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Seasonal dynamic of marls sediments illustrated by field records on hillslopes properties, Draix-Bléone CZO, SE France.

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Sparsely vegetated, badlands are loci of intense erosion that is sufficiently rapid to have observable effects on human timescales and is partly controlled by climate. Characterizing and understanding the physical weathering processes in these areas are key to predict the temporal variability of regolith production and sediment flux, as well as their evolution under changing climate conditions.

Here, we study intra-annual changes of hillslopes properties and explore the relationship between production and transport of sediments in steep marly badland catchments of the Draix-Bléone Critical Zone Observatory (SE France), where decades-long monitoring records show rapid morphologic changes. Remote-sensing imagery has recorded the seasonal dynamics of these badlands, but characterization and quantification of physical weathering processes have been lacking up to now. We explore this gap by monitoring key regolith parameters including grain size distribution (GSD), surface resistance, and water content in the regolith layer (surface to 10 cm depth) at different locations, through repeated field surveys over a 2-year period. While water content appears to be directly controlled by the last previous rainfall event, GSD and resistance show a similar cyclic annual pattern, with a maximum at the end of summer and a minimum during winter. Principal component analysis (PCA) highlights the strong correlation between resistivity and GSD (characterized by D50). However, resistance is also partly controlled by water content. We therefore suggest that D50 provides the best proxy of regolith weathering in these marls; this is supported by vertical GSD profiles that show an exponential decrease of D50 toward the surface, resembling the theoretical profile of weathering intensity (e.g., Heimsath et al., Nature, 1997). The cyclic annual pattern in observed D50 suggests that loose and finaly fragmented regolith is mainly produced and accumulates during the winter season, whereas sediment transport is dominant during spring-autumn, reducing regolith thickness and inducing a coarsening of hillslope surface material. These observations thus support a model in which frost-cracking is the main process controlling sediment production in these catchments (Ariagno et al., ESurf, 2022). These results also corroborate the strong annual dynamics of these catchments, where hillslopes and gullies are drained during spring and early summer high-intensity precipitation events, inducing high sediment yields.

We use these quantitative observations to develop and calibrate a landscape-evolution model at

(sub-) annual timescales. We aim to use this model to (1) reproduce sediment dynamics in badland catchments and (2) improve predictive models of sediment export from such catchments under a changing climate.