

Computation of Extreme Sea Levels along the Indian Coasts Due to Tropical Cyclones in Probabilistic Climate Risk Scenario

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Abstract: Indian coasts are frequently affected by the extreme sea levels generated by the tropical cyclones which have tremendous impact on human life and coastal infrastructure. Quantitative risk analysis of consequence of a tropical cyclone is important for planning, preparedness and mitigation processes by the coastal authorities. The finite-element ADCIRC model is configured for the entire Indian coast with very high resolution near the coast to compute maximum possible total water elevation (TWE) considering the non-linear interaction of local high-tide. The TWE or storm tides is computed at every 10km interval along the coast. Using the past cyclone data base (1891-2016) from India Meteorological Department, the return periods of the cyclone intensity (pressure drop) for every 10, 50 and 100 years is calculated for each maritime state along the east and west coasts of India. Synthetic tracks are generated by composing actual tracks as well as from theoretical ones, ensuring that each coastal district is covered. The model bathymetry is obtained from the 30-sec GEBCO global bathymetric grid. The cyclonic wind distribution is computed using the wind scheme described in Jelesnianski and Taylor (1973) by considering pressure drop and uniform radius of maximum winds of 30km. Using recent IPCC reports, simulations for the climate change scenario are considered by enhancing the cyclonic wind stress by 7% (an average value) and of 11% (extreme value) over the present (normal) scenario (Knutson, 2010). These experiments are carried out for all the return periods. The model is initially extensively validated for tides and storm surges for the recent cyclones.

The storm tide simulations made for different scenarios follow a similar trend along the Indian coasts. In the case of extreme scenario for 100-year return period, the TWEs are enhanced to about 10m along north of the east coast of India. The reason for generation of high storm tides along this coast is due to shallowness of the head bay region in addition to the presence of high tidal conditions. However, the cyclones are very uncommon to the west coast of India except for the Gujarat coast. As the tidal range is very high in this region, particularly in the Gulf of Khambhat, the storm tides are found to be very significant. The simulations in the extreme climate change scenario for 100-year return period suggest that the maximum water level increases up to 11.0m along the Gujarat coast. The rise of storm tide in the case of extreme climate change is noticed all along the Indian coast of about 13% over the present scenario. This study, being first of its kind for the entire coastal stretch of India, provides TWE at every 10km along the coast. This information is an important component used to create sustainable local-level development action plan for preparedness and mitigation.

Keywords: storm surges, tides, extreme sea level, Indian coasts