

Flood Inundation Simulation of Noto Peninsula Torrential Rainfall Considering Sediment Production by Earthquake

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The Noto Peninsula Earthquake, which occurred on January 1, 2024, triggered numerous slope failures in river catchments within the Noto Peninsula. The sediment produced by these failures was subsequently remobilized and transported downstream due to heavy rainfall on September 21, 2024. For instance, in the Suzuya River basin, a tributary of the Machino River, sediment discharged from several tributaries reached agricultural land and urban areas, causing flooding with sediment transport. The topographic changes in the river channels and surrounding areas due to sediment transport potentially affected the extent and depth of inundation.

To evaluate these impacts, this study conducted simulations using the Distributed Rainfall and Sediment Runoff Inundation Simulation (DRSRIS) model, which integrates a rainfall-runoff model and a sediment transport model, on the Machino River basin in the Noto Peninsula. The simulation classified the land use of each mesh into three categories: forest, urban areas, and river channels, and simulated water and sediment transport within the mesh system. Water transport in forested areas was simulated using the Diffusive Wave method, which considers surface and seepage flows, while in urban and river areas, surface flow was analyzed using the two-dimensional shallow water equations. Sediment transport modeling accounted for both bedload and suspended load, treating urban areas as non-erodible fixed beds below the initial surface.

The computational domain encompassed a rectangular region including the entire Machino River and Najimi River basins, with a spatial resolution of 5 meters. Sediment production due to the earthquake was incorporated as a spatial distribution of sediment deposition depth. These data were derived from the difference between pre- and post-earthquake DEMs based on Airborne Laser Profile (ALP) data. However, since significant ground deformation occurred not only by landslides and debris flows but also by the earthquake itself, the pre-earthquake surface point cloud was corrected using the three-directional deformation field data from Fukushima et al. (2024) to obtain accurate differential data. The grain size distribution of the produced sediment was determined through sieve analysis of sediment samples collected in a field survey conducted on November 13, 2024. Rainfall data were obtained from XRAIN observations.

The simulation results provided a spatial distribution of sediment deposition depth across the target domain. Around the outlets of Ushio and Terachi Rivers, significant sediment deposition was computed, and the results agreed with the sediment deposition depth and extent observed by ALP difference data before and after the heavy rainfall event. Additionally, by comparing water level simulation results with and without earthquake-induced sediment production, the study quantitatively assessed the impact of earthquake-induced sediment on inundation depth. Furthermore, the spatial distribution of the contribution rate of the bed deformation to water level was obtained. These results are crucial for evaluating the extent to which this disaster can be classified as a multi-hazard event involving both an earthquake and heavy rainfall. However, the model underestimated sediment deposition in downstream areas such as the Suzuya River basin, likely due to the exclusion of new sediment production from slope failures triggered by the heavy rainfall and the lack of explicit modeling of natural dam breaches. Future

work will examine the inclusion of these factors to enhance the reproducibility of simulation results.

Keywords: Landslide, Sediment dynamics, Flood inundation, Topographic change