

## Risk Assessment of Dam Breach Scenarios Using HEC-RAS 2D Modeling under Finnish Dam Safety Framework

### Abstract

Dam breach risk assessment is essential for ensuring the safety of hydraulic structures and mitigating downstream risks. This presentation introduces dam breach modeling and risk analysis performed in accordance with the Finnish dam safety guidelines, focusing on the worst realistic failure scenario. The objective is to estimate dam breach flood wave inundation impacts and assess risks to population and infrastructure using HEC-RAS 2D flow modeling and various GIS datasets.

Previously, 1D hydraulic models have been widely used due to their lower computational demands. However, advances in computing power and the availability of high-resolution spatial data have made 2D modeling the preferred approach to dam breach studies. Two-dimensional flow simulation enables realistic representation of lateral spreading and using complex floodplain topography, resulting in improved risk estimation and spatial presentation of results for further use in emergency planning.

The flow model is calibrated with data from multiple discharge situations, with emphasis on high-discharge flood events. Water structure features and discharge / water-surface-elevation datasets are supplied by the dam operator and validated with hydrographic surveys, including ADCP measurements and water surface elevation monitoring. Nationally available GIS datasets are used to represent terrain characteristics, including LiDAR-based elevation data and Corine 2018 land cover data used for surface roughness estimation. Bathymetric data is obtained from variable sources and supported by acoustic surveys.

Computational mesh is optimized for accuracy, reliability, and computational efficiency. Model outputs such as maximum depth, velocity, and inundation extent are exported as raster data and analyzed in GIS-software against building and population data from open national sources to identify hazards. Depth-velocity-combination thresholds are used to define dangerous zones.

The study demonstrates a workflow for dam breach hazard mapping and risk assessment in the Finnish regulatory context. The results support dam safety classification and emergency action planning.

**Keywords:** dam safety, risk assessment, HEC-RAS 2D, dam breach modeling, GIS analysis

### Thematic relevance:

This work is thematically aligned with Dam Safety Policy & Governance themes covering hydraulic safety assessment, risk-based dam classification, and emergency planning support integrating 2D flow modeling, hydrographic surveys, and open geospatial data.