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Fate of organic contaminants in a boreal forest catchment

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The aim of the study was to investigate and predict the impact of hydrological and atmospheric processes on the mobilisation of contaminants in a remote catchment where the major input is related to diffuse pollution. The project included priory substances according to the European water framework directive (WFD), such as the persistent organic pollutants (POPs) HCB, PCBs and dioxins. The study was conducted at a well-characterised catchment system in northern Sweden dominated by two landscape types: forest and mire.

Chemical analyses of POPs in forest soil and mire peat at various depths were performed. Evaluation of POP composition by principal component analysis (PCA) showed distinct differences between surface and deeper samples. This was attributed to vertical transport, degradation and/or shifting sources over time. The calculated net vertical transport differed between surface (0.3% of the pollutant reservoir) and deeper soils (8.0 %), suggesting that vertical transport conditions and processes differ in the deeper layers compared to the surface layers.The fate of POPs in soils and waters was explored through the development of a chemical fate model. The northerly location of the studied catchment enabled a study on the impact of spring snow melt and associated hydrological processes on contaminant mobilization. Input was based on bulk atmospheric deposition and was dominated by accumulation in the winter snowpack. The model considered air-soil exchange and accumulation in forest and mire soil as well as export of dissolved and particle-bound POPs from soil to catchment surface water. The predicted export of POPs to catchment surface waters was up to 40 times higher the during snow melt period (three week during April/May) compared to the snow covered period (approximately 4 months), highlighting the importance of the seasonal snow pack as a source of these chemicals. Release from soils was governed by the POP concentration in soil, the fraction of soil organic carbon and soil-water dissolved organic carbon (DOC) content. Significant differences in export of POPs were apparent between the forested and mire areas, and this could be linked to observed differences in hydrology, biogeochemistry and flux of DOC. Levels of POPs in surface water along the water path from the studied catchment to the Baltic Sea (the Gulf of Bothnia subbasin) were measured and the results showed that for this water system, atmospherically derived diffuse pollution has impact on the surface water quality in addition to downstream point sources.

In conclusion, it is evident that a full understanding of the baseline contribution and the soil-to-water processes controlling the transport of priority substances at catchment scale is a prerequisite for assessing the variation of priority substances in water streams and river basins on a seasonal and regional scale. It is also clear that mobilization of headwater atmospherically derived diffuse pollution may have an impact on stream water quality in addition to downstream point sources. The above findings are applicable to a wide variety of north European catchments systems and provide an integrated and process-based understanding of base-line contamination of major catchments. The presented data highlight the findings from the PERSPEC project, which was possible under the umbrella of the European Commission's 6th Framework Programme project SNOWMAN (contract no ERAC-CT-2003-003219).