Laboratory analysis of plastic particle transport in vegetated patches

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Objective

The present work is focused on the study of the interaction between plastic particles and riparian vegetation, evaluating the trapping capacity of the vegetation.

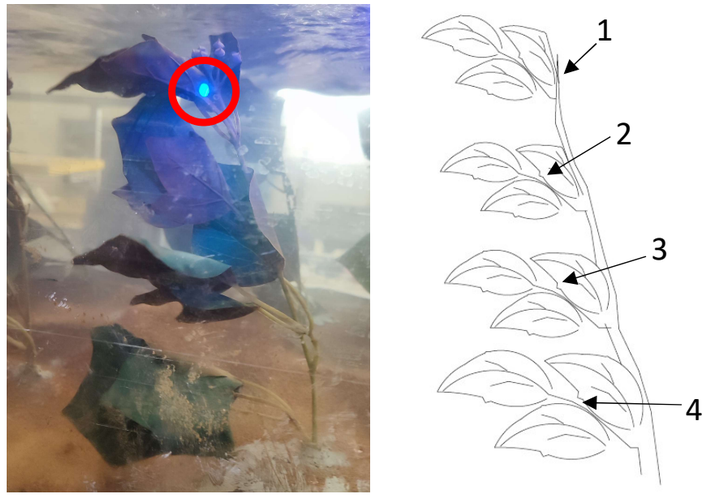


Fig. 1 - (a) Single plant with trapped plastic particle, (b) Single plant design

Why

During transport in rivers, plastic particle can accumulate on the bed with sediment, by river structures and riparian vegetation. Recent studies observed that riparian vegetation plays an important role in the dynamics of transported plastic elements.

The vegetation structure can act as a trap for plastic litter while they are transferred by the discharge and then become a source of plastic for the next flood. In particular, has been observed that some vegetative type, like arboreal and shrubby, play a significant role in trapping bidimensional plastic elements.

Experimental conditions:

- 40 plants – 2 rows – 20 columns;
- Flux 36.4 l/s, water depth 0.227 m, bed slope 0.8% (Artini et al., 2022);
- PET Particles, ϕ 5 mm; ρ_1 = 1.04 g/cm^3, ρ_2 = 1.2 g/cm^3;
- Two different vegetative patterns: 1234 (all the leaves), 123X (without leave 4).

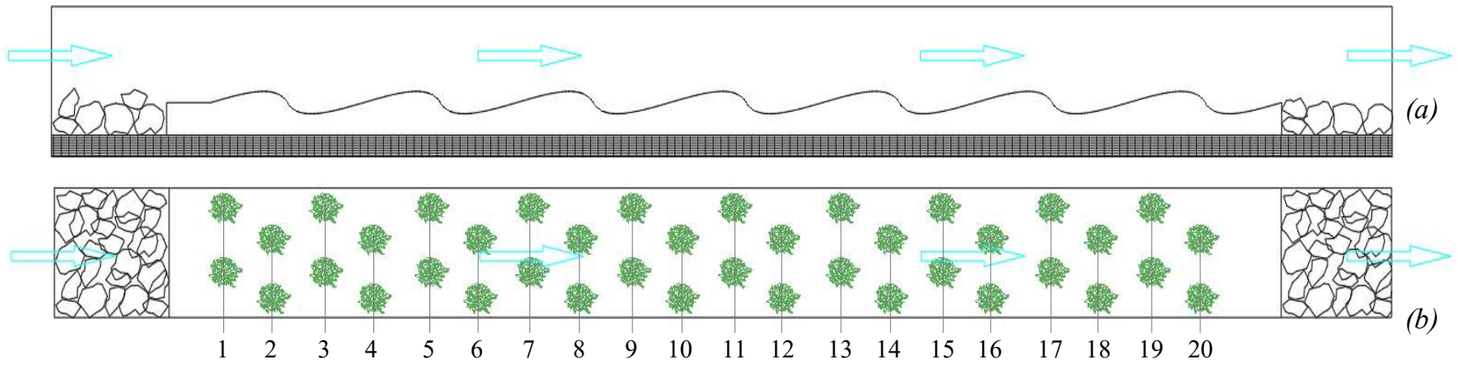


Fig. 2 – Sketch of the channel used for the experiments: (a) cross-sectional view, (b) plan view. Plants position is highlighted in green

Methods

The experiments were conducted in a recirculating flume with fixed bed reproducing a dune morphology, superimposed with staggered lines of artificial vegetation able to mimic the real riparian vegetation in natural river (Fig. 1 & 2).

Plastic particles used in the experiments were shaped like regular disks with diameter of 5 mm, and densities ρ_1 = 1.04 g/cm3, ρ_2 = 1.2 g/cm^3.

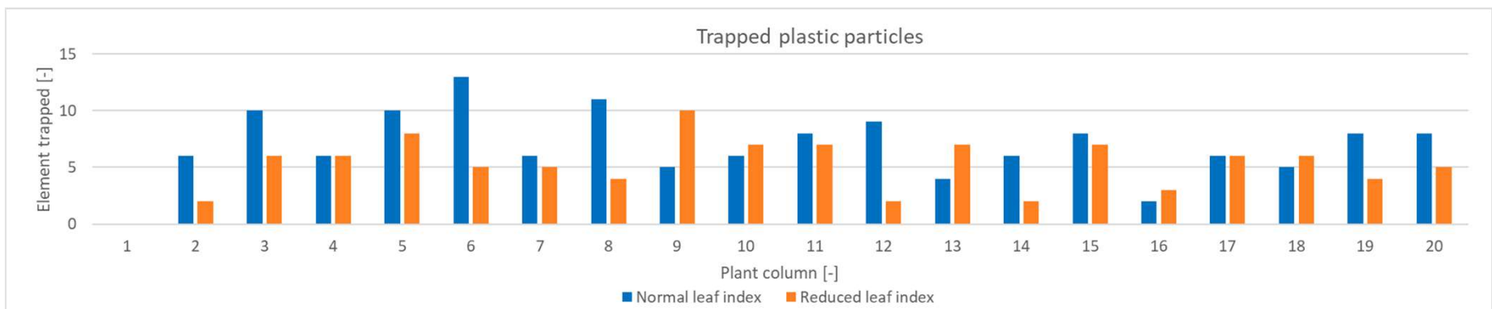
The trapping effect of vegetation on plastic is investigated by changing the leaf area index of the flexible vegetation, removing one leaf at different heights.

Results

The experimental results are focused on the spatial distribution of trapped elements along the vegetated area.

Results show that the vegetation directly trapped about the 20% of the lightest plastic particles, while heavier particles were mostly trapped in the recirculation zones of the dunes bed, with a total retained fraction of about 60%.

The change of the leaf area index strongly affected the trapping effect of vegetation, reducing the percentage of trapped particles to about 10%.



References

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