Geophysical Research Abstracts
Vol. 21, EGU2019-9879, 2019
EGU General Assembly 2019

Modelling the impact of changes in seasonal snowpack on annual runoff and summer low flows

Michal Jenicek (1) and Ondrej Ledvinka (2)

(1) Charles University, Department of Physical Geography and Geoecology, Prague, Czech Republic (michal.jenicek@natur.cuni.cz), (2) Czech Hydrometeorological Institute, Prague, Czech Republic (ledvinka@chmi.cz)

Mountain catchments are largely influenced by snow, but it is expected that an increasing proportion of the precipitation will fall as rain in the future. Consequently, snow storage is expected to decrease, which, together with changes in snowmelt rates and timing, will cause changes in spring and summer runoff, mainly low flows and thus water availability. The objectives of this study were 1) to simulate the effect of changing snow storage on spring and summer runoff, mainly summer low flows and 2) to relate drought sensitivity to the inter-annual variations in snow storages at different elevations. The consideration of different elevations is crucial as snow storage and its potential change due to climate changes is highly variable with elevation. A bucket-type catchment model, HBV (in its version HBV-light), was applied to 60 mountain catchments in Czechia to simulate snow storage and streamflow in the period 1980–2014. The model performance was evaluated against observed daily runoff and snow water equivalent (SWE) using three objective functions. We also performed hypothetical simulations, which allowed us to analyze the effect of inter-annual variation in snow storage on seasonal low flows and annual runoff separately from other water balance components. This was done in the HBV snow routine using the threshold temperature TT that differentiates between snow and rain and sets the air temperature of snowmelt onset. By changing the TT, we can control the amount of accumulated snow and snowmelt timing, while other variables remain unaffected.
The results showed that about 30% of the total runoff in our selected study catchments originates as snowmelt, despite the fact that only 24% of the precipitation is falling as snow. This means that snow is more effective to generate catchment runoff compared to liquid precipitation. This was proved also by modelling experiment which showed that total annual runoff decreases in the case of precipitation shift from snow to rain even in the case where the total amount of precipitation and evaporation remains unchanged. In general, snow-poor years are clearly characterized by a lower ratio of snow runoff to total runoff compared to snow-rich years in the analyzed period. Additionally, snowmelt started earlier in these snow-poor years and influenced total runoff for shorter period compared to the snow-rich years. Differences between individual catchments are strongly related to catchment elevation. Inter-annual variations in snow storages also affected summer baseflow, which is, besides snow, related to summer precipitation. For most of the catchments, the lowest summer baseflow was reached in years with both relatively low summer precipitation and snow storage. This showed that summer low flows (directly related to baseflow) are not only the function of low summer precipitation, but they are strongly affected by previous winter snowpack. This effect might intensify the summer low flows in the future when generally less snow is expected.