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The role of feedbacks between geomorphic and vegetation dynamics for lateral moraine slope configuration and development

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In proglacial areas, lateral moraines represent one of the most important sediment storages and dynamic areas. Glacier retreat since the Little Ice Age is accelerated by climate change and believed to control simultaneous paraglacial adjustment and vegetation succession on lateral moraine slopes. Biogeomorphic research suggests strong feedbacks between geomorphic processes, landforms, vegetation and vegetation dynamics in these environments. However, for lateral moraine slopes, these feedbacks are only partly understood. In our study, we use and develop biogeomorphic concepts in a scale-based approach to understand the role of feedbacks between geomorphic and vegetation dynamics for lateral moraine slope configuration and development. We illustrate our concepts with empirical evidences from on-going research in the Turtmann glacier forefield (Switzerland) and give first answers to the following questions: (i) Which plant species can influence geomorphic dynamics on lateral moraine slopes, and how? (ii) Under which conditions can feedbacks between geomorphic and vegetation dynamics occur? (iii) Which are the main factors influencing lateral moraine slope configuration and development?

On a small scale (i), we identify dwarf shrubs (e.g., Dryas octopetala L.) as an engineer species, which can influence geomorphic processes through their specifically adapted plant functional traits, e.g., the trapping of fine sediments in their high-cover mats. On a meso scale (ii), feedbacks between geomorphic and vegetation dynamics can occur in a 'biogeomorphic feedback window' with moderate magnitude and frequency processes, e.g., debris slides, interrill erosion, or between lower frequency processes, e.g., debris flows and snow avalanches. Under these conditions, engineer species with high resistance can establish and change the dominant geomorphic processes from flow and sliding to bound solifluction. Our empirical data shows that on a large scale (iii), vegetation and geomorphic patterns on lateral moraines do not necessarily follow a terrain age gradient. Instead, patch dynamics driven by geomorphic processes and biogeomorphic feedbacks can determine the development and spatial configuration of lateral moraine slopes, which in turn influence sediment flux in space and time (Eichel et al., in rev.).

Reference: Eichel, J.; Corenblit, D. and R. Dikau (in rev.): Feedbacks between geomorphic and vegetation dynamics on lateral moraine slopes: a conceptual biogeomorphic approach. Earth Surface Processes and Landforms.