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Nutrient load simulations at Lake Puruvesi, Finland: extreme case event in 2012

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Background

In the Open-Air Laboratory (OAL)-Finland, Lake Puruvesi, the main land-use is forested areas, with minor areas in agriculture, and urban land-use. Activities related to these land-uses together with infrequently occurring high runoff peaks due to heavy rain events or rapid snowmelt cause nutrient (phosphorus, nitrogen) and sediment load risks and thus threaten recreation, fishing (professional and recreational) and biodiversity of the area. Various Nature- Based Solutions (NBS) are planned to reduce nutrient loading for the Puruvesi area. Modelling will be used to estimate the impact of NBSs on nutrient loading. It is important to increase understanding of the impacts of the extreme weather events on the amount of nutrient concentration in the water.

According to model simulations the nutrient load increases during the years with high precipitation. However, the total annual precipitation alone explain only partly the variations in the nutrient loads. The nutrient load depends also on the timing of the precipitation and the moisture condition and nutrient content of soil before the precipitation or snow melting event. Typically in Finland, the high nutrient load peaks take place during spring snow melt or after the autumn precipitation. Heavy precipitation during summer may as well induce a peak in nutrient concentrations.

Case study: Snow melt event in 2012

Here we focus on the impacts of an extreme spring snow melt event in year 2012. In the Puruvesi region the winter 2012 was wetter than average with snow depths reaching more than 50 cm in March and lasting until mid-April (See Fig. 1A, re curve). During the permanent snow cover period (31.12.2011-23.4.2012) the total precipitation was 150 mm at the weather station in the Lake Puruvesi catchment area. The snow water equivalent, i.e., the amount of water contained within the snow, is not measured in Lake Puruvesi. However, the Finnish Environment Institute produces estimates of snow water equivalents over Finland with the Watershed simulation and forecasting system (VEMALA). According to modelling the snow water equivalent was about 120 mm in mid-April in Savonlinna located about 10 km west from the Punkaharju weather station. The whole snow pack melted during 13 days (11.4.2012-23.4.2012) from 50 cm to 0 cm as the daily mean temperatures rose permanently above 0 °C. During the snow melt period the total precipitation was about 30 mm. The VEMALA model simulations show a peak of 90 µg/l in phosphorus concentrations during the snow melt in the end of April 2012 (See Fig. 1B, red curve). As a comparison, the drier than average year, 1993, with less snow (max depth 30 cm and slower melting) lead to a lower phosphorus concentration peak of 60 µg/l (See Fig. 1B, blue curve). Furthermore, the total phosphorus load in 2012 was 2.5 times higher than the load in 1993.

Conclusions

This review demonstrates that, in extreme years, the number or effectiveness of NBS measures must be significantly increased to achieve the required reduction in nutrient leaching compared to normal or drier years.

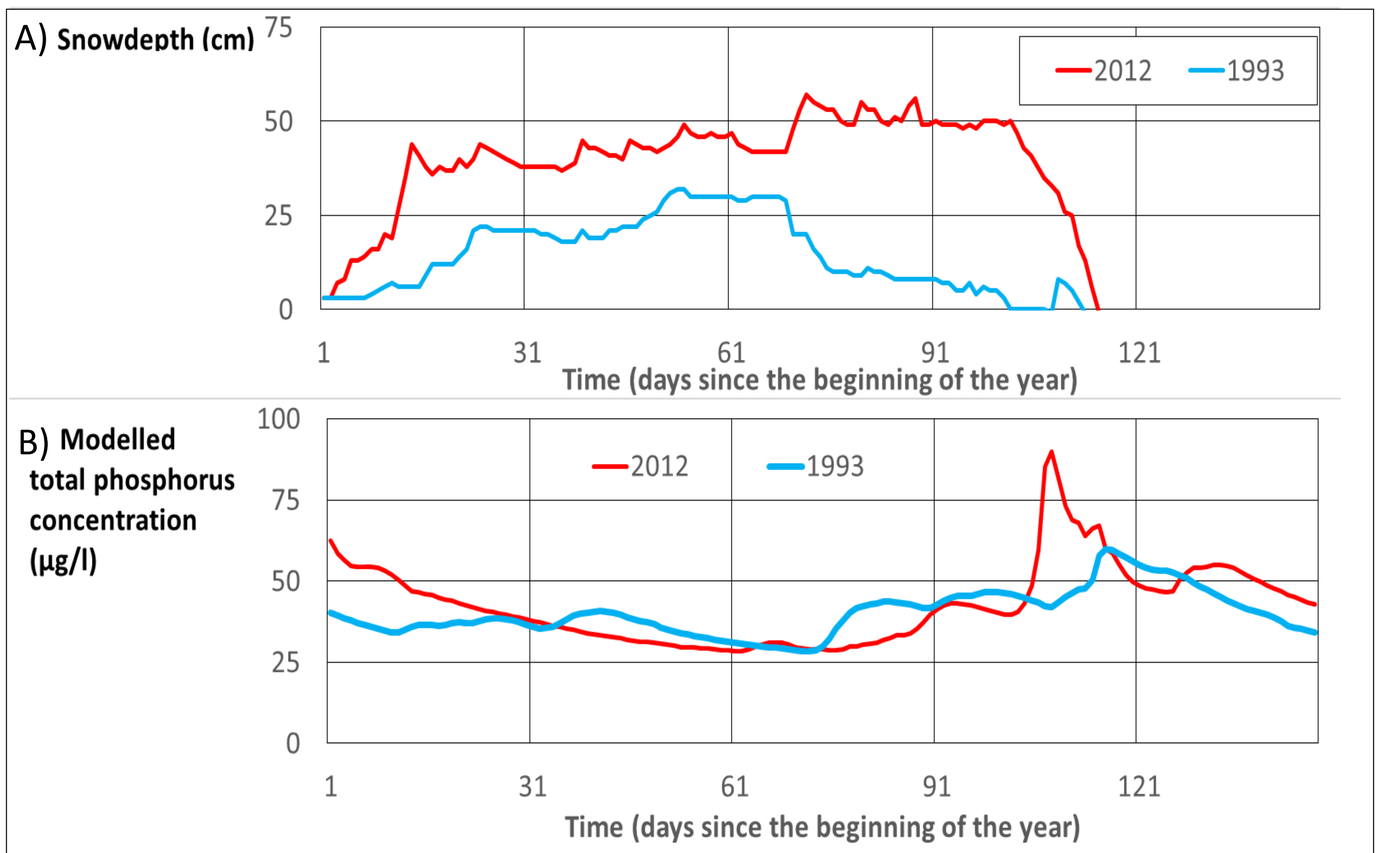

Figure 1 A) observed snow depth at the Punkaharju Laukansaari weather station situated in the Lake Puruvesi catchment area, and B) the modelled total phosphorus concentrations (Tattari et al. 2019).

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References: *Tattari S. et al. (2019) Freshabit tarinakartta: Metsän hakkuuskenaarioiden vaikutukset ravinnehuuhtoumiin. Available at: https://metsakeskus.maps.arcgis.com/apps/MapJournal/index.html?appid=f18e7754288b440d996c734df7963bed*

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