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Quantile Kriging: improving the uncertainty

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The state-of-the-art interpolation method for hydrological variables is Kriging, providing a linear estimated expectation value Z*[u] and an associated uncertainty, expressed as estimated variance σ_K^2(u), at the unknown location u. However, the spatial distribution of the uncertainty is solely depended on the spatial structure of the known locations (i.e.: gauges) and their global variance, but not on the magnitude of Z*[u]. The objective of this study is to develop a Kriging method in order to improve the associated uncertainty by relating it to Z*[u]:

As a first step, an assumed theoretical distribution (e.g.: Γ- distribution, Weibull-distribution) was fitted to the recorded monthly precipitation values from raingauges in South Africa by (1) the Method of Moments or (2) Maximum Likelihood Method. The resulting quantiles W and the distribution parameters μ and λ were subsequently interpolated to unknown locations using External Drift Kriging (EDK, drift: altitude). The expectation values of the precipitation and the corresponding uncertainty, originating from the estimated variance σ_K^2(u) of the quantiles W, were back-calculated using the 2-point Rosenblueth method.

Secondly, some modifications were introduced to the parameters: a) instead of the distribution parameters μ and λ, the sampling mean $\underline{x}$ and the sample variance σ^2 were interpolated and b) the dependent parameters were orthogonalised using a Principal Component Analysis (PCA) prior to interpolation.

Thirdly, the quantiles were transformed a) for each time step into a Beta-distribution and subsequently by a Normal-Score transformation or b) for each raingauge by a Normal-Score transformation. Both transformations are converting quantiles into a Gaussian distribution which is implicitly assumed by Kriging.

For the different modifications and transformations, a cross-validation of the expectation values and the associated uncertainties was performed and compared to the results of the “normal” EDK using directly the recorded precipitation values. The selected performance indicators (e.g. Nash-Sutcliffe, LEPS, etc.) demonstrate that Quantile Kriging shows similar performance in estimating the expectation value, but that the estimation of the associated uncertainty is clearly improved in comparison with the “normal” EDK..