Modelling the impacts of climate change and land-use change on the hydrology of Vietnam's river basins

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Quantifying how land-use change affects hydrological components is a challenge in hydrological science. It is not yet clear how changes in land use relate to runoff extremes and why some catchments are more sensitive to land-use change than others. Identifying which areas are hydrologically more sensitive to land-use change can lead to better land-use planning, reduction of the impacts of extreme rainfall events and extended dry periods. In this study we aim to quantify how land-use change and climate change are affecting the hydrological response of Vietnam's basins. Over the past decades the country's land use has shifted from forest to agriculture, with very high production of rice, coffee, tea, pepper and sugar cane.

We combine the historical, the Intergovernmental Panel on Climate Change's (IPCC) Representative Concentration Pathway (RCP) RCP4.5 and RCP8.5 climate change scenarios developed for Vietnam, with two different land cover maps (from the years 1992 and 2017). The combined and separate effect of land use and climate change are assessed and the most sensitive to change areas are identified. The Variable infiltration Capacity (VIC) surface water and energy balance model applied here is a grid-based model that calculates evapotranspiration, runoff, base flow, soil moisture and other hydrological fluxes. Surface heterogeneity within VIC is represented by a tiled approach, whereby the surface of each grid-box comprises fractions of the different surface types. For each surface type of the grid-box, the energy and water balances are solved, and a weighted average is calculated from the individual surface fluxes for each grid-box. Hydrological fluxes were compared for each grid cell and basin to analyse the degree of difference between the scenarios.

Significant changes in future hydrologic fluxes arise under both climate change scenarios pointing towards a severe increase in hydrological extremes. The changes in all the examined hydrological components are greater in the combined land-use and climate change experiments.