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Analysis of snowpack variability in mountain catchments: Assessing the role of vegetation and topography

Michal Jeníček, Hana Pevná, and Ondřej Matějka

Charles University in Prague, Faculty of Science, Department of Physical Geography and Geoecology, Prague, Czech Republic (michal.jenicek@natur.cuni.cz)

The knowledge of water volume stored in the snowpack and its spatial distribution in the basin is important for many hydrological applications. Such information is useful for hydrological forecast and reservoir management and it is often used for calibration of snowmelt runoff models. The research situated into small mountain catchments in the Czech Republic is focused on 1) assessing the role of vegetation and topography on snow accumulation and snowmelt and 2) calibration of snow accumulation and snowmelt models and performing impact simulations in the changing environment. We are focusing mainly on the impact of areal forest change and change of the forest structure on runoff. Coniferous forests were damaged by the bark beetle in some parts of the study area. Forest changes are still in progress and they have a significant impact on runoff at the local scale.

Automatic and field measurements of the snow depth and snow water equivalent (SWE) have been caring out at specific localities since 2008. We performed hemispherical photographs using fish-eye camera in order to quantify different forest structure. Based on photographs and digital terrain model we calculated canopy openness, leaf area index (LAI) and potential amount of shortwave radiation for each locality. Data were assessed using both simple statistical analysis and multiple regression and cluster analysis in order to describe the differences in snow accumulation and snowmelt. The correlation of SWE with canopy characteristics, elevation, aspect and slope was tested. Canopy openness and topography characteristics show a significant correlation with the SWE in the study area both during snow accumulation and snowmelt period.

Melt factors were calculated for different vegetation types based on data measured during various snow accumulation and snowmelt conditions. Together with data obtained from hemispherical photographs it enable us to set up a simple snow accumulation and snowmelt model based on degree-day approach including solar radiation and interception components. The model was calibrated and validated based on measured data and it was used for SWE simulation in different vegetation.

The main findings of the research showed the differences of the snow depth and SWE distribution in different types of forest and in open areas due to interception and different amount of solar radiation. A suitable set of independent variables is crucial for the calculation of the snowpack distribution. However, the set may differ from basin to basin depending on local climate and topography. Our results showed that the variable set may differ also within one winter period due to the increasing role of vegetation and aspect during snowmelt.