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Effects of burrowing animals on soil erosion for Chile derived with a fully parameterized erosion model based on in-situ measurements, remote sensing and machine learning

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To date, hillslope-wide effects of burrowing animals on soil erosion, infiltration, surface runoff, water storage and field capacity are hardly understood. Consequently, the effects of burrowing animals are not yet included in erosion models. A suitable approach considering their impacts in erosion models is lacking but needed in order to fully understand the feedbacks between biosphere and sediment fluxes.

For this presentation, we combined in-situ measurements, high resolution remote sensing data and machine-learning methods with a Daily based Morgan-Morgan-Finney soil erosion model for hillslopes along a climate gradient from arid to humid Chile. To parameterize the erosion model, we trained random forest models to upscale in-situ measured soil properties and the presence of animal burrows to each catchment using high-resolution WorldView-2 data. We conducted a land cover classification to provide the vegetation cover. ith this data, we parametrised one model per climate zone. The model was validated using in-situ installed sediment traps. Model experiments in- and excluding animal burrows were conducted to determine the daily and yearly impacts of burrowing animals on soil erosion, infiltration, surface runoff, subsurface runoff, water storage and field capacity on the burrow and hillslope scale at 0.5 m grid resolution.

The presence of burrows increased sediment erosion, infiltration and water storage and decreased surface runoff and field capacity. The effects were most pronounced on the daily and burrow scale in the semi-arid and mediterranean climate zone. In the semi-arid climate zone, the burrows heavily increased surface infiltration and subsurface runoff. In the mediterranean climate zone, the distribution of burrows had an impact on the surface runoff and increased the erosion rate in the adjusting areas without burrows. In the arid zone, the impact of burrowing animals was solely detectable during sporadically occurring heavy rains.

Our study presents, to our knowledge, for the first time a soil erosion model which includes burrowing animal activity. The results clearly underpin the general importance to consider burrowing animals in erosion modelling.