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Effects of restoration of forestry-drained peatlands on carbon and nutrient fluxes

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Drainage for forestry has been a widespread use for boreal and temperate peatlands. As unintended side effects it has caused loss of biodiversity on the landscape scale, loss of peat and soil carbon, and deterioration of water quality. Restoration of forestry-drained peatlands is one of the major means of protecting and increasing biodiversity in the boreal region. Also improvements in water quality and restoring the carbon accumulation function of peatlands are listed as benefits from restoration of these areas.

The effects of restoration on aqueous phosphorus (P), nitrogen (N), and carbon (C) fluxes were studied in two studies utilizing data sets spanning up to seven post-restoration years in a set of restored peatlands of different fertility levels in Southern Finland. Methane (CH_4) dynamics were studied on a set of undrained, drained, and restored spruce swamps over one growing season. The effects of peat properties on the release of iron (Fe), P, N, and C and redox (Eh) conditions after rewetting were studied in a laboratory incubation experiment utilizing peat from drained peatlands from ombrotrophic to meso-eutrophic level.

Fertile spruce swamps were found to be a major source of aqueous nutrients and carbon after restoration, with P_{tot} emissions of up to 5 kg ha^{-1} a^{-1} and N_{tot} emissions of 30 kg ha^{-1} a^{-1} in the first years after restoration. Restoration of the less fertile sites caused small emissions in comparison, but still comparable to those of forestry operations on drained peatlands.

The CH_4 dynamics of restored spruce swamps resembled those of the drainage ditches in drained sites, eg. occasionally very high emissions. The water level was higher and the peat more decomposed in the surface layers of the restored sites than the undrained sites. The undrained and drained sites were minor sources of CH_4 with occasional CH_4 oxidation.

Fe content in peat was found to correlate with the release of dissolved organic carbon and the establishment of reducing conditions in the incubation experiment, while the release of P was controlled by several factors including the Fe/P ratio and the content of easily dissolvable P in the peat. Fertile peat was found to have a minor risk of P release if Fe/P content was high enough.

In conclusion, methods for restoring meso-eutrophic sites with heavily altered peat need to be improved for restoration of forestry-drained peatlands to achieve the stated goal of improving water quality in headwaters. Water course protection should also be taken seriously when restoring less-fertile sites.