ABSTRACT

Dams are massive structures constructed across the river for purposes such as electricity generation, flood control, irrigation, recreation, water supply and navigation, which have significantly contributed to the development of human civilisation. In this study, the Hydrologic Engineering Center's Hydrologic Modelling System (HEC-HMS) and the Hydrologic Engineering Center's River Analysis System (HEC-RAS) were used to simulate the hypothetical dam failure under overtopping scenario for the Jiri Dam. In this study, the Hydrologic Engineering Center's Hydrologic Modelling System (HEC-HMS) part model, and the Hydrologic Engineering Center's River Analysis System (HEC-RAS) were used to simulate the potential dam failure by overtopping at the study time for the Jiri Dam.

Using the Hydrologic Engineering Center's Hydrologic Modelling System (HEC-HMS), a surface rainfall-runoff model was initially developed for the Jiri Dam Project in order to evaluate the Probable Maximum Flood (PMF) for the dam over a 10,000-year return period. In addition, dam failure model that integrates HEC-HMS and the Hydrologic Engineering Center's River Analysis System (HEC-RAS) with ArcGIS was also developed. In the dam failure incidents, the HEC-RAS model was run under unsteady flow conditions to evaluate travel time, velocity, water surface elevation and inundation height downstream. This model serves as a preliminary screening tool to assess and mitigate the potential impacts of catastrophic flood scenarios.

For this study, the HEC-HMS model was setup to simulate rainfall-runoff within the Jiri watershed with historical rainfall data from local stations as well as discharge data at the Jiri gauging station at the Jiri River from 1998 to 2017. The rainfall-runoff relationship in the Jiri watershed was modelled using HEC-HMS, which was then calibrated and validated, showing satisfactory performance with Nash-Sutcliffe Efficiency values of 0.765 and 0.858 for calibration and validation, respectively. 24-hour maximum rainfall corresponding to a 10,000-year return period when simulated in HEC-HMS, yielded a hydrograph with a peak discharge of 462.5 m^3/s.

Breach parameters estimation was carried out using the Froehlich (2008) regression equation and hydrodynamic modelling was performed in HEC-RAS 2D to generate flood inundation maps. A maximum flood depth of 14.79 meters was observed in the Khimti Headworks Area, with flood velocities reaching up to 10.7 m/s along the river channel. The flood wave arrival time was estimated to be approximately 1 hour and 36 minutes to reach the Jiri Khola Small

Powerhouse and 1 hour and 40 minutes to reach the Khimti Khola HEP Headworks. The results obtained under this study provide a road map for comprehensive flood risk assessment and the creation of an emergency action plan for the safeguarding community and their properties in case of floods resulting from a dam break.

Keywords: Dam break modelling, HEC-HMS, HEC-RAS, Jiri Dam