Using NutSpaFHy model to assess nature-based solutions for mitigating nutrient and sediment loading under changing forest management and climate scenarios

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Forest harvesting increases nutrient and sediment load to the adjacent watercourses and further deteriorates water quality. Effect is stronger after heavy rainfall events, which are predicted to be more frequent in future and thus, posing an increased risk of leaching of dissolved elements and suspended solids. There are several potential nature-base solutions (NBS) available to mitigate export of nutrients and suspended solids. The efficiency of most of them is based on their ability to reduce flow velocity and ability to capture eroded suspended solids and nutrients before they enter to the receiving water body. Such NBS include e.g. sedimentation ponds and pits, as well as peak flow control structures, constructed wetlands and overland flow areas. Furthermore, certain forest management practices such as continuous cover forestry are assumed to decrease leaching of nutrients and suspended solids.

Nutrient and sediment loading emerges as a result of complex processes that have spatial and temporal variability. In order to be able to assess the current and future status of nutrient and sediment loading, the factors influencing those and possible management actions to mitigate negative impacts, we need a systemic approach based on modelling tools. In Finland, the decision support protocol is used for producing catchment scale nutrient and sediment load scenarios including different NBS and their combinations to involve the local land owners and other stakeholders in co-designing the sustainable future for Lake Puruvesi. The decision support protocol (NIM) considers the loading of nutrients and sediment from the terrestrial part of the catchment with each land use separately and combines this with the ecological status of the receiving water body. NutSpaFHy is a grid-based catchment-scale distributed model based on a simplified and computationally efficient hydrological model SpaFHy and is part of NIM enabling the identification of forest management history and its load and anticipation of future, probable forest management and the resulting load. NutSpaFHy includes a nutrient balance component where nutrient uptake, release and storage are quantified grid by grid (16m resolution) at daily scale based on meteorological drivers and spatial data from national forest inventory and soil and
topography. After calculating nutrient balance, the export loading component is used, and it includes an exponential delay function which is built upon the hydrological simulation and nutrient balance quantification. NutSpaFHy is simulating export loading with good performance level during climatological events in boreal forested catchments. NutSpaFHy utilizes open source datasets available, including forest resource data, digital elevation model (DEM) and soil maps. Built upon simulated forest growth information, soil water table and saturation deficits modelled by SpaFHy, a grid-scale computation of daily N and P balance was conducted.

Nutrient loads are calculated in current and future climate with two different logging scenarios to assess the functioning of the NBS in mitigating nutrient loading. The results will show the role and potential of NBS in future climate.