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Statistical downscaling of climate model projections for design and adaptation of water infrastructure

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It is expected that some of the largest impacts of climate change will be through more extreme climate events, which will be crucial for the design and adaptation of water infrastructure. The problem of estimating extreme value statistics in a changing climate is challenging since statistics based on past observations cannot be directly extrapolated, and we must then rely on models. However, climate projections from global circulation models (GCM) and regional climate models (RCM) have biases and cannot adequately represent the variability in climate extremes at the spatial and temporal scales relevant for design of water infrastructure. Statistical downscaling is required to reduce uncertainties and obtain bias-corrected, high-resolution projections for climate change impact assessments at the local scale of application.

In this study an ensemble of RCM projections from the ENSEMBLES data base have been downscaled for estimation of changes in extreme precipitation characteristics and assessment of the associated uncertainties. Different statistical downscaling procedures based on a common change factor methodology have been considered. These include: (i) standard bias correction (delta-change approach), (ii) mean and variance correction, and (iii) stochastic weather generators. The downscaled data are then used to force a hydrological model for analysing the impacts of climate change on floods and droughts.

A large variability is observed in the projected extreme value statistics, which is caused by variability between the different RCMs and variability between the different statistical downscaling methods. A separation of the total variance shows that the variability related to the statistical downscaling contributes the most for extreme events. This result suggests that the choice of statistical downscaling method is crucial in impact assessments of critical water infrastructure and there is a large potential in reducing the uncertainty by statistical downscaling. On the other hand, when the emphasis is on the mean properties of rainfall, the variability of RCMs is more important, and hence in these cases a simple bias correction may be sufficient.