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# Climate change impacts on water balance in the Romanian Carpathians: more droughts but fewer floods?

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The understanding of the impacts of climate change upon hydrological systems and water balance remains a fundamental challenge for research in the environmental sciences not least because of the need to forecast the propagation of possible climate change and variability into the domains of critical importance for both ecosystems and human society (e.g. water supply, flood risk). This is particularly important in temperate mountainous regions where climate scenarios suggest significant possible changes in temperature. Even given the relatively high uncertainties regarding precipitation changes, warming effects can significantly change mountain hydrology such as through the partition of rainfall between liquid and snow and evapotranspiration. Further, strong orographic forcing and poorly-developed soil-vegetation systems can lead to the strong amplification of the impacts of climatic variability on the hydrological system. This paper is set within this context and has as a general objective the analysis of the temporal variability of the main climatic parameters and their coupling to hydrological response and water balance in the Romanian Carpathians, specifically focusing on the Bucegi Mountains (maximum altitude: 2505 m a.s.l.; c. 400 sq.km), a region that has been much less studied as compared with other European temperate mountain environments. The project uses two approaches: (1) detailed analysis of climatic and hydrological records for 1961 to 2007 (e.g. temperature, precipitation, wind, sunshine duration, air moisture, thickness of the snow layer, river discharge); and (2) mathematical modelling using WaSIM-ETH to provide higher temporal and spatial resolution predictions of river flow but also the parameters responsible for driving changes in river flow. The analysis of data shows a strong coupling between temperature and precipitation variability and river flow response, superimposed upon both rising temperatures and declining precipitation. However, the critical variable appears to be a temperature driven hydrological response, where a general shift in the solid precipitation to liquid form earlier in spring and even into the late winter, significantly reduces cumulative snow depths, and leads to substantially lower summer river flows, regardless of rainfall changes. Concurrently, the reduced stock of snow in spring and early summer reduces the probability that a warm spring-summer rain event can combine synergistically with snow-melt to create higher flood flows. The net result is an increase in the risk of summer drought conditions but a reduction in the risk of late spring and early summer flood conditions.