30th EWG-IE Meeting
Bologna, 9-11 September '24
European Working Group on Internal Erosion in Embankment Dams, Levees and Dikes, and their Foundations

30th Meeting of the European Working Group on Internal Erosion (EWG-IE)
Bologna, 9-11 September 2024

A NOVEL MEDIUM-SCALE EXPERIMENTAL SETUP TO INVESTIGATE BACKWARD EROSION PIPING

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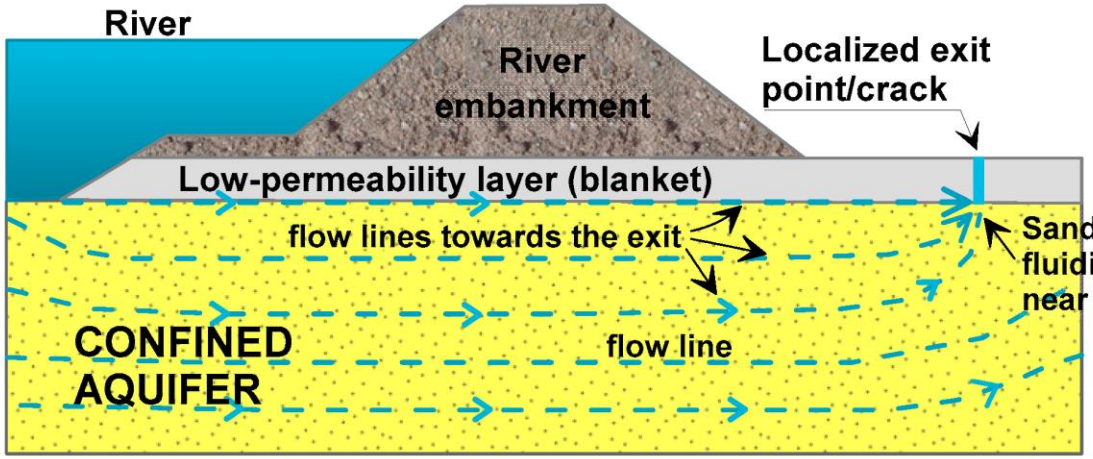
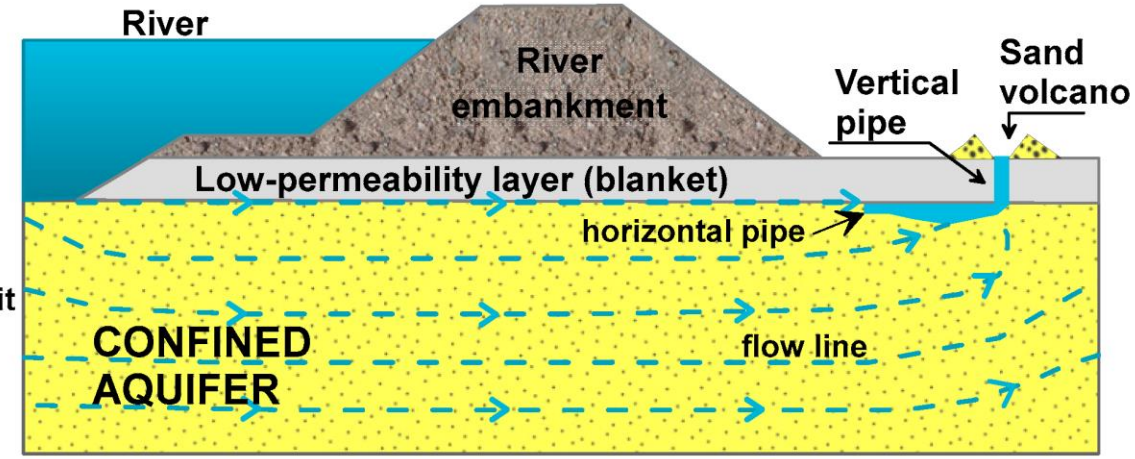
LIFE SAND BOIL

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA
DEPARTMENT OF CIVIL, CHEMICAL, ENVIRONMENTAL, AND MATERIALS ENGINEERING

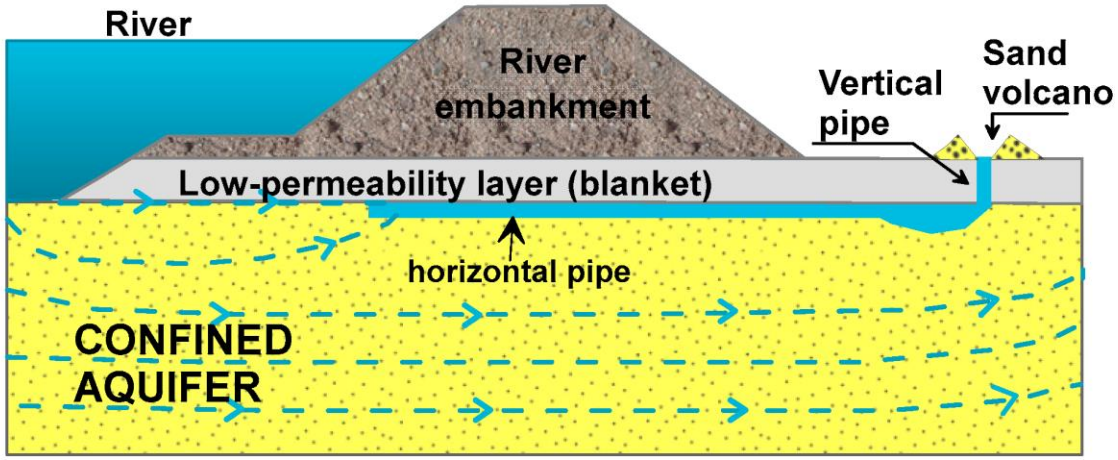
The backward erosion piping phenomenon



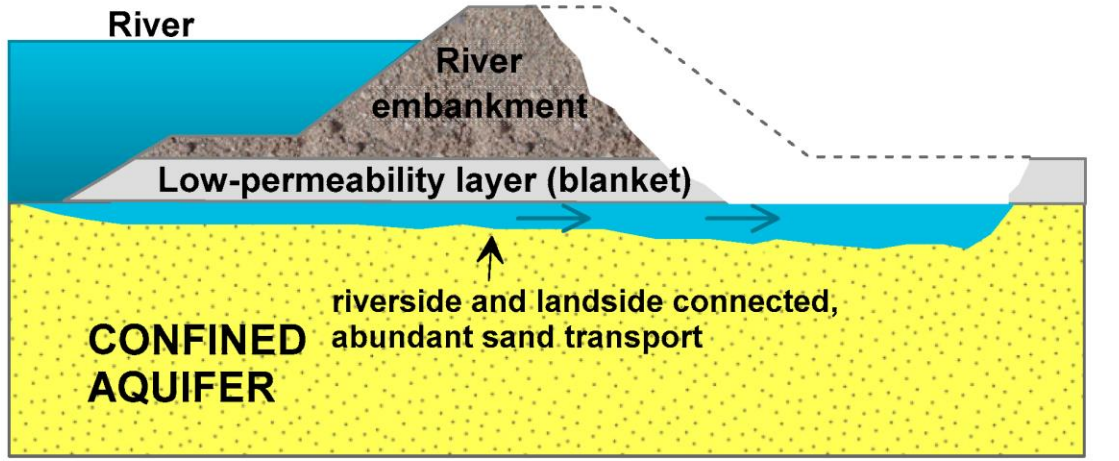
(a) Seepage and erosion onset



(b) Backward Erosion Initiation



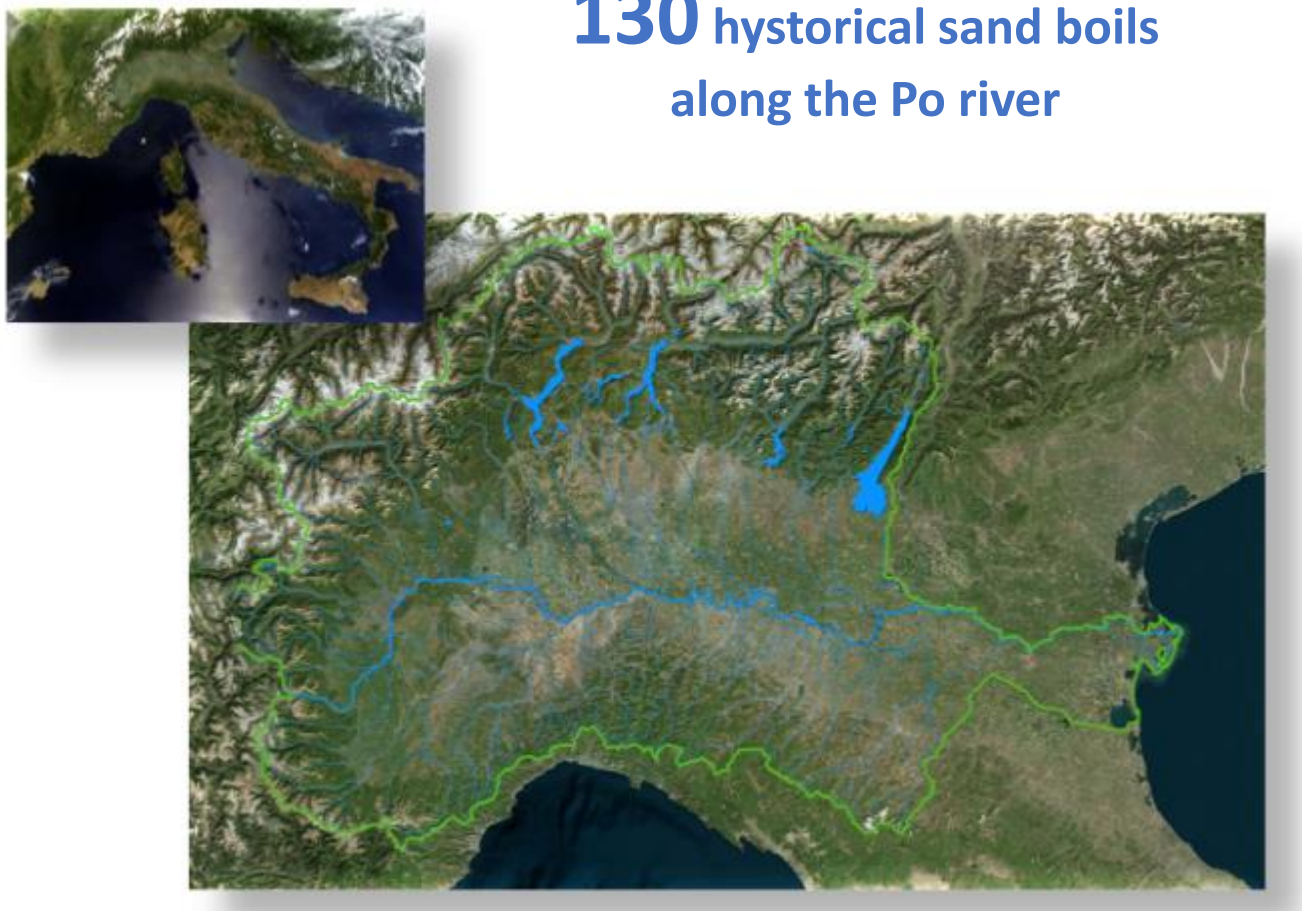
(c) Backward Erosion Progression



(d) River Embankment Failure

Motivations and context of the study

Northern Italy



130 hystorical sand boils along the Po river

➢ During emergencies

➢ Need to introduce new and reliable mitigation strategies against backward erosion piping

The LIFE SandBoil project

- **SCOPE**: to develop and validate a technology for mitigating backward erosion piping, suitable for large-scale implementation in river embankment systems affected by this phenomenon.

DATA COLLECTION

Development of an
up-to-date database of sand boils
along the Po river(Italy) and the Danube river (Hungary) to be used for as a
mitigation planning tool

PROTOTYPE VALIDATION

Validation of the technology in
the lab & in a pilot site
for the identification of
the most effective configuration
of the mitigation strategy

INSTALLATION IN DEMONSTRATIVE SITES

Installation of the mitigation technology
in piping-prone river embankments
along the Po river (IT)
and Danube river (HU)

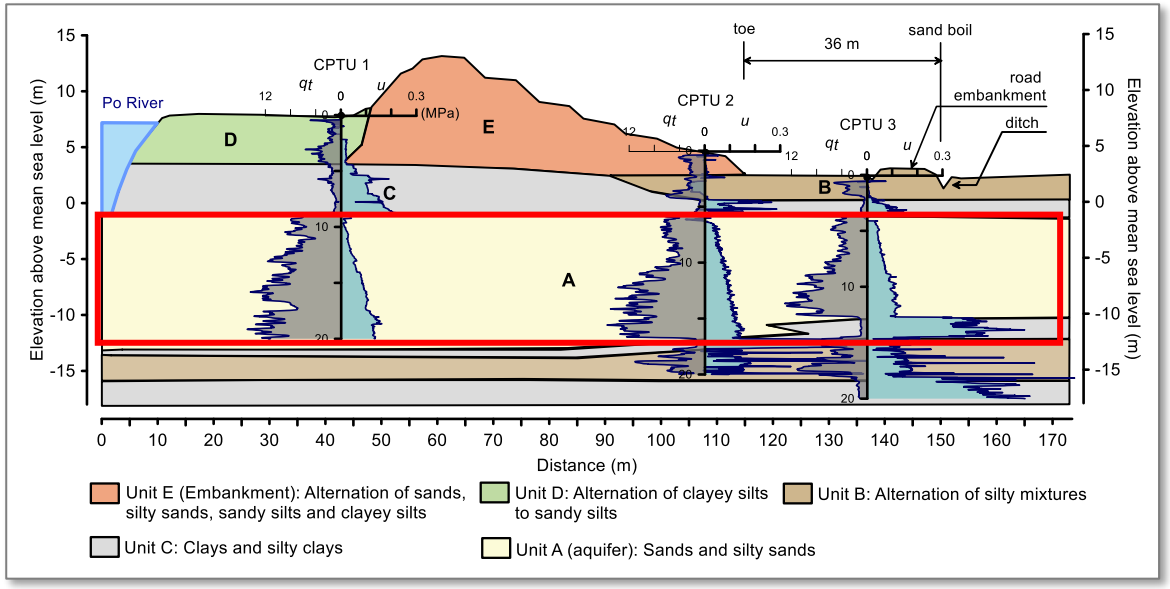
LIFE SandBoil

https://lifesandboil.eu

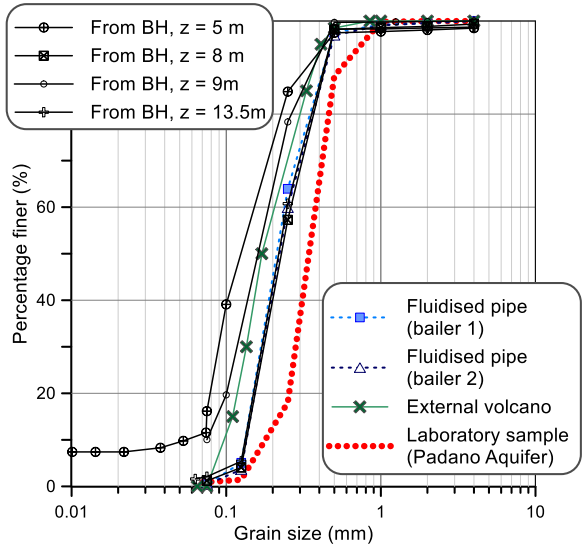
Testing soil and sample preparation

$\gamma_{d,min}$=13.7 kN/m^3, $\gamma_{d,max}$=16.2 kN/m^3

Guarda Ferrarese

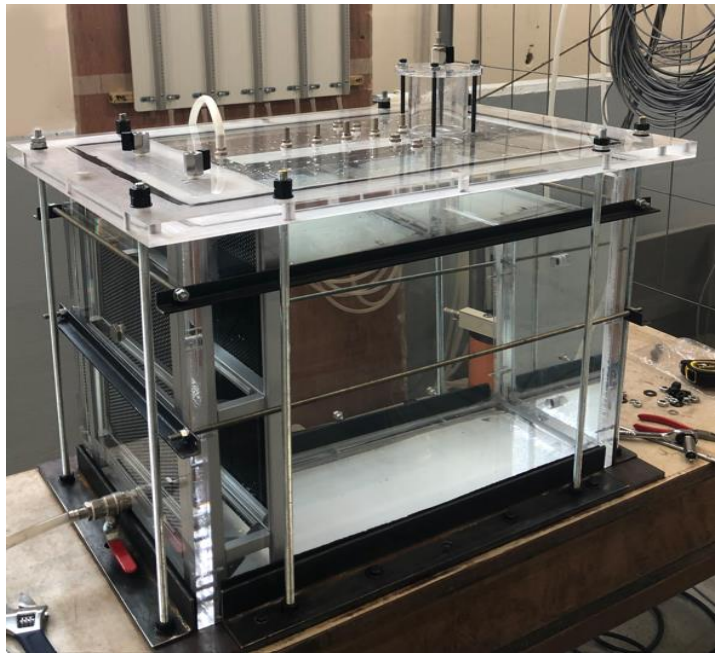


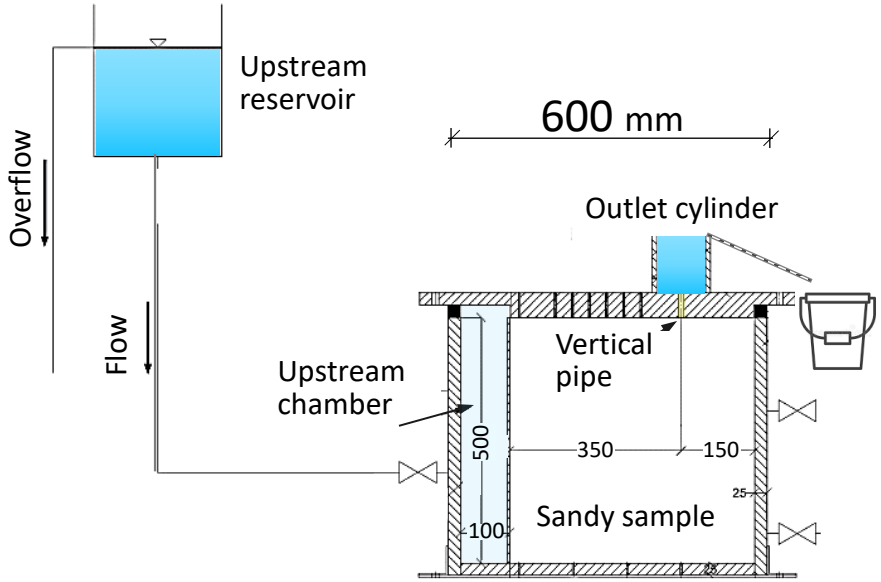
Soil	G_s -	D_{50} mm	U_c -	C_c %	k_{sat} m/s
Silica Po fine sand	2,68	0,34	2,1	3,45	$5 \cdot 10^{-4}$

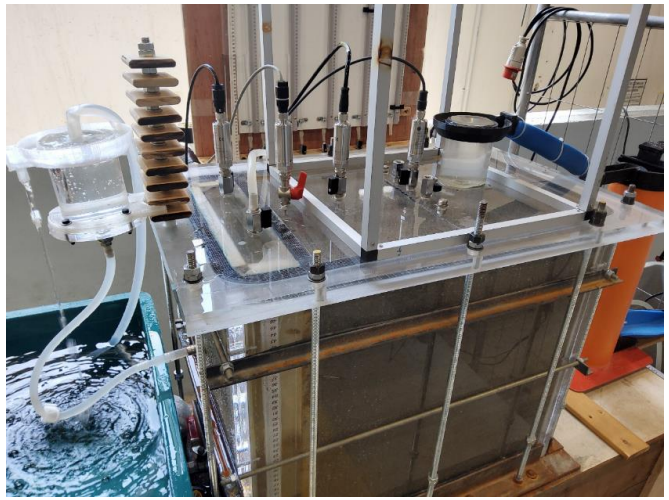


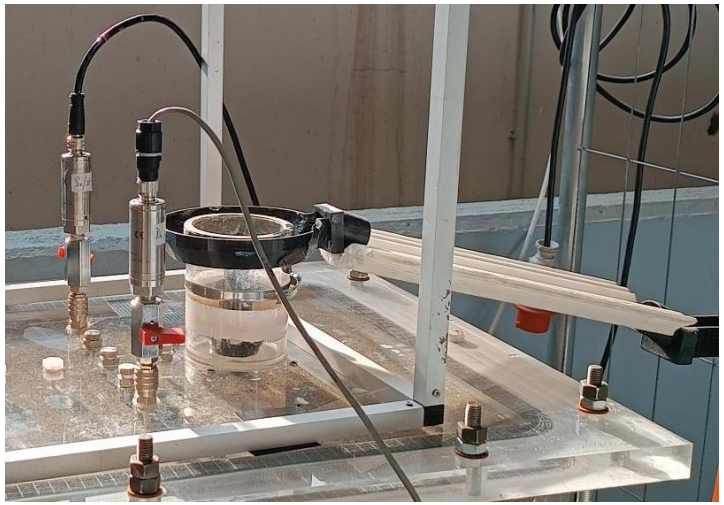
➢ **Sand pluviation** → D_R = 20% - 30%

Experimental setup at the small scale

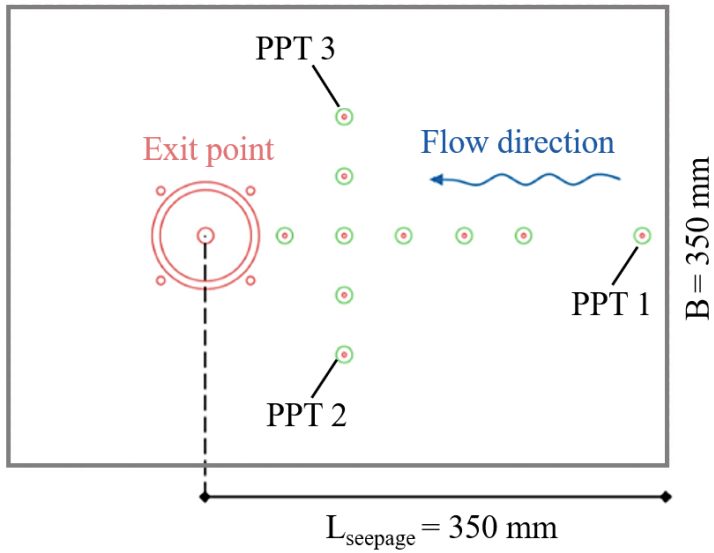








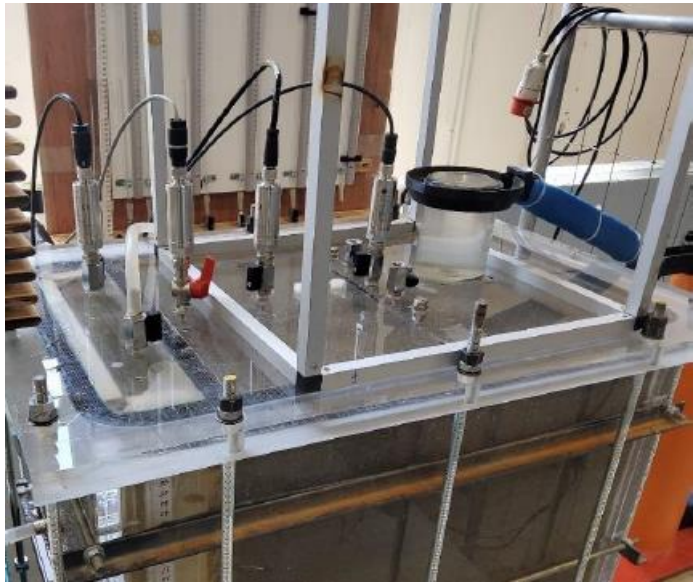
L = 500 mm



$L_{seepage}$ = 350 mm

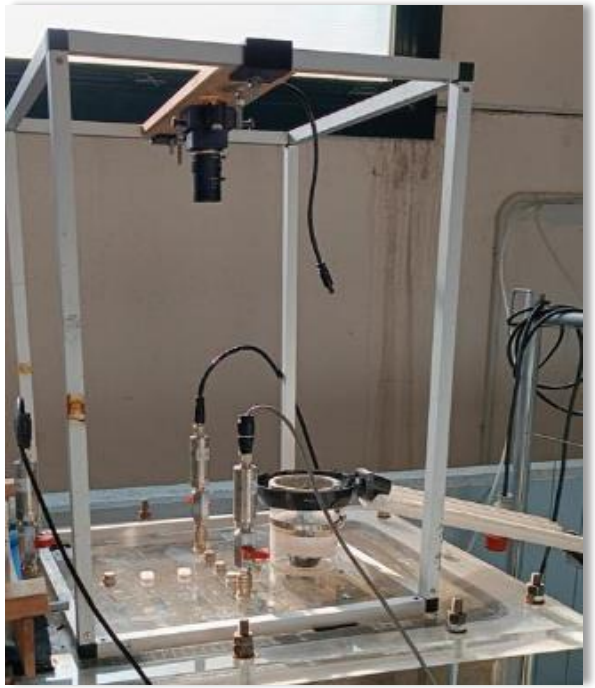
Monitoring instrumentation for the small-scale setup

- Pore pressure transducers (PPT)



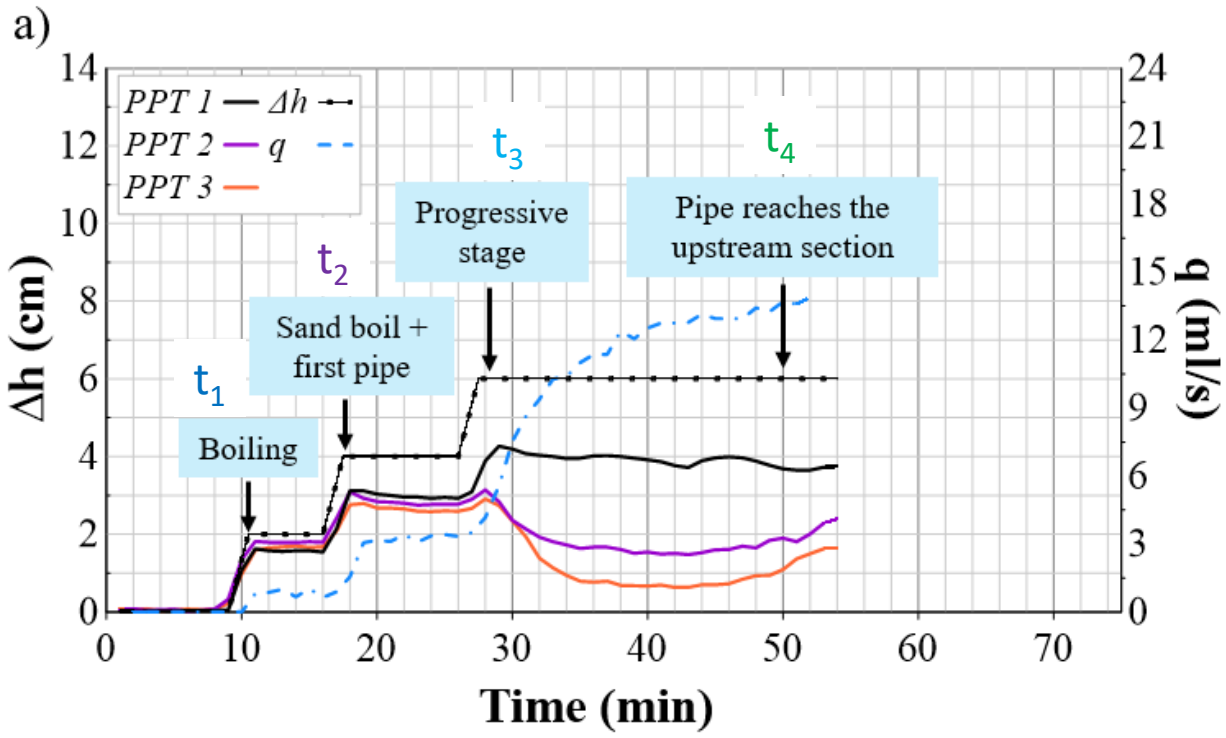
- Flow meter/Load cell/Balance for manual measurements of the flow rate

- High resolution camera

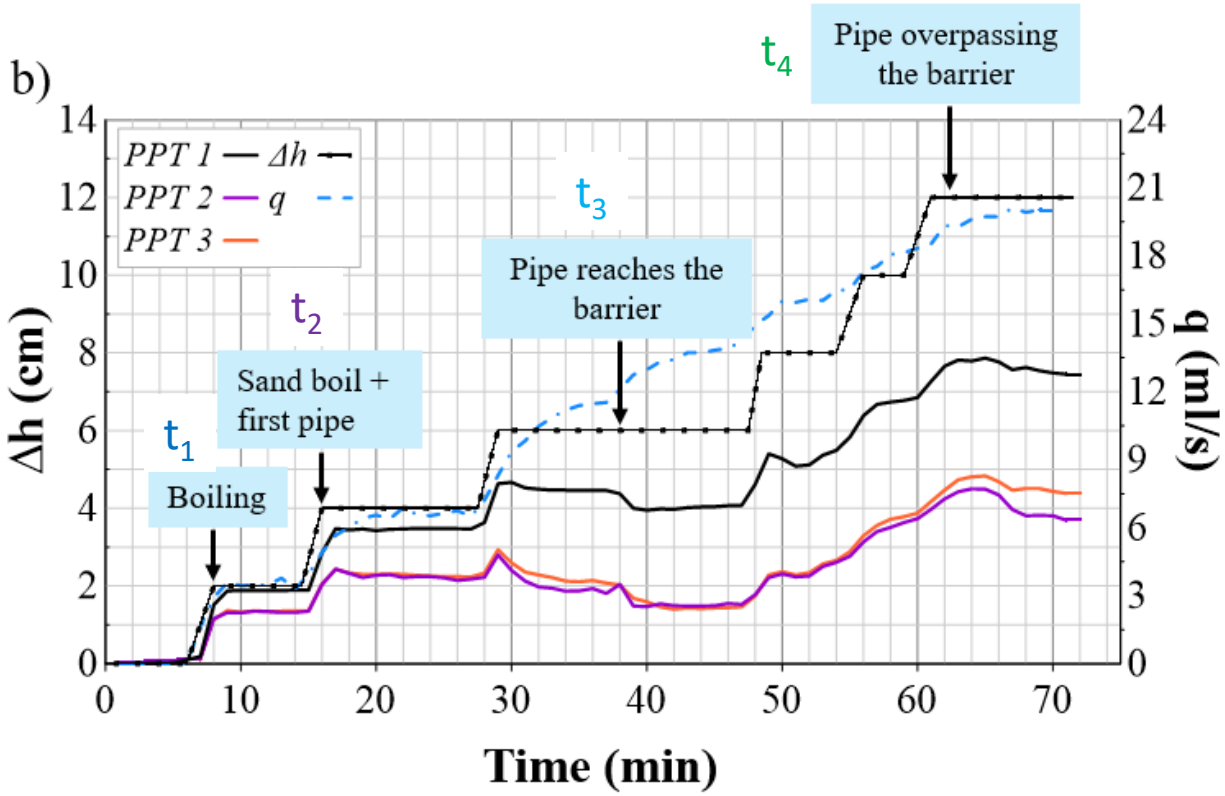


Experimental results

➢ Without any mitigation technology



➢ With the geocomposite vertical barrier

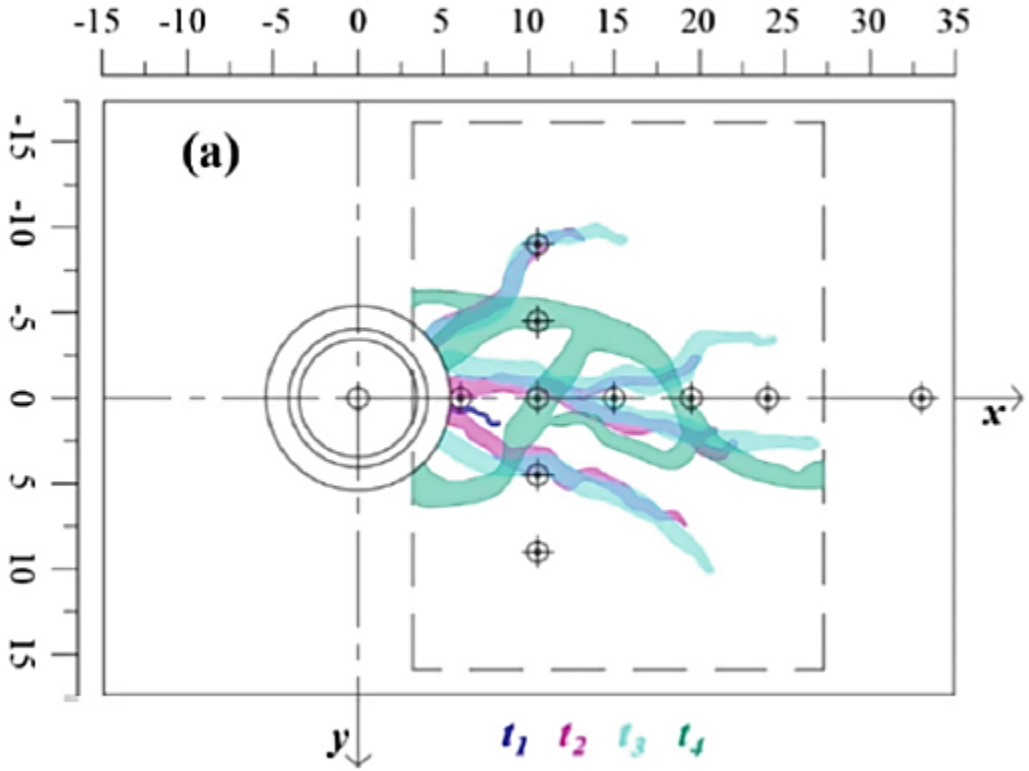


In *Test b*, the critical condition is reached with a **hydraulic gradient** value that is double with respect to *Test a*.

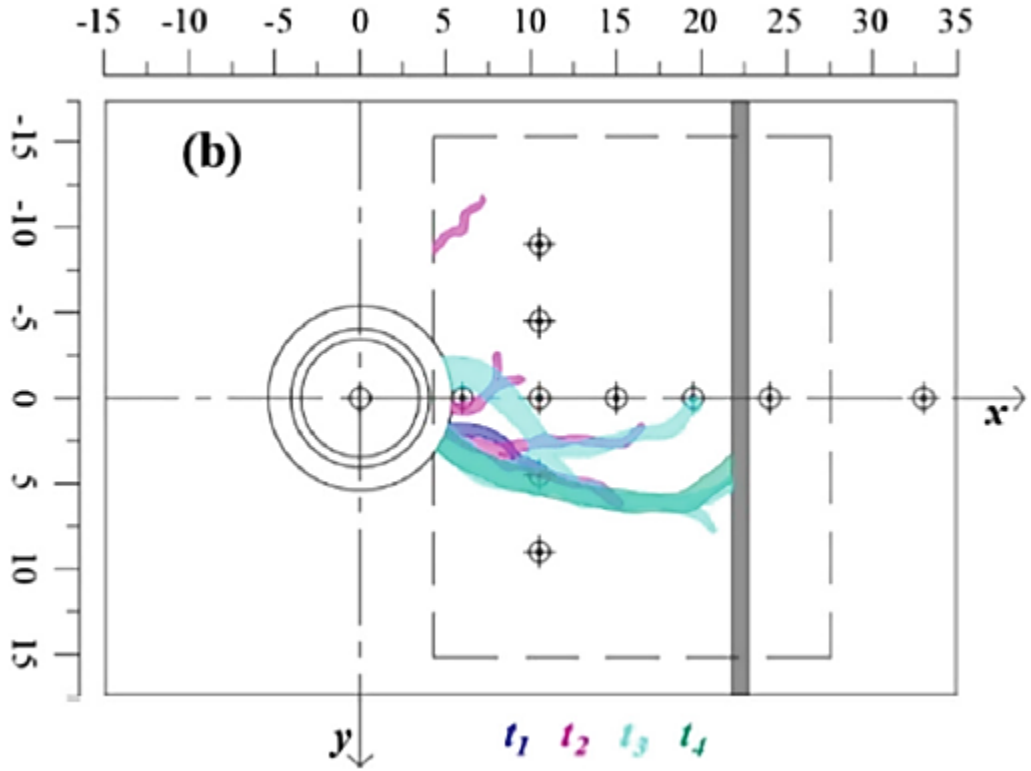
Mcdrain W1101 - Maccaferri

Experimental results

➢ **Without any mitigation technology**



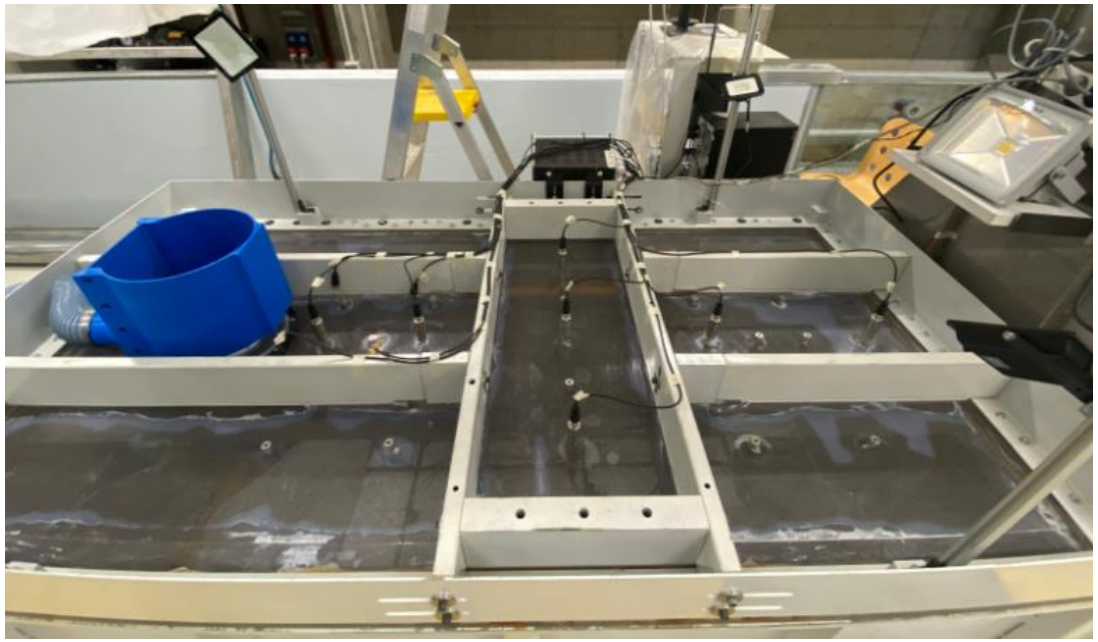
➢ **With the geocomposite vertical barrier**



- During the progression of the phenomenon, the **erosive channels widened and meandered**, with a gradual rise in the outflow of water, due to the increased volume of eroded soil.

General view of the medium-scale apparatus

Monitoring system of the medium scale apparatus - PPT



Concluding remarks and further research activities

A gradual increase in hydraulic load can trigger a backward erosion process that, without any mitigation measures, may lead to the collapse of the embankment infrastructure.

The installation of a vertical barrier results in a significant slowdown of the erosive process.

Samples characterized by a higher relative density will soon be tested and the monitoring system for the medium-scale box will be integrated with optical fibers.

Thank you for your attention

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