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High-resolution glacial lake outburst flood impact evaluation using high-performance hydrodynamic modelling and open-source data

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Glacial lake outburst floods (GLOFs) are one of the major natural hazards in certain populated mountainous areas, e.g. the Himalayan region, which may lead to catastrophic consequences including fatalities. Evaluating the potential socio-economic impact of GLOFs is essential for mitigating the risk of GLOFs and enhancing community resilience. Yet in most of the cases, the impact evaluation of potential GLOFs is confronted with limited data availability and inaccessibility to most of the glacial lakes in the high-altitude areas. This study aims to exploit recent advances in Earth Observation (EO), open-source data from different sources, and high-performance hydrodynamic modelling to innovate an approach for GLOF risk and impact assessment. GLOF scenarios of different glacier dam breach width and depth are designed according to high-resolution aerial imagery and terrain data acquired from unmanned aerial vehicle surveying. High-performance hydrodynamic model supported by open-source multi-resolution data from the latest EO technologies is used to simulate the flood hydrodynamics to provide spatial and temporal flood characteristics. Detailed information on communities and infrastructure systems is collected and processed from multiple sources including OpenStreetMap, Google Earth, and global data products to support impact analysis. The evaluation framework is applied to Tsho Rolpa glacial lake in Nepal, which has been identified as one of the potentially dangerous glacial lakes that may create GLOFs to threaten the downstream communities and infrastructure. According to the simulation results, the worst GLOF scenario can potentially inundate 27 villages, 583 buildings and 20.8 km^2 of agricultural areas, and pose high risk to 1 airport, 1 hydro power plant, 3 bus stations, and 21 bridges. Additionally, the spatial and temporal flood simulation results, including water depth, flow velocity and flood arrival time may help identify impacted sites and objects, which would be valuable for the development of evacuation plans and early warning systems.