EGU22-1223
https://doi.org/10.5194/egusphere-egu22-1223
EGU General Assembly 2022

An integrated sediment export quantification approach for the sustainable management of agroecosystems

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Soil erosion and the subsequent transport of sediment and pollutants are critical challenges for guaranteeing food security and water quality. Controlling sediment and particle-bound substance export requires the implementation of improved ecological restoration schemes, especially in areas experiencing drastic increases in erosion rates. To this end, we propose the design of an ensemble technique that combines the use of sediment fingerprinting together with radionuclide dating and remote sensing data to fill these critical knowledge gaps.

This project will focus on testing and developing powerful specific land use tracers, such as Compound Specific Stable Isotopes (CSSI) and environmental DNA (eDNA), to improve the land cover discrimination of sediment provenance through the collection and dating of sediment cores in sink areas. This research will be conducted in two contrasting catchments with different land use histories allowing to test the effectiveness of this novel approach: i) the Ésera catchment that flows into the Barasona reservoir (Spain), representative of areas experiencing sediment export decrease due to land abandonment and the subsequent natural revegetation, and ii) the Kihira catchment, Lake Kivu (DR Congo), representative of intensively cultivated areas undergoing an unsustainable and increasing sediment export and nutrient loss. By combining the investigation of these two contrasted catchments and by applying state-of-the-art methods, it will be possible to evaluate the main driving factors of the past and present erosion rates and predict the effects of human management and climate change.

In this first stage of the project, representative sediment samples from different land cover sources will be collected in the Ésera catchment (1.535km^2) until its mouth into the Barasona reservoir. Several bulk cores and surface sediments collected in 1995 will be characterised and compared with samples collected in 2013 at the Barasona reservoir. An extra sampling campaign is planned for 2022 to examine the changes that occurred in recent years. Records of known flood

events and reservoir management data will be combined with ^{137}Cs chronology to ascribe the sedimentary record to specific years. Besides, a set of remote sensing and aerial photographs will be analysed to reconstruct the land use variation during the last six decades.

To track the land use apportionment variation during the last decades, geochemistry and radioisotopic activity will be analysed in both source and sediment samples and examined as possible tracers for fingerprinting modelling. The fingerprinting technique will be implemented following state-of-the-art methodologies such as the Consensus and Consistency tracer selection methods.

Thus, by combining the use of remote sensing, novel fingerprinting techniques and radiometric dating, we aim to provide a novel and powerful tool to understand the driving factors of sediment sources (e.g., deforestation, agricultural intensification and abandonment) and associated pollutants, and their variations in space and time in the last decades.