INTERCOMPARISON AND INDEPENDENT VALIDATION OF VERTICAL ACCURACY OF 30-M GLOBAL DEM OVER THE PHILIPPINES: IMPLICATIONS FOR ELEVATION-BASED SEA LEVEL RISE IMPACT ASSESSMENT

Jojene R. Santillan, Meriam Makinano-Santillan, Sherwin P. Pulido

CSU Phil-LiDAR 1 Project, Caraga Center for Geo-informatics,
College of Engineering and Information Technology, Caraga State University,
Ampayon, Butuan City, 8600, Philippines
Email: jrsantillan@carsu.edu.ph, mmsantillan@carsu.edu.ph

KEY WORDS: Global DEM, ASTER GDEM2, SRTM DEM, AW3D30, Accuracy, Sea Level Rise, Philippines

ABSTRACT: In this work, we conducted an inter-comparison and independent validation of the vertical accuracy of three freely-available, 30-m resolution global Digital Elevation Model (DEM) over the Philippines. These DEMs are the ASTER GDEM Version 2 (GDEM2), SRTM-30m, and ALOS World 3D-30m (AW3D30). The vertical accuracy assessment was done by comparing the true and DEM elevations of 648 geodetic control points (GCPs) distributed over a portion of Mindanao, Philippines, with the EGM96 as vertical datum. The GCPs are part of the Philippines' Geodetic Control Network established and maintained by the National Mapping and Resource Information Authority (NAMRIA). The results of the vertical accuracy assessment showed that all the 3 DEMs overestimated the true ground elevations. On the average, the ASTER GDEM2 overestimated true ground elevation by 3.71 m while the SRTM-30m overestimated it by 2.64 m. On the other hand, the AW3D30 overestimated true ground elevation by only 1.43 m which is the least among the three. The Root Mean Square Error (RMSE) of the elevation differences was found to be highest in ASTER GDEM2 (RMSE = 9.69 m), and lowest in AW3D30 (RMSE = 5.13 m). The RMSE for SRTM-30m was found to be 5.73. This suggests that the AW3D30 is more accurate than SRTM-30m and ASTER GDEM2 – a finding which is consistent with other studies. The three DEMs were then used to map coastal inundations due to sea level rise scenarios of 0.5m, 1m, and 1.5m. The inundated areas were found to be different for the three DEMs, with inundated areas having wider extent when using AW3D30 than those when using ASTER GDEM2 and SRTM-30m. This was found to be implied by the various levels of overestimation of true ground elevations by the three DEMs. To ensure consistency in mapping inundated areas due to sea level rise, regression equations based on the comparison of the true ground and DEM elevations were used to calibrate each of the three DEMs to reflect true ground elevations. The accuracy of the inundated areas using the calibrated DEMs were then assessed by comparing them with inundated areas mapped using a LiDAR-derived Digital Terrain Model. Result showed that application of the calibrated global DEMs in mapping coastal inundation due to sea level rise can provide acceptable results, with majority of the inundated areas similar to those mapped using a LiDAR DTM.his paper proposes the integrated use of LiDAR data and 1D-2D flood simulation models for assessing the effectiveness of existing and proposed flood control structures under extreme/climate change-induced rainfall scenarios. A thorough assessment of existing flood control structures is critical to determine whether these structures (as originally designed) can curtail floods due to changing climate and extreme weather events. Moreover, rivers that have not caused flooding before needs to be hydrologically and hydraulically analyzed to check whether it will overflow under extreme/climate change scenarios. Such analysis can help in proposing and evaluating appropriate flood control strategies and structures. The proposed approach utilizes LiDAR-derived data products such as Digital Terrain and Surface Models (DTM & DSM) to extract/map existing, as well as to incorporate, proposed flood control structures such as dikes, levees, detention ponds, impounding structures, and diversion channels. Then, an integrated 1D-2D hydrologic and hydraulic models based on HEC HMS and HEC RAS that are capable of simulating detailed and spatially-distributed flood depth and other characteristics such as flood arrival time, velocity, extent, duration, and recession are developed using LiDAR-derived topographic datasets (DTMs and DSMs). The integrated HEC HMS and HEC RAS 1D-2D hydraulic model are then used to simulate the impacts of flooding caused by extreme/climate change scenarios with or without the presence of flood control structures. The model outputs can be used to differentiate the impacts of flooding due to extreme/climate change-induced rainfall scenarios, with or without the presence of flood control structures. Finally, an assessment of the effectiveness of current flood control structures in a particular area can be

conducted. The approach presented in this study can be an important reference for undertaking flood control structures assessment in the Philippines considering the threatening effects of climate change.