Flood Hydraulic Model Calibration and Scour Potential Prediction Based on Advanced ASV-Measured Extreme Flood Events Triggered by Snowmelt

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February 3, 2023

Abstract

The primary factor in hydraulic modeling for assessing flood vulnerability is water discharge. However, the absence of discharge data and information on observed river bathymetry resulted in inaccurate flood inundation mapping, particularly for flood-prone rivers like the Red River of the North. This research aims to determine Manning's n coefficient of the Red River near Grafton, North Dakota and flood inundation mapping using simulation tools in s Hydraulic Engineering Center-River Analysis System (HEC-RAS) for flood modeling. Autonomous Surface Vehicle (ASV) were used to collect bathymetry and discharge data during low and high flow conditions, including a flood event with 16.5 years return period in 2022. LiDAR DEM (Digital Elevation Model) data for the area obtained from the US Geological Survey (USGS) National Map were processed and adjusted for the study area. Bathymetric and velocity data were also used to draw conclusions about the scour potential revealed by flood inundation mapping and to examine for any local scour development in the streambed near the bridge piers. Hydraulic model under steady flow condition indicated that Manning's n-coefficient of 0.07 and 0.15 for the channel and overbanks, respectively, agreed well with the observed and simulated water level values. The results indicate the efficiency of using ASVs for flood mapping to the advantages of integrating bathymetry, flow velocity, and flood prediction.

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