Geophysical Research Abstracts
Vol. 14, EGU2012-8226, 2012
EGU General Assembly 2012

Temporal Analysis of Snow Cover Depletion in the Eastern Part of Turkey Based on MODIS-Terra and Temperature Data

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Snow cover is an important feature of mountainous regions. Depending on latitude, the higher altitudes are completely covered by snow for several months in a year. Snow cover is also an important factor for optimum use of water in energy production, flood control, irrigation and reservoir operation optimization, as well as ski tourism. Snow cover depletion curve (SDC) is one of the important variables in snow hydrological applications, and these curves are very much required for snowmelt runoff modeling in a snow-fed catchment. In this study it is aimed to monitor the temporal changes in the snow cover depletion in Upper-Euphrates basin for the period of 2000-2011. Snow mapping was performed by reclassifying the fractional snow cover areas obtained from MODIS-Terra (MOD09GA) data by the algorithm derived for the region. An automatic approach was developed in deriving the snow cover depletion curves. Maximum snow cover occurs in winter months in Upper-Euphrates basin and the amount of maximum snow cover is between 80-90 % of the total area. Approximately 45% of the area is covered with snow in the autumn, the melting occurs in spring and 15% of the area is covered with snow during spring months. At the beginning of April there exists snow generally above 1900 m in the basin, at the lower elevations snow does not stay after the end of February. The previous studies indicate warming trends for the basin's temperatures. Statistically insignificant decreasing trends in precipitation in the basin except autumn season for the period of 1975-2008 were obtained. The major melting period in this basin starts in early April, but in the last three years a shift in snow melting time was detected. When sufficient satellite data are not available due to cloud cover or due to some other reasons, then SDC can be generated using temperature data. Mean cloud coverage for the melting period was obtained as 82% from MODIS-Terra images in the basin. Under changed climate conditions also, modified SDC is required. Therefore, to have SDC under such situations, a relationship between snow cover area (SCA) and cumulative mean temperature (CMAT) has been developed for five elevation zones of the catchment. Mean daily temperature data observed at five meteorological stations in the basin were used to estimate the areal mean daily temperature of the elevation zones of the basin. Mean daily temperatures observed at five meteorological stations for a total of 1800 days in the period of 2000-2011 were used in the analysis. Geographically Weighted Regression method was used in spatial distribution of temperature. Elevation was used as the spatially exhaustive covariate data in the distribution. The analysis revealed that SCA values obtained from MODIS-Terra satellite images are exponentially correlated to CMAT for the whole basin. The relationships were obtained for the period of 2000-2010 and 2011 was used for the validation. In order to generate snow covered area in a new climate to see the impact of climate change on snowmelt runoff studies, snow depletion curves with 1oC and 2oC were also generated for each zone of the basin.