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A systematic intercomparison of regional flood frequency analysis models in a simulation framework

Daniele Ganora, Francesco Laio, and Pierluigi Claps

Politecnico di Torino, Department of Environment, Land and Infrastructure Engineering, Torino, Italy (daniele.ganora@polito.it)

Regional frequency analysis (RFA) is a well-established methodology to provide an estimate of the flood frequency curve (or other discharge-related variables), based on the fundamental concept of substituting temporal information at a site (no data or short time series) by exploiting observations at other sites (spatial information). Different RFA paradigms exist, depending on the way the information is transferred to the site of interest. Despite the wide use of such methodology, a systematic comparison between these paradigms has not been performed.
The aim of this study is to provide a framework wherein carrying out the intercomparison: we thus synthetically generate data through Monte Carlo simulations for a number of (virtual) stations, following a GEV parent distribution; different scenarios can be created to represent different spatial heterogeneity patterns by manipulating the parameters of the parent distribution at each station (e.g. with a linear variation in space of the shape parameter of the GEV). A special case is the homogeneous scenario where each station record is sampled from the same parent distribution. For each scenario and each simulation, different regional models are applied to evaluate the 200-year growth factor at each station. Results are than compared to the exact growth factor of each station, which is known in our virtual world.
Considered regional approaches include: (i) a single growth curve for the whole region; (ii) a multiple-region model based on cluster analysis which search for an adequate number of homogeneous subregions; (iii) a Region-of-Influence model which defines a homogeneous subregion for each site; (iv) a spatially-smooth estimation procedure based on linear regressions.. A further benchmark model is the at-site estimate based on the analysis of the local record.
A comprehensive analysis of the results of the simulations shows that, if the scenario is homogeneous (no spatial variability), all the regional approaches have comparable performances. Moreover, as expected, regional estimates are much more reliable than the at-site estimates. If the scenario is heterogeneous, the performances of the regional models depend on the pattern of heterogeneity; in general, however, the spatially-smooth regional approach performs better than the others, and its performances improve for increasing record lengths. For heterogeneous scenarios, the at-site estimates appear to be comparably more efficient than in the homogeneous case, and in general less biased than the regional estimates.