Meteorological Drought Monitoring based on Satellite Rainfall Estimates: A case study on the Andean Rapel River Basin (Chile)

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Abstract

Traditionally, methods for drought monitoring are based mainly on indices derived from time series of ground-based observations alone, and then its spatial distribution is obtained by interpolation. However, developing countries are characterized by a sparse network of meteorological stations and short or incomplete historical records, in particular in mountainous regions, leading to large uncertainties in the assessment of precipitation amounts. This work presents the use of the Tropical Rainfall Measuring Mission (TRMM) Multi-satellite Precipitation Analysis product (TMPA; 3B43 v7) as a free and publicly available precipitation data source for drought monitoring in a mountainous basin of the Chilean Andes.

Monthly satellite data at a spatial resolution of 0.25ºx0.25º were downloaded for the period January 1998 to July 2014. The study area was the Rapel River Basin (33°51'-35°01' S), which is one of the most important agricultural regions in Chile, with elevations ranging from sea level to 5200 m a.s.l. First, satellite precipitation data were successfully compared against precipitation values measured at nine rain gauges. Afterwards, the standardized precipitation index (SPI) was computed for each grid cell at 1, 3, 6, 9, 12 and 24 months, which represents typical time scales for precipitation deficits affecting water resources. All the aforementioned computations were carried out with R, a free and open-source software environment for statistical analysis and graphics. The analysis correctly identified two severe droughts happened in 1998/1999 and 2007/2008. In addition, the negative values of SPI-12 and SPI-24 all over the basin for July 2014 indicate that a decreasing trend of precipitation is ongoing. In general, the SPI values were lower in the eastern part of the basin, characterized by high elevations and absence of raingauges above 1500 m a.s.l., what might lead to severe impacts on agriculture, reservoirs and groundwater levels in the region.

This work shows that TMPA 3B43 satellite rainfall estimates can be used as a "proxy" for the real-state of precipitation in the Rapel River Basin, or other regions that have a sparse distribution of rainfall measurement instruments. The proposed approach for drought monitoring has the potential to be used in support of decision making, when coping with droughts at the regional or basin scale. Moreover, this approach can be considered as a first step towards the implementation of a cost-effective drought early-warning system for Andean or other under-gauged regions in Latin America and Caribbean.