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Dynamics in surface water solute concentrations and consequences for water quality monitoring

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For the evaluation of action programs to reduce surface water pollution, water authorities invest heavily in water quality monitoring. However, sampling frequencies are generally insufficient to capture the dynamical behavior of solute concentrations. This results in large uncertainties in the estimates of loads and average concentrations, which complicates water quality assessments.

The main causes of dynamics in groundwater and surface water quality are variations in human land management, biochemical processes, and meteorological conditions. In this study, we focused on the short-term variations in water quality that are normally not captured with common monthly measurement intervals. Our multi-scale experimental research setup in The Netherlands revealed that weather induced variations are the major cause of short-term variations in water quality. During rainfall events, the relative contribution of different flow routes (groundwater, tile drain, overland flow) to the total surface water discharge changes. These different flow routes have different residence times in the subsurface and therefore different chemical compositions. For example, our continuous nitrate concentration measurements repetitively showed a lowering in stream water nitrate concentrations in response to rainfall events. This lowering was caused by a temporal dilution of nitrate-rich tile drain effluent with nitrate-poor rainwater. On the other hand, the continuously measured phosphorus concentrations peaked during rainfall events due to the resuspension of phosphorus-rich sediments.

We will also present the following options to deal with the highly dynamic behavior of solute concentrations in surface water quality monitoring practice: (1) use modern equipment for continuous concentration measurements, (2) measure average concentrations using passive samplers, and (3) use the explanatory strength of generally available high-frequency data (e.g. precipitation and discharge records) to reconstruct concentration patterns between low-frequency concentration measurements.