Contribution of MODIS Derived Snow Cover Satellite Data into Artificial Neural Network for Streamflow Estimation

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Contribution of snowmelt and correspondingly snow observations are highly important in mountainous basins for modelers who deal with conceptual, physical or soft computing models in terms of effective water resources management. Long term archived continuous data are needed for appropriate training and testing of data driven approaches like artificial neural networks (ANN). Data is scarce at the upper elevations due to the difficulty of installing sufficient automated SNOTEL stations; thus in literatures many attempts are made on the rainfall dominated basins for streamflow estimation studies. On the other hand, optical satellites can easily detect snow because of its high reflectance property. MODIS (Moderate Resolution Imaging Spectroradiometer) satellite that has two platforms (Terra and Aqua) provides daily and 8-daily snow images for different time periods since 2000, therefore snow cover data (SCA) may be useful as an input layer for ANN applications. In this study, a multi-layer perceptron (MLP) model is trained and tested with precipitation, temperature, radiation, previous day discharges as well as MODIS daily SCA data. The weights and biases are optimized with fastest and robust Levenberg-Marquardt backpropagation algorithm. MODIS snow cover images are removed from cloud coverage using certain filtering techniques. The Upper Euphrates River Basin in eastern part of Turkey (10 250 km2) is selected as the application area since it is fed by snowmelt approximately 2/3 of total annual volume during spring and early summer. Several input models and ANN structures are investigated to see the effect of the contributions using 10 years of data (2001-2010) for training and validation. The accuracy of the streamflow estimations is checked with statistical criteria (coefficient of determination, Nash-Sutcliffe model efficiency, root mean square error, mean absolute error) and the results seem to improve when SCA data is introduced. Furthermore, a forecast study is conducted with Mesoscale Model 5 (MM5) numerical weather prediction data for 2011. Preliminary results of ANN streamflow estimation are promising for short-term operational use in snow-dominated basins.

Keywords: Artificial Neural Network; Snow; MODIS; Streamflow Estimation; Turkey