USING CATCHMENT-SCALE IN-SITU WIRELESS SENSOR NETWORK TO ASSESS HUMAN-INDUCED LOADING FROM AGRICULTURAL AREAS

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In the present study, we utilize Wireless Sensor Network (WSN) to locate and assess heavy rain events and their responses in river and ditch waters in terms of discharge, nitrate content and turbidity. A watershed-scale (2000 km2) Wireless Sensor Network, "SoilWeather" is currently located in the Karjaanjoki river basin in Southern Finland and consists of ca. 70 measurement nodes that provide high-frequency measurements on local weather parameters, soil moisture, water discharge, turbidity and nitrate content. The network was jointly set up by MTT AgriFood Research Finland, the Finnish Environmental Institute and the Finnish Meteorological Institute during 2007-2008 and it is a part of Finnish long-term socio-ecological research network FinLTSER.

This study utilises the network to assess loading from agricultural fields. We monitor water turbidity, nitrate content and discharge on stream and ditch locations and study selected loading events that are following heavy rainfall. Together with other spatial data, the observed load responses from each sub-area are then related to the magnitude of each rainfall event causing it. With this procedure, we both acquire knowledge on the loading phenomenon and obtain information on how susceptible each of the sub-areas are to leaching of nutrients, at the time of the experienced rainfall.

In Finland, agriculture is the most significant anthropogenic source of nutrients to water systems. Farmers have an active role as owners and managers of land area in the watershed. The magnitude of the nutrient loading from fields depends to a large extent on farmers' decisions. It is in the farmer's interests to keep nutrients in the soil available for growing crops, not to let them leach out and harm natural water systems. Actionable information is needed to support better management decisions and also to target water protection efforts on watershed level.

Characteristics of the load response differ according to the watershed area and its location within the stream network. Smaller areas, especially those in agricultural use, tend to give flashier responses both in water discharge and in concentrations of nitrate and suspended solids. Due to the rapid nature of loading phenomena, we assess the loading dynamics using 15 min to 1 hour measurement intervals. In this study, we combine automatic monitoring of water discharge, nitrate content and turbidity in the river network with intensive agrometeorological monitoring in the surrounding area.

Our results show that a significant amount of annual loading is entering the water system during peak hours, when both the flow and nutrient concentrations are highly elevated from their normal level. Preparation for these events is thus an important aspect for a farmer. As an example, during one full year of continuous monitoring on one of our sub-basins, the worst 35 hours accounted for more than 10 % of the yearly loading of nitrate. These load events were induced by snowmelt or heavy rain. The intensity of the load events varied significantly in different parts of the watershed, indicating heterogeneity in the area.

Preferably the water quality monitoring information should be available in such a way that it gives feedback to the farmer's management efforts and identifies areas that are susceptible to leaching. Also, it would be important to be able to separate anthropogenic effects from e.g. effects of changing weather conditions. These expectations are hard to meet, but with our work we hope to get closer to these goals. Dealing with spatio-temporal sensor data is challenging, but can provide new insights on the dynamics of nutrient loading events.

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