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Modeling of Tsunami Propagation and Impact on West Vancouver Island, Canada

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Abstract : Large tsunamis strike the British Columbia coast every few hundred years. The Cascadia Subduction Zone, which extends along the Pacific coast from Vancouver Island to Northern California is one of the most seismically active regions in Canada. Significant earthquakes have occurred in this region, including the 1700 Cascade Earthquake with an estimated magnitude of 9.2. Based on geological records, experts have predicted a 'great earthquake' of a similar magnitude within this region may happen any time. This earthquake is expected to generate a large tsunami that could impact the coastal communities on Vancouver Island. Since many of these communities are in remote locations, they are more likely to be vulnerable, as the post-earthquake relief efforts would be impacted by the damage to critical road infrastructures. To assess the coastal vulnerability within these communities, a hydrodynamic model has been developed using MIKE-21 software. We have considered a 500 year probabilistic earthquake design criteria including the subsidence in this model. The bathymetry information was collected from Canadian Hydrographic Services (CHS), and National Oceanic Atmospheric and Administration (NOAA). The arial survey was conducted using a Cessna-172 aircraft for the communities, and then the information was converted to generate a topographic digital elevation map. Both survey information was incorporated into the model, and the domain size of the model was about 1000km x 1300km. This model was calibrated with the tsunami occurred off the west coast of Moresby Island on October 28, 2012. The water levels from the model were compared with two tide gauge stations close to the Vancouver Island and the output from the model indicates the satisfactory result. For this study, the design water level was considered as High Water Level plus the Sea Level Rise for 2100 year. The hourly wind speeds from eight directions were collected from different wind stations and used a 200-year return period wind speed in the model for storm events. The regional model was set for 12 hrs simulation period, which takes more than 16 hrs to complete one simulation using double Xeon-E7 CPU computer plus a K-80 GPU. The boundary information for the local model was generated from the regional model. The local model was developed using a high resolution mesh to estimate the coastal flooding for the communities. It was observed from this study that many communities will be effected by the Cascadia tsunami and the inundation maps were developed for the communities. The infrastructures inside the coastal inundation area were identified. Coastal vulnerability planning and resilient design solutions will be implemented to significantly reduce the risk.

Keywords : tsunami, coastal flooding, coastal vulnerable, earthquake, Vancouver, wave propagation
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