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Understanding soil erosion process within herbaceous vegetative hedges using plant functional traits approach in North-West Europe

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Runoff and soil erosion induce major environmental and economic damages. Concentrated runoff control by aboveground plant biomass in upstream areas constitutes a key feature to reduce runoff and soil erosion in Western Europe (WE). Indeed, aboveground plant biomass can reduce runoff and soil erosion respectively by increasing hydraulic roughness and trapping sediments. However, studies of plant effect on runoff reduction are usually based on the taxonomical characterisation of species and do not refer to effect of aboveground plant functional traits. Plant functional traits approach allows to understand ecosystem processes and quantify services. Traits effect could vary depending on hydrological processes (i.e. discharge) and their aggregation could have a synergetic effect on hydraulic roughness and erosion reduction. In this study, objectives are to i) examine effects of aboveground plant functional traits of herbaceous hedges on hydraulic roughness; ii) test the effects of their aggregation on hydraulic roughness.

Seven aboveground functional traits were measured on 14 indigenous plant species from North-West Europe with a high morphological variability (stem and leaf densities; stem diameter, stiffness and dry matter content; leaf area and specific leaf area (SLA)). Those species are perennial herbaceous caespitose or comprising dry biomass in winter. Effects of plant functional traits and their abundance within the community on hydraulic roughness were examined using a runoff simulator at four discharges. Furthermore, the effect of plant functional diversity was analysed using four monospecific (mono-trait) conditions compared to multispecific (multi-traits) conditions.

Results showed traits and their abundance influence hydraulic roughness. Indeed, leaf density and leaf area (traits), as well as plant community weighted stem, leaf and shoot areas, stem diameter and SLA are significantly correlated to hydraulic roughness. Moreover, leaf density and leaf area (traits) and weighted SLA responses depend on the discharge. Results also highlighted that functional diversity has no synergetic effects on hydraulic roughness mitigation. This study that is the first characterisation of aboveground functional traits in relation to hydraulic roughness under temperate climate will allow the selection of candidate plant species and thus design vegetative infrastructures to reduce soil erosion.