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Abstract: The coastal areas of Bangladesh are recognized by the United Nations (UN) as the most vulnerable areas in the world to tropical cyclones and also the sixth most vulnerable country to floods around the world. Cyclone Sidr (2007) was one of the most catastrophic natural disasters in Bangladesh causing nearly 10,000 deaths and $1.7 billion damage. During cyclone Sidr, mangrove forests in coastal areas played a crucial role in the mitigation of these deadly effects. Sunderban Mangrove, the world's largest mangrove ecosystem with 7,900 sq. miles, forms the seaward frontier of the bay and is now facing significant degradation. The Sunderban mangrove ecosystem is increasingly being degraded for a variety of purposes such as agriculture, fishing, farming and settlement. In this study, we evaluate the potential impacts from the degradation of the Sunderban Mangrove on storm surge flooding. We evaluate two hypothetical and extreme scenarios: 1) the conversion of the entire mangrove land cover to an estuarine forested wetland; and 2) by considering a full degradation scenario where the entire mangrove is converted to grassland. To quantify the benefits of the mangrove forests to attenuate storm surge in this area, we applied a framework combining a spatial characterization of mangroves vegetation with numerical simulations. Storms surge was calculated using a hydrodynamic model (ADCIRC) coupled with wave model (SWAN) under a High Performance Computing environment. An unstructured numerical mesh with 200,000 nodes was developed and validated along with the coupled SWAN+ADCIRC model at six separate locations in the Bangladesh coast using Cyclone Sidr (2007) meteorological inputs. Twenty seven model simulations were performed considering nine cyclones of different categories to quantify the effects of mangrove degradation on spatial flood inundation and storm surge magnitude. Simulation results showed that, on average, the mangroves degradation to grassland could raise the surge elevation as high as 57% and had a significant impact on increasing the velocity of the flood wave by up to 2730% for category 3 cyclones. In addition, the inundation inland penetration and total flooded area would increase almost 10 km and 18% respectively for low intensity cyclones. Furthermore, these hypothetical scenarios support the importance of the existing Sunderban mangrove in the reduction of surge elevation, velocity, inundation penetration and flooded area. More importantly, it also demonstrates how the continuous degradation of this important ecosystem has the potential to adversely impact the future cyclone induced hazards in the region.

Keywords: Bangladesh, Sunderban mangrove, Cyclone, Storm surge, Coastal hazard, ADCIRC

1. Introduction

Cyclone surges in Bangladesh have caused deaths of over 700,000 people since 1960 (Chowdhury and Karim, 1996) and it is still considered as one of the most damaging meteorological phenomena in the region. The exposure to storm surge combined with the low-lying heavily inhabited areas and a continental shelf with shallow bathymetry leaves the entire coastal region of Bangladesh very vulnerable to catastrophic inundations along the coast (Murty et al., 1986; Dube et al., 1997; Madsen and Jakobsen, 2004). Almost one sixth of tropical cyclones that developed in the Bay of Bengal made landfall on the