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Hydrological response to forest disturbance under a changing climate in experimental headwater basins, Central Sumava Mountains

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In forested basins, forest disturbance and climatic variability are commonly recognized as two major drivers of hydrological regimes changes. Vydra's mountainous headwater basin in the Czech Republic, which is selected as study area, has undergone simultaneously an increase in temperature and extensive forest disturbance mainly resulting from bark beetle outbreak. The study area consists of 8 small experimental sub-basins of size around 3-5 km2. Water stages have been monitored in 10-min interval since 2005. Data on precipitation, air temperature, radiation, air humidity, wind speed and direction exist at 10-minute interval, in 4 stations since 2009. Different sub-basins are covered by different types of physiographic conditions, land cover and varying intensity and nature of forest disturbance.

A paired basin methodology was used to study the effect of land cover change on the runoff regime. In the studied basins, the cumulative effects of the changing climate and the extensive forest decay are reflected in the observed discharge data in terms of the seasonal shift in peak flow and low flow magnitude, frequency, and duration by statistical methods.

From the basin comparison, we could identify which factors determine the differences in hydrological regimes adjustment. Two main conclusions can be drawn: 1) forest disturbance largely changes the interception and transpiration, and 2) paired basins method is able to trade time for space in understanding the process of forest degradation and regeneration, especially in the growing season. In winter the hydrological regime shifts were mainly driven by climate variability.

Subsequently, we used this knowledge in hydrological models and tested our hypothesis by stepwise modelling. We assume that the topography and land cover have great influence on the hydrological regime under different climate conditions. Thus, we test the split-sample validation as well as model transferability within the framework of the FLEX-Topo modelling approach. Furthermore, hydrological models enable us to separate and quantify the two major drivers, based on the predicted hydrological regime shift under different climate and forest disturbance conditions.

Key words: Vydra basin, FLEX-Topo model, forest disturbance, climate change