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Storm surge modeling of the extreme events in Gold Coast, Queensland

A. Golshani (1), R. Tomlinson (1), and G. Stuart (2)

(1) Griffith Center for Coastal Management, Griffith University, Gold Coast, Australia (a.golshani@griffith.edu.au / +61 7 5552 8067), (2) DHI, Southport, Australia

Most Queensland coastal communities have been developed in close proximity to the beach front, estuaries and tidal entrances or within a coastal flood plain. Historical evidence shows that Queensland's coastline is highly variable over time scales of decades and centuries and subject to catastrophic events such as Tropical Cyclones (TC) and East Coast Lows (ECL). In this regard, a major project – Future Coastlines - is assessing the impact of climate variability and change on coastal morphology and estuarine dynamics at key coastal regions within Queensland. Part of this project is related to the estimation of storm tidal levels and providing inundation maps of the Gold Coast.

Firstly the extreme events were chosen from all available sources including global wave models (C-ERA40 (1958-2001),WW3 (1997-2009)), Buoy data (Brisbane (1976-present), Southport (1987-present) and Tweed River (1995-present)) and a report by Jeff Callaghan and Peter Helman (2008) titled "Severe Storm on the East Coast of Australia (1770-2008)". As a result, five major TCs and five ECLs which occurred after 1950 were considered as extreme events. The Fraser ECL (2007-2008) was also considered for calibration of the numerical models.

A local atmospheric model (RAMS, WRF) covering the area of interest was used to simulate these events. The model is driven by NCEP/NCAR wind fields at the boundaries and pressure maps. The model outputs were corresponding wind fields including speed components at 10m above sea level and pressure. These outputs are used to force the hydrodynamics (Mike21 HD) and spectral wave models (Mike21 SW).

These models have unstructured meshes. Regional models cover an area of approx. 1900*1700 km with mesh size of 20 to 0.1km while local models cover an area of approx. 80*25 km with mesh size of 2km to 20m. These models are run in the following order:

1) Regional HD model using the simulated wind field and pressure.
2) Regional SW model using the simulated wind field and surface elevation map from the regional HD model.
3) First local HD model: Water level boundaries (wind induced surge boundaries) extracted from the regional HD model results combined with pure tide signal to generate storm tidal boundaries will be forced on the local HD model and run.
4) Local SW model: Surface elevation map from the local HD model results, as well as wave energy spectrum boundaries extracted from regional SW results, will be forced to the local SW model.
5) Second local HD model: Wave radiation stress map from the local SW model as well as storm tidal boundaries (same as step 3) will be forced on the local HD model and run.

Finally, coastal regional inundation maps will be produced based on predictions of flood level using ocean level surge levels as tail water conditions. Analysis of the results of this research will develop a framework for understanding the nature of physical changes that will occur in response to extreme events, long term climate variability over decades and climate change and will build the capacity of coastal planning and risk management strategies to deal with the full extent of known climate variability.