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Climate change and forest disturbance effect on runoff response in montane basin. Case study - Vydra basin, Sumava Mountains

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Climate change, along with the changes in land use, is one of the key factors driving the changes in hydrological regimes and runoff response in basins. In montane regions, the long-term, as well as abrupt changes may result in significant shifts in runoff regime, especially in relation to extreme runoff events. This study aims to discuss the effect of two key driving forces - climate change and extensive forest disturbance in montane mid-latitude environment. The study area of the Vydra basin is located in the headwater regions of the Sumava Mountains at the border between the Czech Republic and Germany, Central Europe. The study area has undergone an Increase in yearly temperature and extensive forest disturbance resulting from windstorms, consequent bark beetle outbreak and clear-cutting for forest management simultaneously.

Various data sources were used for the analyses in this study. The global climate model CM2 was used for reanalysis of historical time series of temperatures since 1871. Selected climate change scenarios of the same model were used for identifying the prospective changes in trends and seasonality of climate parameters. Statistical techniques based on measured data from both spatial and temporal resolutions in the study area were used to detect the co-relationship between hydrologic and meteorological variables for testing the homogeneity of data and identifying the points of change.
Furthermore, the daily discharge and precipitation monitored by CHMI at the outlet of the basin were used to analyze various aspects of runoff change. There was an assessed rainfall-runoff relation, runoff variability, changes in seasonal runoff distribution and changes in frequency and seasonality of peak flows.

The identified extent and timing of changes are notable and they can be attributed to the cumulative effects of two key driving forces: climate change and forest disturbance, both affecting runoff in the study area. The impact of the two drivers on runoff dynamics and balance is apparently different in time and space. The period of upwards trend in annual temperature have been detected in the basin's observed data since 1980s as well as in regional data resulting from the global 20th century climate reanalysis. The rising temperatures as well as the changing climate seasonality, derived from the global climate model for the study area are identically reflected in the observed discharge data in terms of the seasonality shifts in peak flow's magnitude, frequency and durations.

Moreover, the detected changes in runoff variability, including the CUSUM differences of daily discharge, deciles deviation and intra-annual monthly runoff variability all reported that the turn point of rising variability coincided with the period of most extensive forest decay. However, the cumulative effects of the two factors are difficult to separate in this study as they act almost in the same time period and in some aspects have contradictory effects and offsetting effect on runoff.

Keywords: climate change, forest disturbance, runoff dynamics, montane basin, headwater, Vydra basin