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The implications of soil erosion model conceptualization, bias-correction methods and climate model ensembles on soil erosion projections under climate change

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Climate models project increased extreme precipitation for the coming decades, which may lead to higher soil erosion in many locations worldwide. The impact of climate change on soil erosion is most often assessed by applying a soil erosion model forced by bias-corrected climate model output. A literature review among more than 100 papers showed that many studies use different soil erosion models, bias-correction methods and climate model ensembles. In this study, we assessed how these differences affect the outcome of climate change impact assessments on soil erosion. The study was performed in two contrasting Mediterranean catchments (SE Spain), where climate change is projected to lead to a decrease in annual precipitation sum and an increase in extreme precipitation, based on the RCP8.5 emission scenario. First, we assessed the impact of soil erosion model selection using the three most widely used model concepts, i.e. a model forced by precipitation (RUSLE), a model forced by runoff (MUSLE), and a model forced by precipitation and runoff (MMF). Depending on the model, soil erosion in the study area is projected to decrease (RUSLE) or increase (MUSLE and MMF). The differences between the model projections are inherently a result of their model conceptualization, such as a decrease of soil loss due to decreased annual precipitation sum (RUSLE) and an increase of soil loss due to increased extreme precipitation and, consequently, increased runoff (MUSLE). An intermediate result is obtained with MMF, where a projected decrease in detachment by raindrop impact is counteracted by a projected increase in detachment by runoff. Second, we evaluated the implications of three bias‑correction methods, i.e. delta change, quantile mapping and scaled distribution mapping. Scaled distribution mapping best reproduces the raw climate change signal, in particular for extreme precipitation. Depending on the bias‑correction method, soil erosion is projected to decrease (delta change) or increase (quantile mapping and scaled distribution mapping). Finally, we assessed the effect of climate model ensembles on soil erosion projections. We showed that individual climate models may project opposite changes with respect to the ensemble average, hence, climate model ensembles are essential in soil erosion impact assessments to account for climate model uncertainty. We conclude that in climate change impact assessments it is important to select a soil erosion model that is forced by both precipitation and runoff, which under climate change may have a contrasting effect on soil erosion. Furthermore, the impact of climate change on soil erosion can only accurately be assessed with a bias‑correction method that best reproduces the projected climate change signal, in combination with a representative ensemble of

climate models.