ABSTRACT

Comparing Hydrodynamic Models and GIS for Coastal Flood Vulnerability Assessment

Avidesh Seenath

Under climate change, Sea-Level Rise (SLR) and increasing storm surge intensity will increase the probability of floods for low lying coastal areas. Therefore, Coastal Flood Vulnerability Assessments (CFVA) are needed to guide decision making for coastal management. However, the right tool for these assessments must be used for the acquisition of accurate results. Geographic Information Systems (GIS) and hydrodynamic models are commonly applied for these assessments. To ascertain the best approach for CFVA for coastal management purposes, a GIS (ArcGIS 10.1) is compared to 2 two-dimensional hydrodynamic models of different grid structure, LISFLOOD-FP (simple, structured grid) and TELEMAC-2D (complex, unstructured grid), using Pigeon Point, southwest Tobago, as a case in point, because of its ecological and economic importance and potential vulnerability to climate change impacts. To accomplish this, a structured and unstructured grid hydrodynamic flood model were created from existing and surveyed bathymetry and elevation data, current and future projected Mean Sea-Level (MSL), and tidal data using the LISFLOOD-FP and TELEMAC-2D code, respectively. Using the same data on topography and bathymetry, a coastal Digital Elevation Model (DEM) of Pigeon Point was developed and incorporated into ArcGIS 10.1. These models were subsequently used to simulate a series of storm surge scenarios under current and future projected sea-level estimates. A comparative analysis of all results revealed that there was a less than 5% difference in flood predictions generated by all models. Next, all models were used to simulate an observed spring high tide event for model validation purposes. The Root Mean Squared Error (RMSE) of each model's prediction was calculated as an indication of their performance. RMSE values acquired informed that all models were consistent and matched well to the field observations. However, further analysis revealed that inherent in the use of GIS for CFVA are hydraulic connectivity issues and the inability to account for flow dynamics, which leads to an over-estimation in flood extent. Acknowledging that over-estimation may lead to over-management, it was concluded that hydrodynamic models are better for CFVA, while GIS can be used as a potential indicator of flood exposure. Also, it was found that LISFLOOD-FP, despite its simplicity, was able to produce equally good results as the more complex TELEMAC-2D in a shorter time. As such, structured grid hydrodynamic models may be more apt for CFVA. Therefore, LISFLOOD-FP was used to project the current and future flood vulnerability of Pigeon Point to storm surges. Results obtained indicated that Pigeon Point is currently vulnerable to storm surge flooding and inundation from SLR.

Keywords: Coastal flooding; Sea-Level Rise; Storm Surges; Hydrodynamic Modelling; LISFLOOD-FP; TELEMAC-2D; GIS; Vulnerability Assessment; Climate Change; Pigeon Point; Tobago; Caribbean.