to relevant impact as relative damage on coastal and manmade environment. Methodology for set-up and training of the Bayesian network was developed within RISC-KIT project (Resilience-Increasing Strategies for Coasts – toolKIT).
Proposed BN reflects the interaction between boundary conditions, receptors, hazard, and consequences. Storm boundary conditions – maximum significant wave height and peak surge level, were determined on the basis of their historical and projected occurrence. The only hazard considered in this study is flooding characterized by maximum inundation depth. BN was trained with synthetic events created by combining estimated boundary conditions. Flood impact was modeled with the process-based morphodynamical model XBeach. Restaurants, sport and leisure facilities, administrative buildings, and car parks were introduced in the network as receptors. Consequences (impact) are estimated in terms of relative damage caused by given inundation depth. National depth-damage (susceptibility) curves were used to define the percentage of damage ranked as low, moderate, high and very high. Besides previously described components, BN includes also two hazard influencing disaster risk reduction (DRR) measures: re-enforced embankment of Varna Port wall and beach nourishment.
As a result of training process the network is able to evaluate spatially varying hazards and damages for specific storm conditions. Moreover, it is able to predict where on the site the highest impact would occur and to quantify the mitigation capacity of proposed DRR measures. For example, it is estimated that storm impact would be considerably reduced in present conditions but vulnerability would be still high in climate change perspective.