Motivations and objective

- Aging of existing dikes
- Increased magnitude and frequency of extreme events
- Lack of knowledge on fluvial dike failure

▶ Predict the evolution of the breach geometry and the breach discharge

Experimental setup

Measurements
Water level measurements at different points of the main channel and downstream the breach
Measuring the channel and breach discharges using V notch weirs
Monitoring of the breach evolution by means of 3D laser profilometry

Laser profilometry:
Non-intrusive distributed measuring techniques relying on the swiping of a laser sheet on the geometry of interest (i.e. the dike geometry).

The swiping is recorded and the 2D image coordinates of the laser profiles on the geometry of interest are transformed to 3D coordinates by means of the DLT method (Direct linear Transformation).

The laser profiles, corresponding to each swiping, are combined to construct the point cloud, defining the 3D model from which a digital elevation model (DEM) can be interpolated.

Neither the location of the camera nor that of the laser are required → high flexibility

Allows implementing lens distortions correction modules
Reconstruction of underwater geometries with the correction of the refraction bias using Snell-Descartes principle and water level measurements

Breaching mechanism

Overtopping induced fluvial dike failure involves different processes than frontal dike failure
Dike failure occurs through different stages: (1) narrow erosion of the flood plain side of the dike, (2) deepening of the breach and (3) downstream widening of the breach
The expansion of the breach towards upstream is due to flow acceleration and erosion, whilst the expansion towards downstream is caused by slope failure
The breach discharge rapidly increases during the second stage of the breach expansion (i.e. the deepening) and tends to stabilize at values close to the main channel inflow discharge

Influence of channel discharge and floodplain confinement

The breach deepens and widens faster for tests with a higher inflow discharge.
Floodplain confinement reduces breach flow velocities and bed load.
Breach widening and deepening become slower.
Breach discharge becomes lower compared to tests without confinement.
The gap between the channel and floodplain water levels is reduced.

Conclusion and outlook

Dike breaching tests under various flow conditions and floodplain setup
Detailed monitoring of the processes involved in the breach formation and evolution
Correlation of the breach evolution dynamics with the initial flow conditions and boundary conditions allowing an accurate transposition of the experiment outcomes to actual fluvial dikes

Reference