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Effect of the precipitation interpolation method on the performance of a snowmelt runoff model

Alexandra Jacquin
Facultad de Ingeniería, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile (alexandra.jacquin@ucv.cl)

Uncertainties on the spatial distribution of precipitation seriously affect the reliability of the discharge estimates produced by watershed models. Although there is abundant research evaluating the goodness of fit of precipitation estimates obtained with different gauge interpolation methods, few studies have focused on the influence of the interpolation strategy on the response of watershed models. The relevance of this choice may be even greater in the case of mountain catchments, because of the influence of orography on precipitation. This study evaluates the effect of the precipitation interpolation method on the performance of conceptual type snowmelt runoff models. The HBV Light model version 4.0.0.2, operating at daily time steps, is used as a case study.

The model is applied in Aconcagua at Chacabuquito catchment, located in the Andes Mountains of Central Chile. The catchment's area is 2110[Km^2] and elevation ranges from 950[m.a.s.l.] to 5930[m.a.s.l.] The local meteorological network is sparse, with all precipitation gauges located below 3000[m.a.s.l.] Precipitation amounts corresponding to different elevation zones are estimated through areal averaging of precipitation fields interpolated from gauge data. Interpolation methods applied include kriging with external drift (KED), optimal interpolation method (OIM), Thiessen polygons (TP), multiquadratic functions fitting (MFF) and inverse distance weighting (IDW). Both KED and OIM are able to account for the existence of a spatial trend in the expectation of precipitation. By contrast, TP, MFF and IDW, traditional methods widely used in engineering hydrology, cannot explicitly incorporate this information. Preliminary analysis confirmed that these methods notably underestimate precipitation in the study catchment, while KED and OIM are able to reduce the bias; this analysis also revealed that OIM provides more reliable estimations than KED in this region.

Using input precipitation obtained by each method, HBV parameters are calibrated with respect to Nash-Sutcliffe efficiency. The performance of HBV in the study catchment is not satisfactory. Although volumetric errors are modest, efficiency values are lower than 70%. Discharge estimates resulting from the application of TP, MFF and IDW obtain similar model efficiencies and volumetric errors. These error statistics moderately improve if KED or OIM are used instead. Even though the quality of precipitation estimates of distinct interpolation methods is dissimilar, the results of this study show that these differences do not necessarily produce noticeable changes in HBV's model performance statistics. This situation arises because the calibration of the model parameters allows some degree of compensation of deficient areal precipitation estimates, mainly through the adjustment of model simulated evaporation and glacier melt, as revealed by the analysis of water balances. In general, even if there is a good agreement between model estimated and observed discharge, this information is not sufficient to assert that the internal hydrological processes of the catchment are properly simulated by a watershed model. Other calibration criteria should be incorporated if a more reliable representation of these processes is desired.

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