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Interpolation of daily precipitation in mountain catchments with limited data availability

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Statistical properties of precipitation in mountain catchments are likely to be heterogeneous, due to the effect of orography. The interpolation of precipitation gauge data in these cases requires the application of methods that are able to account for the existence of a spatial trend in the expectation of precipitation. Most studies in this subject have used data from regions with relatively dense meteorological networks and the question of what interpolation methods can provide more reliable results in mountain catchments with limited data availability is largely unexplored. This study evaluates the applicability of the techniques kriging with external drift (KED) and optimal interpolation method (OIM) in this scenario. The Thiessen polygons (TP) method is used as a benchmark.

The study area is located in the upper Aconcagua River catchment, in Central Chile. Daily data spanning a period of ten years, from nine stations located between 640[m.a.s.l.] and 2765[m.a.s.l.], are used. Given that precipitation in the area is seasonal with respect to both precipitation amounts and their spatial dependence structure, data from each month of the year are treated separately. Aconcagua at Chacabuquito sub-catchment, with an area of 2110[Km^2] and elevation ranging from 950[m.a.s.l.] to 5930[m.a.s.l.], is used as a case study. KED and OIM incorporate the information on the spatial trend of daily precipitation differently. KED postulates that the function that defines the expectation of precipitation at each location is a linear combination of basis function of known type. Preliminary analysis revealed that a logarithmic relationship between the expectation of daily precipitation and elevation was appropriate. The application of the OIM requires prior estimation of both the expectation and the standard deviation of precipitation at the location of interest. For this purpose, logarithmic relationships between long-term mean precipitation and elevation, and between sample standard deviation and elevation, are fitted to data.

Goodness of fit is first evaluated by means of leave-one-out type cross-validation experiments. Error statistics are calculated separately for the group of five stations located in the river valley, below 1000[m.a.s.l.], and for the group located higher in the Andes. The performance of the three methods is similar in the valley stations, throughout the hydrological year. In the high Andes, the performance of OIM is notably superior to that of KED and TP. In this zone, KED outperforms TP in terms of mean errors, but the root mean squared errors obtained by both methods are similar. Yearly values of long-term mean areal precipitation over Aconcagua at Chacabuquito obtained through interpolation of daily data are compared with the estimate derived from a long-term water balance between observed discharge, evaporation and precipitation. This analysis revealed that the TP method clearly underestimates yearly areal precipitation over the catchment, as expected. Estimates obtained with KED and OIM are quite close to those derived from the long-term water balance. Overall, the results of this study indicate that OIM provides more reliable results than KED for the interpolation of daily precipitation in the study area.

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