Storm Surges Congress, Hamburg, Germany
13–17 September 2010
SSC2010-103


# Simulating changes in flood and erosion risks due to future sea-level rise and storm surges

R. Nicholls (1), M. Mokrech (1), W. Xingzheng (2), J. Hall (2), M. Walkden (3), and S. Hanson (1)

(1) School of Civil Engineering and the Environment, University of Southampton, Southampton, United Kingdom. (mmokrech@soton.ac.uk), (2) School of Civil Engineering and Geosciences, University of Newcastle upon Tyne, Newcastle, United Kingdom, (3) Royal Haskoning UK Ltd., Exeter, United Kingdom

Projections of accelerated sea-level rise and intensified storms will increase the incidence of coastal flooding and erosion. In addition, future urban development of the coastline will add pressure for developing coastal management plans that are technically robust, integrating flood risk and coastal erosion in the context of climate change, spatial planning and have stakeholder concurrence. However, predicting future climate and its impacts on coastal processes and risks are associated with considerable uncertainties that should be both addressed and communicated. This paper demonstrates the capability of the Tyndall Coastal Simulator in capturing possible future risks of coastal flooding and erosion for five different socio-economic futures (i.e. World Market, National Enterprise, Local Stewardship, Global Sustainability and Business as Usual scenario where current planning practices are adopted) under a range of management options. The simulator and its underlying philosophy provide an opportunity to explore different climate scenarios (B1, A1FI, A1B and High++), as well as the range of uncertainty associated with these scenarios. The simulator is based on a series of linked models within a nested framework which recognises three spatial scales: (i) global; (ii) regional and (iii) the simulator domain (coastal sub-cells). Within the nesting, the larger scale provides the boundary conditions for the smaller scale. The models feed into each other and describe a range of relevant processes: sea level, tides, surges, waves, sediment transport and coastal morphology.

Socio-economic impacts along the coastline are investigated using the process-based SCAPE (Soft Cliff and Platform Erosion) model. This is linked with a probabilistic model of cliff top position which allows the analysis of coastal management options by providing feedback on sediment supply, long-shore movement and beach volume. The SCAPE model results regarding beach volume are coupled with a coastal flood risk model for the adjacent coastal lowlands. This considers flood risk under temporal changes in sea level and storm surge and includes consideration of beach nourishment and potential development in the floodplain. Monte Carlo simulations are implemented to allow a more explicit consideration of uncertainties and provide a range of realisations representing the distribution of coastal flood risk in UK sub-cell 3b. This stochastic approach produces an envelope of simulated risk realisations, which helps promote a better understanding of possible risks and may help in the management decision-making process.

The results have shown consistent spatial and quantitative patterns over the 21st century and highlighted the role of beach nourishment in reducing flood risks under the investigated scenarios. Although there are increases in flood risk under all socio-economic scenarios, sensible comparison with previous investigations (Dawson et al. 2009) has shown a significant reduction in flood risk due to the effect of beach nourishment. The results also quantify the relationship between protection levels and risks; the higher protection level along the cliffed area the higher flood risk is produced in the nearby lowland areas. The World Market scenario has the highest flood risk, while the Global Sustainability has the lowest; this can be best explained by the number of assets exposed to flooding under these scenarios.