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Present and Future Coastal risk assessment

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Coastal areas are highly vulnerable and exposed to extreme flood and erosion events, to long-term erosion due to changes in coastal dynamics and sea level rise, as well as to long-term changes in the inland system (population, economical activities, ecosystems). The objective of this work is to establish a conceptual framework to quantitatively estimate present and future coastal flood and erosion risk in a given coastal stretch, suitable to different spatial scales (global, regional and local). In the proposed methodology, the risk associated to climate change for a given scenario and a given time horizon is obtained as a difference between present climate risk and future climates associated to different socio-economic scenarios, in the periods 2010-2040 (short), 2040-2070 (medium) and 2070-2100 (long-term).

The basic idea of the proposed risk analysis is to characterize, for present and future climates, the coastal system (waves, tide, surge) as well as the inland system (population, economy, ecosystems, land uses), taking into account the uncertainty in the estimation of future coastal dynamics as well as possible future inland systems. In order to simplify the complexity of the problem, the coastal system is divided in a number of homogeneous forcings, depending on the local wave, wind and long wave dynamics. On the other hand, the coastline of the inland system is also divided in terms of homogeneous coastal defence units (seawalls, beaches, clifss,…). This approach allows splitting up the complex problem of flooding and erosion risk at a particular area in a number of sub-scale simple linear Source-Pathway-Receptor (S-P-R) problems, factilitating the integration of the risk. In other words, we follow the S-P-R approach to evaluate how the Sources (waves, tide, storm surge, mean sea level, river discharge, run-off) through the Pathways (coastal defence units) affect the Receptor (inland system) generating damages (economical, social, environmental, affected population, land losses).

For every S-P-R unit, the coastal hazards that affect every coastal defence type must be defined. Examples of hazards are the flooding, overtopping, episodic or non-permanent erosion, and permanent erosion or loss of land. Therefore, for every S-P-R unit, the objective is to characterize the hazard statistical distributions, both in intensity and frequency. Examples of variables that define the hazard are sea level, run-up, overtopping discharge, volume eroded, beach surface, shoreline retreat, etc.

For every S-P-R unit and hazard, and considering the damages associated to every hazard, the risk (estimated by the expected annual damage and variance) is obtained as the sum of the damages that occur throughout the year. For rare events, this can be expressed in terms of the probability density function of the intensity of the hazard and the frequency (Poisson process). Finally, the total risk in a given coastal area is calculated as an aggregation of the sub-scale S-P-R problems.

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