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Over-parameterization: Destiny or choice for distributed, physically-based water quality models?

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There seems to be an implicit view among modelers that 'physically-based' water quality models require many parameters due to their nature. Here we exemplify how over-parameterization can be avoided without much compromise on the representation of physical processes when modeling stream water quality in a boreal forest catchment. Our approach is based on the realization that stream water quality is not simply the sum of the contributions from different landscape elements and takes hydrological connectivity into account. When accounting for hydrological connectivity in boreal areas with forested till soils, wetlands and riparian zones emerge as hot spots that almost completely buffer the chemical signal from any more distant hydrological unit. Our choice to exclude less important processes from hydrologically disconnected locations lead to the development of the parameter-parsimonious but physically-based Riparian flow-concentration Integration Model (RIM). Linking RIM with topography-based pedotransfer functions allows spatio-temporal simulations of variable stream water quality at the catchment scale. More importantly, however, RIM could be used for hypothesis testing, which is often hardly feasible when using water quality models with many parameters and degrees of freedom.