



The national-level nutrient loading estimation tool for Finland: WSFS-Vemala

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The WSFS-Vemala tool has been developed for the estimation of nutrients loading to rivers and lakes in Finland and to the Baltic Sea. The tool includes total phosphorus, total nitrogen, suspended solids and total organic carbon. WSFS-Vemala provides for each of the 58 000 lakes about in Finland an estimate of nutrient concentration in the lake, incoming and outgoing nutrient load and division of incoming load by sources, i.e. agriculture, forests and forestry, scattered dwelling and point sources. The aim of the tool is especially to answer the needs rising from the practical implementation of the WFD. For that purpose, the WSFS-Vemala tool provides an estimate of the present state of the lake using nutrient concentrations, an understanding of the reasons explaining the state of the lake by presenting a division of the loading by sources and finally scenarios for the future state and loading of the lake with different load reduction options.

The WSFS-Vemala tool is based on a modeling system which includes the simulation of hydrology, nutrient leaching from fields and forests and nutrient transport in rivers and lakes. The hydrological simulation is based on the WSFS system, which simulates the hydrological cycle on a daily time step using daily precipitation and temperature. The simulated components are snow accumulation and melt, soil moisture, evaporation, ground water flow and runoff and, discharges and water levels of rivers and lakes. The remote sensing data used in the model includes satellite data of snow coverage and snow water equivalent and precipitation from weather radars.

Since agriculture is the main source of nutrient loading, fields are described in detail. Slope profile, crop and soil type data for each 1 100 000 fields in Finland are described, which cover 2 450 000 hectares of fields. For phosphorus leaching and erosion simulations, the field scale Icecream model is applied. In the Icecream model farming practices, fertilization, crop growth, phosphorus cycling in the soil and finally leaching and erosion are simulated on a daily time step. For nitrogen simulation in fields, a similar process based model is applied on a sub-basin scale. A field scale nitrogen simulation with the Icecream model is under development. Point loads, atmospheric deposition and loads from scattered dwelling are included in the model. Sedimentation, erosion and denitrification are modeled in rivers. In lakes, sedimentation, release from the sediments and denitrification are modeled.

The WSFS-Vemala tool has been applied for a set of nationwide load reduction and climate change scenarios. The DREMFIA sector model from MTT Agrifood Research Finland provides scenarios on the effects of climate change on agriculture. The DREMFIA model gives scenarios as hectares of different crops, fertilization levels and number of cattle in four regions in Finland. Scenarios for point loading, scattered settlements, forestry and background leaching are based on expert estimates. In the scenarios water quality until year 2060 is simulated. For each scenario, an estimate of the state and incoming loading of each lake and loading of each river into the Baltic Sea are provided. The tool can also be applied for basin specific scenarios, where even farming practices and fertilization of each field can be adjusted separately according to the characteristics of the field. In general, scenario results show a slight increase in annual loading and a remarkable shift in seasonal loading, with increased loading during the winter.

The targeted users of the WSFS-Vemala tool are decision makers, local stakeholders and the public. The readymade countrywide scenarios give an overall picture for the decision makers on the possible pathways to improve the water quality. The lake specific scenarios give local stakeholders information on the lakes and rivers in their own catchment. Together with local stakeholders, specific catchment scenarios are also made. For the public, selected scenarios are provided and the WSFS-Vemala tool is also applied for real time water quality simulation and forecasting, and the forecasts are provided for the public at www.environment.fi/waterforecast.

The WSFS-Vemala tool is developed partly within the EU LIFE+ GisBloom project www.environment.fi/syke/gisbloom, where the target is to demonstrate tools for evaluation and management of water quality together with local stakeholders and the public on six river basins.