Biogeochemical impacts of windthrow disturbances in a mountainous Austrian karst system

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Kart systems contribute around 50% to Austria’s drinking water supply. In 2007 and 2008 Middle Europe was hit by a series of storms that caused major windthrows. This resulted in significant mobilisation of organic matter and a change of water quality. In this study, we consider the time period of before and during the wind disturbance period to identify impacts on DIN (dissolved inorganic nitrogen) and DOC (dissolved organic carbon) with a process based simulation model.

**STUDY SITE**

The study site UER Zölboden is located in the northern part of the national park “Northern Lime-stone Alps”. Its altitude ranges from 550 m to 956 m ASL. Due to the dominating dolomite, the catchment is not as heavily karstified as limestone karst systems, but shows typical karst features such as conduits and sink holes.

**IMPACT OF DISTURBANCE**

Around 5-10 % of the study site has been subject to windthrow.

There is a positive correlation between concentrations and discharge. But there is no change in interannual variability of DOC concentrations before and during the disturbance.

There is no obvious relation between discharge and DIN concentrations. But they show a clear increase during the disturbance period.

**MOBILISATION OF DIN**

The individual components indicate a significant deviation of simulated DIN concentrations during the disturbance period. Variability a) and bias b) are under-estimated, while correlation c) is lower than during the calibration and validation period.

A connection of the DIN production parameters in the model during the disturbance period improved the DIN simulation performance. They indicate an overall increase of DIN production, a decrease of production variability, and a shift of production seasonality for the time period May 2007 - Sep 2011.

The deviations between simulated and observed DIN concentrations indicate an additional release of 11.9 kg ha⁻¹ of DIN over the whole period of ~5.5 years, or 2.2 kg ha⁻¹. Considering an average release of 5.2 kg ha⁻¹ the impact of the storm resulted in an increase of 50% in DIN.

**SYNTHESIS**

Our simple modeling approach enabled us to assess the impact windthrow disturbances at an Austrian karst system. Disregarding the damaging processes our simulation model could be used as a base-line for the undisturbed system allowing for quantification of DIN mobilisation. A correction of the model parameters to improve the simulations during the disturbance period additionally revealed changes in the production dynamics of DIN.

Overall, our study shows that windthrow disturbances of ≤10% can produce massive mobilisation of DIN of ≥50%.