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Interpolation of monthly precipitation in mountainous areas with limited gauge data using Universal Kriging

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Because orography can strongly affect the spatial distribution of precipitation, precipitation fields in mountainous areas are not likely to be spatially homogenous, as traditional interpolation methods used in hydrology, such as Thiessen Polygons, implicitly assume. Universal Kriging (UKr) is a geostatistical interpolation method that is able to account for the existence of an external drift, i.e. a large-scale trend in the long-term expectation of precipitation. The function m that defines precipitation expectation at each location x is supposed to be a linear combination of basis functions. The application of UKr requires a prior assumption on the nature of these basis functions, a decision that may be difficult if the precipitation network is too sparse to confidently prescribe a choice merely based on regression analysis.

This study describes the process of selection of an appropriate external drift model for the application of UKr to the interpolation of monthly precipitation in the Andes of Central Chile, a region where precipitation is strongly influenced by elevation and very limited gauge data is available. The study area is located in the Aconcagua River catchment. Monthly data from nine stations in the period April 1965-March 2001 are used. These stations are located between 640[m.a.s.l.] and 2765[m.a.s.l.] Considering that precipitation in the area is seasonal with respect to both precipitation amounts and their spatial dependence structure, as indicated by the variograms of monthly precipitation, data from each month of the year are treated separately. In order to account for the relationship between long-term mean monthly precipitation and elevation z shown by field data, the following external drift models m(z(x)) are tested: linear, parabolic and logarithmic trend models.

The goodness of fit of precipitation estimates is evaluated by means of leave one out cross validation experiments. Root mean squared error and mean error statistics are calculated separately for the group of five stations located below 1000[m.a.s.l.] and for the group containing the remaining gauges. In the case of the first group, all types of UKr interpolations have a similar performance throughout the year. In the case of the stations located above 1000[m.a.s.l], where the existence of an external drift is more evident, the advantages of using UKr with a logarithmic trend model are more obvious. In this zone, UKr with linear and parabolic trend models generally obtain root mean squared errors that are considerably larger than those obtained using a logarithmic trend. It was also observed that the application of UKr with a parabolic trend model results in a much larger bias than the other UKr interpolations in some months of the year, as revealed by the mean error statistics. Overall, results indicate that a logarithmic relationship between the expectation of monthly precipitation and elevation is the most appropriate external drift model for the application of UKr to the interpolation of monthly precipitation in the study area.

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