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Trees and shrubs as a component of buffer zones: advantages and disadvantages in P-retention

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Introduction and results

Vegetated buffer zones along watercourses are among the most cost-effective options for reducing non-point source pollution from agricultural fields to aquatic ecosystems. In monotonous cultivated landscapes, buffer zones are also key habitats for the preservation of local biodiversity. So far in the Nordic countries, the emphasis has been on grass filter strips. However, grasses accumulate nutrients in their foliage, and when the leaves die and cell walls break, nutrients leak from leaves and are washed away with overland flow during rainy periods or snow melt. Trees and shrubs are mainly composed of long-lived tissues that can hold large absolute quantities of nutrients, whereas nutrient concentrations of their leaves are low. Therefore, woody plants might be more suitable for nutrient retention than grasses. In addition, structurally complex buffer zones including woody species should harbour a larger number of species than simple grass filter strips, and might therefore help to preserve local biodiversity. However, individual plant species vary in their ability to retain a given nutrient because of their different nutritional requirements and possible mutualistic relationships with nitrogen-fixing bacteria. Plant species vary also e.g. in their ability to grow in different kind of soils, in the number of herbivorous pest species they attract, and in their ability to survive and recover from herbivore attacks.

We constructed buffer zones with trees and bushes in 2001 in six experimental sites of SW Finland to determine the interactions between phosphorus retention, herbivory level and plant performance. Each of the six experimental sites included fenced/open areas (30 x 15 m^2) with seedlings of woody species in two plots (7 x 9 m^2) per area, except in hay controls. One plot per area was a black alder monoculture, the other a mixture of six species. Nutrient samples were collected in late autumn and early spring from soil and overland flow.

According to our preliminary results, saplings of woody species survived well but grew slowly on heavy clay soil. Voles gnawed most saplings at high vole densities but the majority of saplings recovered from vole attacks. Despite the slow growth of saplings, soil phosphorus levels dropped significantly faster in plots with woody species than in hay controls (Figure 1). Greenhouse experiments indicated that the most efficient woody species for phosphorus retention included alders (*Alnus* spp.) and willows (*Salix* spp.).

In contrast to a clear effect in soil, the presence of woody species did not improve nutrient retention from overland flow compared to hay controls (Figure 2). One possible confounding factor behind this result was accumulation of dead hay in plots with tree saplings, since the presence of tree saplings prevented effective mowing and removal of hay between the saplings whereas all treeless areas were mowed yearly. After two growing seasons, the spring biomass of (mainly dead) hay vegetation in plots with tree saplings was approx. 1.5 times higher than in hay controls: in April 2003, mean above-surface dry biomass was 6 tons/ha in plots with saplings vs. 4 tons/ha in treeless parts of the same zones.

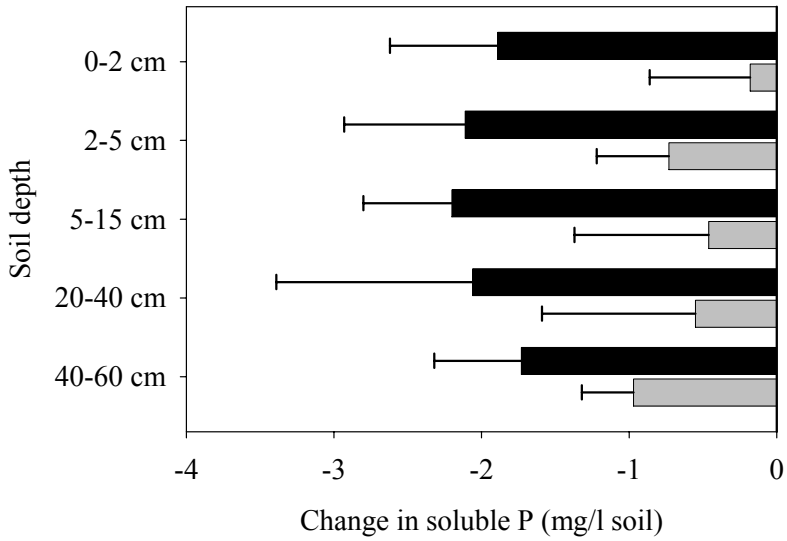

Figure 1. Mean (±S.E.) change in the amount of soluble phosphorus (P) in soil samples collected at different soil depths. Black bars denote plots with woody species, grey bars hay controls. Preliminary results from the period 2001–2003.

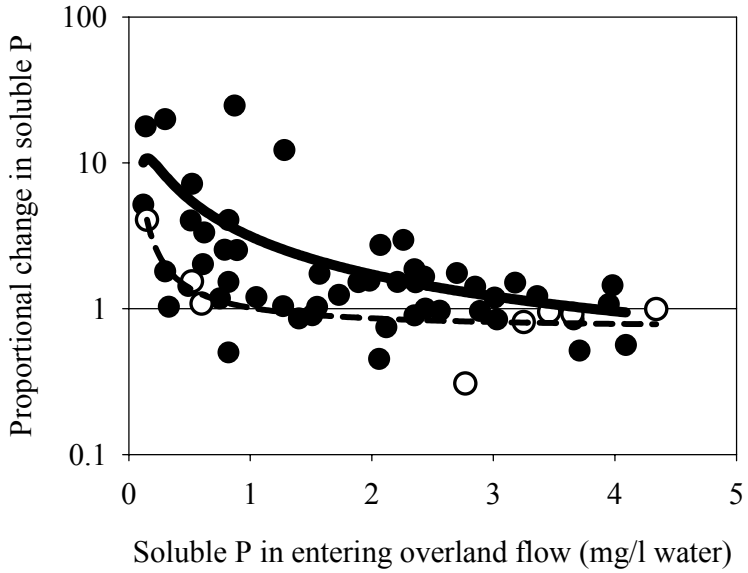

Figure 2. Proportional change (output level / input level) in the amount of soluble phosphorus (P) in overland flow through 7-m plots with (dots and solid line) or without (circles and dashed line) woody species. Water samples were taken in late autumn and early spring. Lines represent fitted polynomial curves. Preliminary results from the period 2001–2003.

Conclusions

Trees and shrubs are potential components for construction of buffer zones, especially for reducing phosphorus levels in soil. Woody species appear to be less efficient in capturing nutrients from overland flow, at least outside the growing season. Tree seedlings prevent effective mowing and removal of hay, which may lead to an accumulation of dead hay on the zone. Therefore woody species should mainly be used in places where yearly mowing and removal of hay is not feasible.