Opinion: Using eDNA fingerprinting in high mountain environments to support soil restoration and hazard control

Amaury Frankl, O. Evrard, Elie Verleyen, Erik Cammeraat, Alexia Stokes

To cite this version:

Amaury Frankl, O. Evrard, Elie Verleyen, Erik Cammeraat, Alexia Stokes. Opinion: Using eDNA fingerprinting in high mountain environments to support soil restoration and hazard control. LASOSU2021: Online International Conference for Land Degradation, Soil Conservation and Sustainable Development, World Association of Soil and Water Conservation (WASWAC); Italian Association of Agricultural Engineering (AIa); Soil Erosion Division of CSWCS (China), Aug 2021, Dalian, China. hal-03335309

HAL Id: hal-03335309
https://hal.inrae.fr/hal-03335309
Submitted on 6 Sep 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L’archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d’enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.
Opinion: Using eDNA fingerprinting in high mountain environments to support soil restoration and hazard control

A. Frankl*1,2, O. Evrard3, E. Verleyen4, E. Cammeraat5, A. Stokes1
1 INRAE, AMAP, IRD, CIRAD, CNRS, University Montpellier, France
2 Department of Geography, Ghent University, Belgium
3 Laboratoire des Sciences du Climat et de l’Environnement (LSCE/IPSL), Unité Mixte de Recherche 8212 (CEA/CNRS/UVSQ), Université Paris-Saclay, France
4 Department of Biology, Ghent University, Belgium
5 Institute for Biodiversity and Ecosystem Dynamics, University of Amsterdam, The Netherlands
*Corresponding A. Frankl, e-mail: Amaury.Frankl@cirad.fr

Keywords: Landslides, Sediment source fingerprinting, Soil Erosion, Vegetation.

Abstract

Mitigating erosion, mass movements, and geohazards in high mountains is increasingly conceived within frameworks of ecological restoration, that is, recovering the form and function of ecosystems that have been damaged by degradation (Hubble et al. 2017). From a geomorphological point of view, ecological restoration involves both the prevention and control of slope and riverbank instabilities as well as the confinement of runoff and sediment regimes to the capacity river channels. In this regard, the practice of soil and water bioengineering is rapidly emerging as a short-term hazard control that can enable long-term ecological recovery (Rey et al. 2019). Vegetation, as a chief ecological engineer, is key to soil and water bioengineering applications. However, the application of soil and water bioengineering in high mountains is limited by severe ecological conditions, making plant establishment and ecological recovery times are slow in high mountains (Dupin et al. 2019).

While applications of sediment source fingerprinting using for example geochemical or radionuclide soil signatures yield a rough distinction between sediment sources, they cannot reflect the multiple vegetation covers that are relevant source types and should be discriminated in high mountain environments to prioritize restoration works. Vegetation may be the most distinctive feature of high mountains, where the underlying lithology is heterogeneous and soils are mainly shallow and poorly developed. Because there are strong interrelations between land cover and geomorphological processes in high mountain environments (Geertsema and Pojar 2007; Giaccone et al. 2019; Lizaga et al. 2019), the use of land cover-based sediment tracers would be particularly meaningful. eDNA has the highest source discrimination potential in that regard, providing information up to the species level and reflecting changes in vegetation on over short timescales. Furthermore, eDNA signals in sediments will be strongest from areas experiencing higher erosion rates and which are highly connected with the hydrographic network. The use of eDNA sediment source fingerprinting would thus allow the investigation of complex and often poorly understood
relationships between vegetation cover, restoration activities, and geomorphological response at the catchment scale.

To improve the success rates of restoration activities, collaboration between scientists and stakeholders can accelerate technology transfer rates (Stokes et al. 2014; Giupponi et al. 2019; Rey et al. 2019). However, time and budget constraints often hamper in-situ monitoring of soil and water bioengineering applications, and very few monitoring programs exist (Giupponi et al. 2019). Knowledge of success rates is, however, essential for restoration (Frankl et al. 2021). To this end, sediment source fingerprinting has been shown to provide a valid framework for supporting soil restoration activities (Mukundan et al. 2012). Environmental DNA has already been used to successfully monitor restoration programs, but with a focus on fungal species (Yan et al., 2018). We opinionate that eDNA fingerprinting – as an emerging technique – could be particularly useful to support soil restoration and hazard control in high mountain environments.

References


