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Projections of rainfall erosivity over Italy exploiting EURO-CORDEX ensemble

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Erosion processes are caused by a combination of predisposing factors (slope, intrinsic soil properties), accelerating factors (removal of vegetation cover, altered soil properties due e.g. to fires, overgrazing, tillage) and triggering factors (water – from rain and rivers – and wind). While the first components are rather unchanging (or changing slowly) at the human time scale, the last two must deal with the consequences of global changes. Indeed, modifications in land use, land management and climate have strong feedbacks so that, from one side, lands are more and more overexploited, degraded and exposed to erosion and, on the other side, over these lands, the frequency, magnitude, duration and timing of triggering events could deviate from their “normal” conditions.

According to the well-known RUSLE soil loss estimation model, the triggering effect of rainfall for sheet and rill erosion is accounted for by means of the so-called rainfall erosivity or “R-factor”. R-factor consists of the annual summation of the erosive power of relevant storm events, averaged over a significant period of observation. For each storm event, computation of R-factors requires high-resolution rainfall information for the evaluation of the maximum rainfall intensity occurring over a time window of 30 min during the rainfall event. Due to the generally limited access to sub-hourly precipitation observations, a number of empirical models relating R-factor to easily accessible climate, physical and geographical covariates, such as rainfall data at coarse aggregation levels, have been developed for different areas of the world.

As concerns Italy, a novel empirical model is proposed relating rainfall erosivity to cumulative precipitation, elevation and latitude. Such model, calibrated for a significant selection of relevant rain gauges with available sub-hourly data, showed a good accordance with observations and a large amount of explained variance at the annual scale, with promising results also at the monthly level. The model was effectively extended to cover the whole Italian Country for the period 1981-2010 by means of gridded rainfall datasets retrievable in the Copernicus Climate Change Service (C3S) Climate Data Store (CDS), with limited performance loss, exploring the feasibility of Copernicus products for erosion-related assessments. Although affected by limitations, the proposed model is particularly suitable for applications involving future rainfall projections since it

explicitly accounts for monthly cumulative precipitation as the only climate covariate, differently for other proposed methodologies also including rainfall-related variables with higher temporal resolution, whose future trends cannot be robustly evaluated with current climate modelling tools. In the present research an ensemble of twelve future rainfall projections included in the Euro-Cordex initiative, bias-adjusted by means of the ERA5-Land reanalysis dataset, is considered to account for the uncertainties coming from the use of multiple projections. The proposed approach provides a unique example of rainfall erosivity dataset accounting for a wide ensemble of bias-adjusted rainfall projections resulting from different General Circulation Models/Regional Climate Models coupling, for multiple Representative Concentration Pathway scenarios (RCP 2.6, RCP 4.5 and RCP 8.5) and different future horizons (near, 2021-2050, and far, 2051-2080, future).