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Use of wetlands, ponds and buffer zones in Finland

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Introduction and Results

Eutrophication of surface waters caused by excessive nutrient loading is a significant environmental problem in Finland. Construction – or re-establishment – of wetlands offers an option to combat eutrophication. Since Finland's accession to the EU in 1995, constructed wetlands (CWs), ponds and wide buffer zones (BZs) between the fields and waterbodies have been included in the special agri-environmental measures for which farmers may receive public subsidies. Here, the present situation in terms of subsidy regulations and numbers of CWs and BZs in Finland is briefly described. Moreover, results on the performance of 4 CWs in Finland (Fig. 1) are presented. Detailed descriptions of materials and methods of these studies can be found in Koskiaho et al. (2003) and (for Tuijanpuro) in Häikiö (1998).

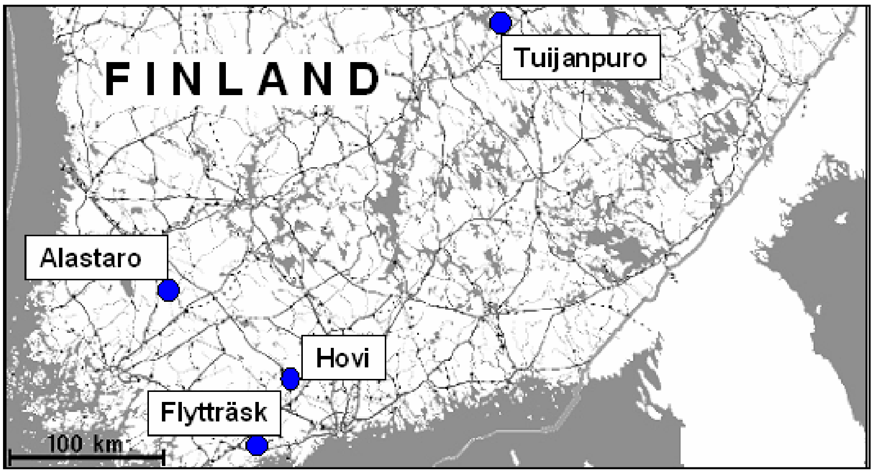

Figure 1. Finnish CWs and ponds with at least one year of intensive monitoring

The highest percentage retention for all substances was measured at the Hovi CW (Table 1), for which the CW:catchment area ratio was largest (5%). Given its clayey catchment, the retention at Hovi, particularly for TSS, was high. Meanwhile the Alastaro CW (also clayey catchment) with the ratio of 0.5% showed poorer results and was sometimes even a source rather than a sink of dissolved P and N. The semi-natural Flytträsk CW showed fairly stable, yet not very high, retention performance. The small sedimentation pond Tuijanpuro retained most kg per pond area, but the percentage retention was not very high. The tolerable result of the Tuijanpuro pond was, particularly in terms of TSS, obviously a consequence of the coarse soil type of the catchment and thereby high rate of sedimentation.

The key factor behind the high retention in the Hovi CW was obviously its longest water residence time (WRT). The highest annual specific retention rates measured in these Finnish studies were lower than those reported in similar studies in other countries, particularly for TN. A possible reason for the difference in terms of N is that the cold, boreal conditions inhibit the denitrification process. The high P retention performance of the Hovi CW was not only due to the long WRT but also to high P retention capacity of its soil. This aim was intentionally realised by removing the uppermost, P-rich soil layer of the CW construction site (a former field) and thereby exposing soil low in P but high in P-retaining Al and Fe oxides. In fact, desorption-sorption tests indicated that without the removal of surface soil there would have been a risk of the CW being a source of P, since the equilibrium P concentration of the soil removed was high compared to the mean P concentration of the inflowing water (Liikanen et al. 2004).

Table 1. Specific and annual retention of soil particles (TSS), total phosphorus (TP) and total nitrogen (TN) in 4 wetlands in Finland

Constructed wetland	Catchment (ha)	Field percentage of the catchment (%)	CW as proportion of the catchment (%)	Specific retention (kg/ha/yr)			Percentage retention (%)		
				TSS	TP	TN	TSS	TP	TN
Hovi	12	100	5	24 300	24	280	68	62	36
Flytträsk	90	35	3	760	1.6	42	13	15	8
Alastaro	2 000	90	0.5	9 400	8,1	11	22	9	0
Tuijanpuro	120	31	0.05	56 500	37	320	18	6	3

Hydraulic efficiency (λ) was calculated as the time elapsed from the simulated tracer input to the detection of peak tracer concentration (tp) divided by WRT. The λ-values of the Hovi and Alastaro CWs were 0.65 and 0.52, respectively (Koskiaho 2003). Although the value of Alastaro cannot be judged poor, this difference further explains the better retention results of Hovi. As for design options, the modelling revealed that in cases like Hovi, baffles are highly recommendable; without them (see LH2 in Fig. 2), the λ-value of the Hovi CW would have been only 0.24. The poor hydraulic efficiency of LH2 is demonstrated by the large stagnated zone (the dark area in Fig. 2) with no or little water movement.

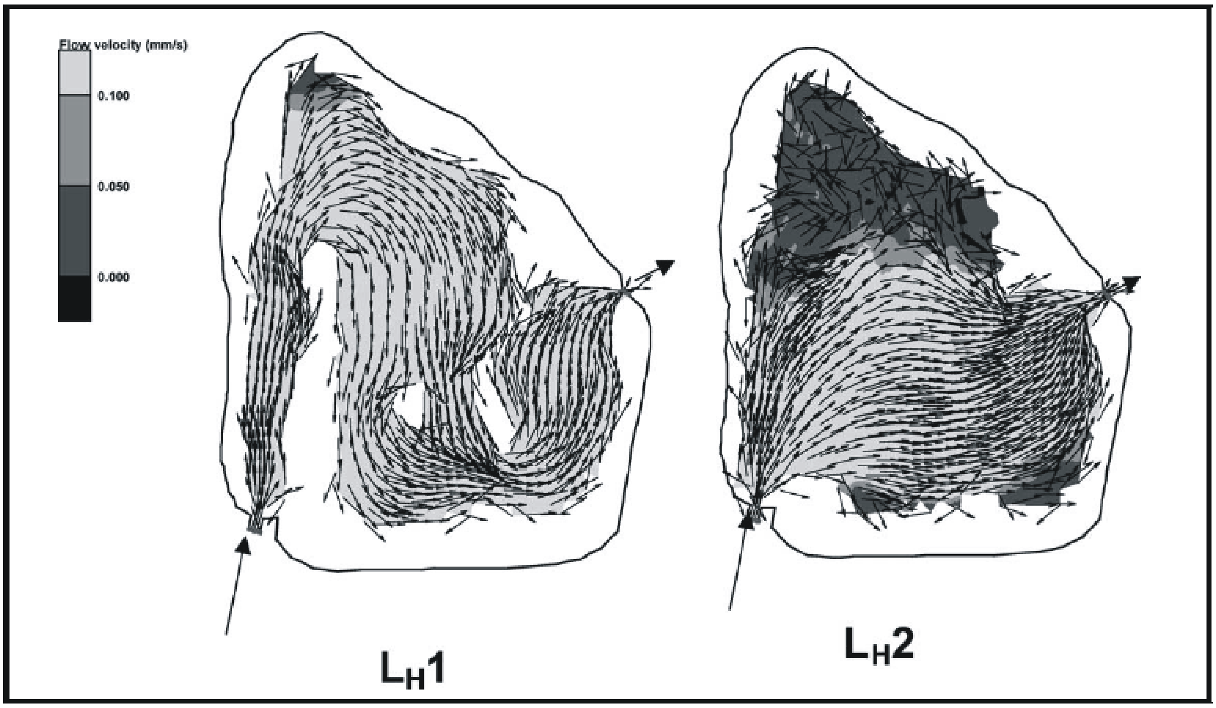

Figure 2. Flow patterns at a typical flood situation in the Hovi CW (L_H1) and its hypothetical layout (L_H2). Tone value of the shading expresses flow velocity in mm s^{-1}.

Due to ample supply of nutrients and water, the vegetation in CWs typically proliferates very fast. Although the development of vegetation in CWs can be enhanced – or guided towards the desired direction – by seeding and transplanting, solely natural development often leads to an appropriate outcome. For example, in the Hovi CW the seeded and transplanted vegetation clearly extended less abundantly than that sprouted naturally. The unmistakably dominant species in Hovi is cattail (*Typha latifolia*). Other species found in the CW are club-rush (*Scirpus sylvaticus*), common water plantain (*Alisma plantago-aquatica*), reed canary grass (*Phalaris arundinacea*), meadowsweet (*Filipendula ulmaria*), yellow flag (*Iris pseudacorus*) and compact rush (*Juncus conglomeratus*). Even if vegetation is the vital element of CWs, arguably the most popular (among the local people) improvement in biodiversity that can be attributed to CWs is birdlife. In agricultural areas CWs can create patches of habitat for waterfowl, which readily utilize these areas offering plenty of food. As a part of the studies carried out at Hovi, the number of birds was calculated in summer 1999 and in spring–summer 2000. In all, 22 bird species were detected, of which six were found nesting in the CW. The nesting waterfowl included pairs of mallard (*Anas platyrhynchos*), teal (*Anas crecca*), and common goldeneye (*Bucephala clangula*). Many species utilized the CW as an eating location. These were e.g. northern hobby (*Falco subbuteo*), crane (*Grus grus*), and great snipe (*Gallinago media*).

Not very many CWs have been constructed so far in Finland. In 2003, only 113 farms had a contract entitling them to receive the special subsidy for CWs. Meanwhile BZs, for which suitable places are more readily available than for CWs, have gained more popularity (1 970 contracts in 2003). As for sedimentation ponds, the number of contracts was at its highest in 1999 (504 contracts) and has declined since that (274 contracts in 2003). This is due to the fact that after 1999, specific pond contracts are not being made any more, but ponds are included in some of the CW contracts. The renewed agri-environmental support scheme, hopefully including elements encouraging farmers to establish more CWs in Finnish arable areas, will be launched in 2006.

Conclusions

- Main purpose of the CWs for the treatment of runoff from agricultural areas is to reduce nutrient loading to surface waters and hence combat eutrophication
- The most important single design parameter controlling retention effectiveness of a CW is its area in relation to the catchment area
- Input concentrations, catchment properties (soil type!), hydraulic efficiency and CW soil properties also have a significant influence on the effectiveness
- CWs possess a strong potential in water protection, but only as a part of comprehensive, catchment-scale management strategy
- Appropriately designed CWs improve the surrounding landscapes and increase biodiversity

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