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Bias-correcting regional climate models for rainfall erosivity projections: How much does it matter?

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Abstract: Water-based soil erosion can have adverse impacts on agriculture, water quality, and biodiversity. It is susceptible to the effects of climate change, where direct impacts result from changes in rainfall patterns that affect the ability of rainstorms to detach soil particles and move them to other areas. The R-factor, also called rainfall erosivity, is a measure used to assess the long-term cumulative erosive power of rainfall. It is applied in the Revised Universal Soil Loss Equation (RUSLE), which is a widely used model for estimating soil erosion at a regional level.

Future projections of rainfall, typically sourced from climate models, are used in rainfall erosivity models to estimate potential climate change impacts on soil erosion. However, the simulated rainfall is not used directly because of substantial biases from both global and regional climate models. These biases are reduced using various bias correction (BC) approaches of differing complexity that target biases in different rainfall attributes (e.g., mean, variation, etc.). Despite the wide availability of approaches, majority of soil erosion studies use simple scaling, where historical time series of rainfall are multiplied by a factor. Therefore, only changes in long-term mean rainfall are captured while other important attributes (e.g. rainfall intensity / occurence) are neglected.

In this study, we evaluate the sensitivity of rainfall erosivity simulations to choice of rainfall bias-correction method. Daily rainfall across Queensland is obtained from the Queensland Future Climate science program (Syktus et al. 2020), responsible for dynamically downscaling Coupled Model Intercomparison Project Phase 6 (CMIP6) climate models. We use a 15-member ensemble and projections under the high emission scenario (SSP 3-7.0) over a 120-year period (1980–2099). In addition to the raw rainfall projections, the erosivity is derived with data bias-corrected using four approaches of increasing complexity: scaling, quantile mapping, quantile mapping with 99th percentile correction, and quantile delta mapping. The bias-correction is applied to the daily data both indiscriminately and with monthly transfer functions. Two 30-year time periods are considered, namely baseline (1981–2010) and end-century (2070–2099).

We found that all quantile-based methods had similar performance in estimating absolute rainfall erosivity over the baseline period, as long as monthly transfer functions were used to reduce biases in both rainfall intensities and seasonality. Spatial patterns of relative changes in future erosivity (and uncertainty) were broadly similar irrespective of BC method, although some differences were visible across northern Queensland. However, projected changes in erosivity and uncertainty were always greater when derived using monthly transfer functions, indicating that rainfall seasonality is an important factor. Overall, we find that the choice of climate model is more influential in projecting future erosivity than the bias-correction method.

REFERENCES

Syktus, J., Trancoso, R., Ahrens, D., Toombs, N., Wong, K., 2020. Queensland Future Climate Dashboard: Downscaled CMIP5 climate projections for Queensland. https://www.longpaddock.qld.gov.au/qld-future-climate/

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