CERIS Civil Engineering Research and Innovation for Sustainability

DikesFPro – Integrating Data and Models to Understand Dikes Failure Processes

DikesFPro

Summary

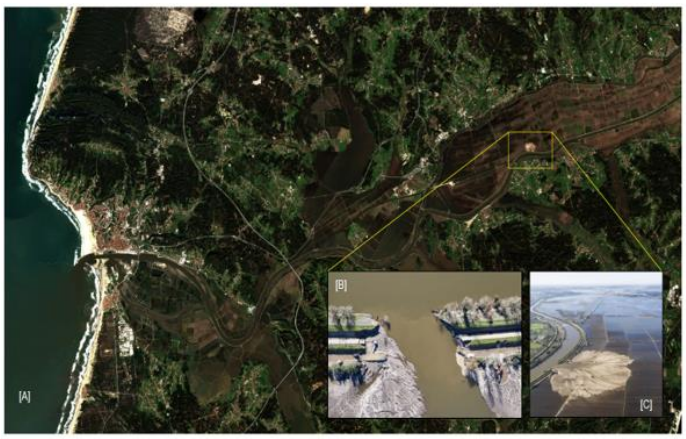
Fluvial dikes are built to protect people and infrastructure in floodplains. Its failure can cause severe human and economic losses. Although fluvial dike failures are quite common events, research has been preferentially focused on failure studies of earthen dams since these accidents are almost impossible to mitigate and can be more lethal. However, dike failure can also be devastating, as was the case of New Orleans in 2005 in which about 85% of the metropolitan area was flooded, causing about $75 billion losses, and directly killing hundreds of persons. In addition, last year in Portugal, on the 22nd of December, two dikes from the Mondego dikes system failed causing remarkable floodplain and urban inundations.

An analysis of published work reveals that most laboratory studies addressing dike failure considered only frontal breaching, thus neglecting the effects of the river flow in the breach near field. In the cases where this effect was considered, only sandy dikes were considered, in some cases with poorly simulated protections. In what concerns numerical studies, most of the solvers adopted for simulating fluid-solid interaction have neither included the non-linear deformation of the dike body nor the non-Newtonian behavior of water-sediment mixture generated as the dike erodes. They, thus, cannot be used to simulate key geotechnics and hydrodynamic components of the dike breaching processes. More importantly, existing methods to estimate the breach outflow discharge are either model-based or data-driven. There are no tested approaches to integrate model results and observations acquired during the breach process.

To overcome the limitations found in the state-of-the-art, the Project main goals are i) to build an integrated conceptual framework for dike breaching, comprising hydrodynamics and soil mechanics; ii) to create a new generation numerical tool for 3D simulations of fluid-sediment mixtures; and iii) to develop a methodology to integrate data and model results through assimilation in real time. To pursue these objectives, the work-program articulates laboratorial, theoretical and computational components.

Pursuing a line of research on dikes failure is a logical step for the project team, which is responsible for some recent advances on earthen dam failures both experimentally and computationally and has a record of funded research on this topic (e.g. Dam&DikeCare FCT). In particular, the IR has a PhD on failure by overtopping of embankment dams. It is worth mentioning that the team has already advanced on this theme by building a laboratorial facility at LNEC, completed in early 2020, for the purpose dike breaching experiments.

Currently, there are no funded research projects in Portugal on dike failures. In the context of climate change, it is reckless not to invest on an increase of knowledge and practical tools to manage dike breach risks, including a new generation of numerical models with the features offered by the Project results. A sustainable society needs expertise and tools to tackle dike-breach accidents. We hope to have made the point that the outcome of the project meets precisely these technical and societal needs.



Project Reference

PTDC/ECI-EGC/7739/2020

Leading Institution

LNEC – National Laboratory for Civil Engineering (Portugal)

Partners

IST-ID – Associação do Instituto Superior Técnico para a Investigação e Desenvolvimento (Portugal), INESC-ID – Instituto de Engenharia de Sistemas e Computadores: Investigação e Desenvolvimento (Portugal)

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2021-2024

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249 990.00€

CERIS

74 026.25€

Project Website

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