Impact of LULC Change on Flood Events and HEC-RAS Two-Dimensional Hydrodynamic Modeling in the Himalayan Beas River Basin

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Abstract

Floods are the most significant and recurrent natural hazards. The Himalayan river basin has been facing increasing flood risk due to the combined effects of land use and land cover (LULC) changes, rapid urbanization, and climate change. The Beas basin in Himachal Pradesh is one of the most dynamic and hazard-prone river basins. In recent years, the region has experienced repeated flood events resulting in extensive property damage and loss of life. This necessitates an integrated approach for flood risk management. The present research uses HEC-RAS two-dimensional hydrodynamic modeling to assess the flood dynamics in response to LULC changes in the Beas River Basin. LULC changes have been analyzed in GIS. A 2-D hydrodynamic model for the Beas River basin was developed using spatially extracted cross sections and recorded stream flow data to analyze extreme flood events. Analysis of water levels, stream discharges, and river cross sections was carried out. The model calibration and validation predict a good output agreement with a coefficient of determination (R2) value of 0.95. The flood simulation results were integrated into GIS to develop the flood inundation maps. The results of this study show considerable LULC changes in the region, with a significant increase in the built-up areas and a decrease in the green cover. The study also provides a scientific basis for flood hazard mapping, land use regulations, and integrated flood risk management in the Himalayan River basins.

Index Terms

Flash Floods, LULC, HEC-RAS, GIS, Flood Hazard Mapping, Hydrodynamic Modeling