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Problems with the interpolation of precipitation amounts in mountainous catchments using traditional techniques

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Spatial distribution of precipitation is a major source of predictive uncertainty in hydrological modeling, especially in catchments characterized by a complex topography. In this case, traditional methods utilized in hydrology are most probably unable to provide reliable estimations of precipitation amounts corresponding to different elevations. However, the simplicity and ease of application of such methods maintain them as attractive alternatives for engineering practitioners. This study is intended to evaluate to what extent precipitation estimates provided by traditional methods are appropriate in the case of Andean catchments.

The catchment case study is Aconcagua River at Chacabuquito, located in the Andean region of Central Chile. This is a snowmelt dominated catchment with a surface of 2110[Km2], where approximately 5% corresponds to glaciers. Elevation ranges from 950[m.a.s.l.] to 5930[m.a.s.l.]. Most precipitation occurs between May and August, while precipitation amounts during the rest of the year are relatively low. The pluviometric network is extremely sparse. In this study, monthly data from nine precipitation stations in the period April 1965-March 2001 are used. All of these stations are located between 600[m.a.s.l.] and 3000[m.a.s.l.] and only four of them are actually within the catchment

Precipitation interpolation techniques applied in this study include multiquadratic function (MF) fitting, Thiessen Polygons (TP) and inverse distance (ID) weighting. The goodness of fit of precipitation estimates is evaluated by means of cross validation experiments. Due to the limitations existing in the spatial extent of data, these experiments only provide information about the plausibility of the precipitation estimates below 3000[m.a.s.l.], where about 62% of the catchment area is located. Results reveal that estimation errors are significant for all methods, especially during the humid season. Throughout the hydrological year, the MF method provides the most accurate precipitation estimates, both in terms of mean squared error and mean error. By contrast, the ID method obtains the largest error measures and generally underestimates precipitation in the lower zone of the catchment.

With the aim of assessing the credibility of the catchment wide spatial distribution of precipitation prescribed by these methods, average precipitation estimates corresponding to different elevation bands are calculated from a 500[m] resolution interpolation grid. In average, it was observed that the largest precipitation estimates in the higher Cordillera are obtained with the TP method, while the smallest estimations are obtained with the ID method. Furthermore, long term mean areal precipitation derived from this latter analysis is compared with the mean areal precipitation estimated by means of a long term water balance between observed discharge at the catchment outlet, evapotranspiration estimates and precipitation. It was found that the traditional methods prescribe a mean areal precipitation that is only about 50% of the estimated long term mean precipitation in the catchment.

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