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Laboratory experiments for analysing the impact of herbaceous vegetation on riverbank erosion

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NBS analysed:
Installation of **herbaceous perennial deep rooting** plants as **coverage of earth embankments.**

Mitigating the erosive action of the water flow and improving soil resistance by increasing the strength of the bank material with their roots, the herbaceous deep rooting plants will reduce the risk of local and shallow instability mechanisms that may lead to the collapse of levees and riverbanks during flood events.

Experimental analyses in a laboratory flume have tested the behavior of bare soil, standard grass and deep-rooting plants under different hydraulic load conditions.

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Real world case study (Open Air Lab): reach of the bank of the Panaro River tributary of Po River (Northern Italy)

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Panaro River

In this section, remediation works (piles and riprap) on the Panaro riverbank have been recently (spring 2019) concluded by the Po river authority (AIPO) to improve bank stability. On the adjacent bank, cracks have already appeared.

Experiment setup: Planting and growing of the vegetation

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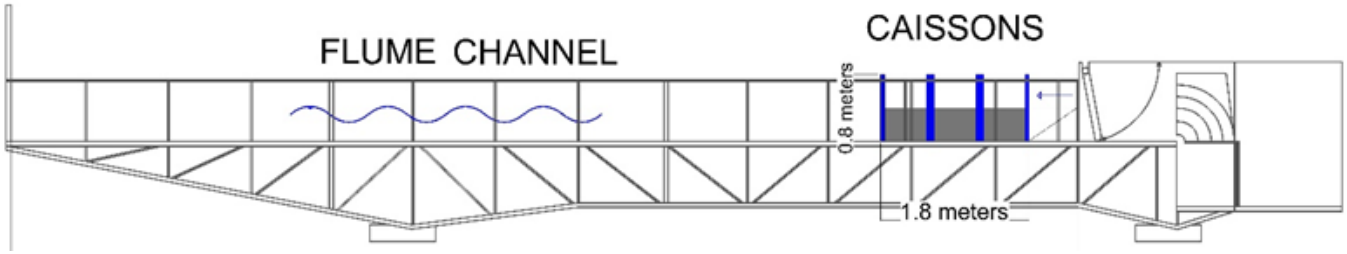
Laboratory flume tests was performed in different soil surface conditions, i.e.:

- Smooth, compacted and **non-vegetated soil;**
- Soil vegetated with **standard herbaceous plants** typically used by the river authority (when any vegetation is planted, since generally there is no artificial seeding along the banks)
- Soil vegetated with **deep-rooted herbaceous plants**



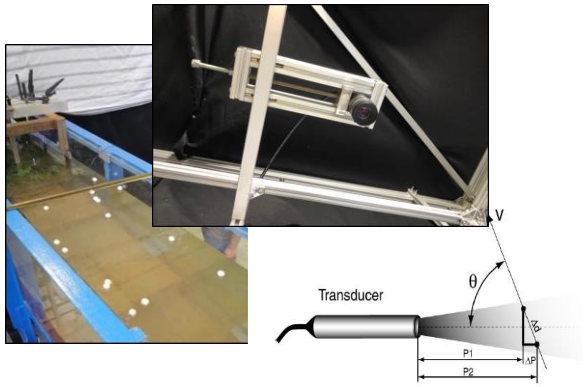

Experiment setup

A set of experiments in a recirculating, tilting hydraulic flume have been designed and implemented, in order to gain, in a controlled environment, information on the influence of the vegetation on both hydraulic and erosive processes



Monitoring system

Camera for Particle Image Velocimetry, Acoustic Doppler Velocimeter, custom-made system for weighting of bed load sediment transport, turbidimeter for suspended sediment transport.



Vegetated soil experiments

For each vegetation type (standard and deep-rooted herbaceous plants), two channel slopes were tested (0.3% and 8.5%), each with three different discharges.

The main challenge resulted to be the estimation of the volumes of soil eroded during the experiments, due to the very limited quantities that are eroded and to the particularly fine-grained texture of the soil.

Partial and local states of failure were obtained during the erosion test at the higher bed slope for the bare soil and, to a lesser extent, for the deep-rooted plants, while erosion processes were negligible for the “standard grass”.

Experiment setup: Influence of plants density

The presence of vegetation produced, a substantial decrease in the surface erosion rate and an increase in flow resistance in comparison with bare soil.

At the time of experiments (i.e. around three months from the plants seeding), **the standard vegetation was characterized by high plants density** on the soil surface, with **limited exposure of bare soil to flow erosion**; **the deep-rooting plants were much less dense** and **offered less hydraulic resistance to the flow**, whatever the flume slope and corresponding discharge.

Vegetated soil experiments: preliminary conclusions

The deep-rooted herbaceous species at the time of the experiment had a root system up to 15 cm long, while this depth was limited to a few centimeters for the standard plants.
Even if root depth seems to have had less influence than plants density on the erosion in our lab tests, **the conditions of the two types of vegetation are expected to be very different in the real-world case study, where the plants grow in a natural environment and for a much longer period and their robustness, strength and health during the years plays a much larger role**.

The dataset of the measures collected during the whole series of tests is still under investigation and interpretation.
The results will help to analyse the hydraulic and erosive processes on the riverbanks, where such vegetation cover will be installed.