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Structured landscapes formed by competition between forest, peat forming wetlands, and rivers.

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Fresh water is crucial for society and ecosystems. However, our ability to secure fresh water resources under climatic and anthropogenic change is impaired by the complexity of interactions between human society, ecosystems, soils, and topography. These interactions cause landscape properties to co-evolve, continuously changing the flow paths of water through the landscape. Such co-evolution driven flow path changes are, to-date, poorly understood. In this presentation we investigate hydrological interactions and feedbacks within a boreal landscape with forests, peat forming wetlands and rivers during the holocene.

We introduce a spatially distributed landscape co-evolution model that simulates interactions between vegetation, soil organic matter, groundwater and rivers under a wide range of climates. Typical interactions of this model are that a denser vegetation (forest) evaporates more than the low biomass vegetation of a wetland, making the forest dryer and the wetland wetter. Wet conditions favour peat formation with a high water content that further reduces groundwater fluctuations, making the landscape even more wet. At the same time these wet condition cause runoff creating incising rivers that drain the peat and favour tree growth. To understand how positive and stabilizing feedbacks within the model structure form complex landscape patterns of forests, peat forming wetlands and rivers, we stepwise increase spatial connectivity within the model. This setup allows us to untangle the effects of climate, groundwater flow and stream erosion on landscape patterns and better understand observed landscape patterns.