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Evaluation of future climate change impacts on semi-arid Cobres basin in southern Portugal

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This study evaluated future climate change impacts on hydrological and sediment transport processes for the medium-sized (705 km2) agriculture dominated Cobres basin, Portugal, in the context of anti-desertification strategies. We used the Spatial-Temporal Neyman-Scott Rectangular Pulses (STNSRP) model—RainSim V3, a rainfall conditioned weather generator—ICAAM-WG, developed in this study but based on the modified Climate Research Unit daily weather generator (CRU-WG), and a PBSD hydrological model—SHETRAN, to downscale projections of change. Climate projections were derived from the RCM HadRM3Q0 output, provided by the ENSEMBLES project, for the SRES A1B scenario for the period 2041–2070. The RainSim V3 and ICAAM-WG models are demonstrated to be able to reproduce observed climatology for the period 1981–2010. The SHETRAN model reproduces hourly runoff with Nash-Sutcliffe Efficiency (NSE) of 0.86 for calibration (2004–2006) and 0.74 for validation (2006–2008) for basin outlet; it reproduces hourly sediment discharge with NSE of 0.48 for the storm from October 23rd 2006 to October 27th 2006.

We found that future mean climate is drier, with mean annual rainfall decreased by ∼88 mm (19%), mean annual PET increased ∼196 mm (16%) and consequent mean annual runoff and sediment yield decreased respectively ∼48 mm (50%) and 1.06 t/ha/year (45%). The future mean annual AET decreases ∼41 mm (11%), which occurs mainly in spring indicating a more water-limited future climate for vegetation and crop growth. Under current conditions, November to February is the period in which runoff and sediment yield occur frequently; however, it is reduced to December to January in future, with changes in the occurrence rate of ∼50%. On the other hand, future wet extremes are more right-skewed. Future annual maximum discharge and sediment discharge decrease for extremes with return periods (T) less than 20 years and the decreases are especially greater for those with T less than 2 years; besides, both quantities present the same or slightly lower magnitudes as those with T larger than 20 years. The annual maximum discharge (sediment discharge) series, under control climate, follows the GEV distribution with location parameter of 64.6 m3/s (164.4 kg/s), scale parameter of 46.5 m3/s (120.3 kg/s) and shape parameter of 0.09 (-0.24); under future climate, the annual maximum discharge series follows the gamma distribution with scale parameter of 75.2 m3/s and shape parameter of 0.97 and the annual maximum sediment discharge series follows the three-parameter lognormal distribution with location parameter of -46.2 kg/s, mean of 5.3 kg/s and standard deviation of 0.78.

This study has confirmed the increasing concerns of water scarcity and drought problems in southern Portugal; but it also indicated the mitigation of sediment transport for most of time in the future except heavy events. However, the results should be interpreted carefully since we did not consider possible changes of land-use in the future, as well as the climate and hydrological modelling uncertainties.