COMPARISON OF DIFFERENT DEM DATA FOR TSUNAMI VULNERABILITY MAPPING USING GIS AND ANALYTICAL HIERARCHY PROCESS

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Abstract: Digital Elevation Models (DEMs) are data files that contain the elevation of the terrain over a specified area. It can visualize the terrain conditions in 3 Dimensions. Various different methods are being used in DEM generation using aerial photogrammetric and satellite remote sensing approaches. SRTM data from Global Land Cover Facility, Aster GDEM-V2 from both Japan Space Systems and U.S. Geological Survey, and DEM product of Geospatial Information Authority of Japan (GSI) were collected and analyzed. This study tried to compare the difference between these four DEM data for the vulnerability mapping and to assess the inundation area in the coastal area due to tsunami hazards. We tried to find suitable data and methods that are easy to apply in other areas. As a case study, we applied this work at the area of Kesennuma in Miyagi Prefecture, Rikuzentakata and Ofunato in Iwate Prefecture. Moreover, ALOS AVNIR-2 is analyzed to map the vegetation density as one of the parameters for the tsunami vulnerability mapping beside elevation, slope and coastal proximity, in which the terrain was segmented into five classes. The Tohoku Earthquake Tsunami Joint Survey Group data and the historical map of tsunami event are used for the comparison. An Analytical Hierarchy Process (AHP) was used to assign weights to each parameter and a spatial multi criteria analysis was applied through cell-based modeling in Geographical Information System (GIS) for vulnerability mapping. The result shows that DEM from GSI indicates tsunami vulnerability area wider than the others DEM data. All DEM data describe that the high vulnerability areas were mostly found in the coastal area with a sloping coast and a cape area. The low elevation of those areas and the tsunami direction are the factors that increase the impact of the tsunami. Inundation area is found in the area of slightly high and high vulnerability. The assessment shows that 17.54 km^2 of the study area in Kesennuma is under the hazard zone, and it has high probability for the occurrence of tsunami inundation. Moreover, in the area of Rikuzentakata, 9.63 km^2 of the area has a high probability for tsunami inundation, and 8.27 km^2 for Ofunato area. Although SRTM DEM indicates that the inundation area is similar enough to the historical data of the 2011 Japan tsunami, GSI DEM illustrates possible inundation areas farther to the hinterland which is useful as a preliminary study for the disaster mitigation and urban planning in the coastal area. In short, due to the limitation of data availability in other area, SRTM is very useful for tsunami vulnerability mapping in the area where other high resolution of DEM is not available.

Keywords: DEMs, tsunami, vulnerability, GIS, AHP