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Assessing the contribution of natural and anthropogenic processes on sediment dynamics in the Rio Santa (Peru) through sediment fingerprinting

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The combination of a changing climate and growing population poses a contemporary challenge for the water-food-energy security nexus in mountain regions, especially in glacier-fed catchments such as the Rio Santa in the Peruvian Andes. Soil erosion due to both natural processes and anthropogenic activities can exacerbate this challenge, with increased levels of sediment in river systems endangering crucial river functions, such as crop irrigation, drinking water, and hydroelectricity. Furthermore, sediment can act as a transport pathway for contaminants, in addition to being a source of contamination itself. Previous studies have suggested that soil erosion related to human activity vastly exceeds the rate of natural soil production in many Andean catchments, where research to date has primarily focused on larger eastern catchments. Smaller western catchments, however, are important for many major Andean cities reliant upon upstream water supplies. It is thus, important to identify sediment sources and better understand sediment dynamics to manage the threats to water supply.

Sediment fingerprinting approaches are one technique that can contribute to improved understanding of sediment sources and dynamics and the impact of soil erosion in a catchment, and thus contribute to water resource management at the catchment level. Taking a distributed approach along the Rio Santa, this study aims to improve understanding of natural and anthropogenic contributions to sediment production in this Andean system. Key sediment sources explored are glacial sediment potentially enhanced by retreat, agricultural land, forestry operations, land under natural vegetation, and mining. The distributed approach permits quantification of their dynamics throughout the catchment. All source and mixture samples were analysed using Wavelength Dispersive X-ray Fluorescence (WD XRF) to develop geochemical fingerprints and the MixSIAR mixing model was used to apportion sediment sources. While sediment sampling presents a number of challenges when working in remote, mountainous regions such as the Rio Santa catchment, sediment fingerprinting has the potential to help reduce environmental degradation when used to guide local resource management decisions.