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Evaluation of methodologies for interpolation of data for hydrological modeling in glacierized basins with limited information

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The availability and consistency of data is a determining factor for the reliability of any hydrological model and simulated results. Unfortunately, there are many regions worldwide where data is not available in the desired quantity and quality. The Santa River basin (SRB), located within a complex topographic and climatic setting in the tropical Andes of Peru is a clear example of this challenging situation.

A monitoring network of in-situ stations in the SRB recorded series of hydro-meteorological variables which finally ceased to operate in 1999. In the following years, several researchers evaluated and completed many of these series. This database was used by multiple research and policy-oriented projects in the SRB. However, hydroclimatic information remains limited, making it difficult to perform research, especially when dealing with the assessment of current and future water resources.

In this context, here the evaluation of different methodologies to interpolate temperature and precipitation data at a monthly time step as well as ice volume data in glacierized basins with limited data is presented. The methodologies were evaluated for the Quillcay River, a tributary of the SRB, where the hydro-meteorological data is available from nearby monitoring stations since 1983. The study period was 1983 – 1999 with a validation period among 1993 – 1999.

For temperature series the aim was to extend the observed data and interpolate it. Data from Reanalysis NCEP was used to extend the observed series: 1) using a simple correlation with multiple field stations, or 2) applying the altitudinal correction proposed in previous studies. The interpolation then was applied as a function of altitude. Both methodologies provide very close results, by parsimony simple correlation is shown as a viable choice.

For precipitation series, the aim was to interpolate observed data. Two methodologies were evaluated: 1) Inverse Distance Weighting whose results underestimate the amount of precipitation in high-altitudinal zones, and 2) ordinary Kriging (OK) whose variograms were calculated with the multi-annual monthly mean precipitation applying them to the whole study period. OK leads to better results in both low and high altitudinal zones.

For ice volume, the aim was to estimate values from historical data: 1) with the GlabTop algorithm which needs digital elevation models, but these are available in an appropriate scale since 2009, 2) with a widely applied but controversially discussed glacier area-volume relation whose parameters were calibrated with results from the GlabTop model. Both methodologies provide reasonable results, but for historical data, the area-volume scaling only requires the glacial area easy to calculate from satellite images since 1986.

In conclusion, the simple correlation, the OK and the calibrated relation for ice volume showed the best ways to interpolate glacio-climatic information. However, these methods must be carefully applied and revisited for the specific situation with high complexity. This is a first step in order to identify the most appropriate methods to interpolate and extend observed data in glacierized basins with limited information. New research should be done evaluating another methodologies and meteorological data in order to improve hydrological models and water management policies.