



A fingerprinting mixing model approach to generate uniformly representative solutions for distributed contributions of sediment sources in a Pyrenean drainage basin

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Spanish Pyrenean reservoirs are under pressure from high sediment yields in contributing catchments. Sediment fingerprinting approaches offer potential to quantify the contribution of different sediment sources, evaluate catchment erosion dynamics and develop management plans to tackle the reservoir siltation problems. The drainage basin of the Barasona reservoir (1509 km²), located in the Central Spanish Pyrenees, is an alpine-prealpine agro-forest basin supplying sediments to the reservoir at an annual rate of around 350 t km⁻² with implications for reservoir longevity. The climate is mountain type, wet and cold, with both Atlantic and Mediterranean influences. Steep slopes and the presence of deep and narrow gorges favour rapid runoff and large floods. The ability of geochemical fingerprint properties to discriminate between the sediment sources was investigated by conducting the nonparametric Kruskal-Wallis H-test and a stepwise discriminant function analysis (minimization of Wilk's lambda). This standard procedure selects potential fingerprinting properties as optimum composite fingerprint to characterize and discriminate between sediment sources to the reservoir. Then the contribution of each potential sediment source was assessed by applying a Monte Carlo mixing model to obtain source proportions for the Barasona reservoir sediment samples. The Monte Carlo mixing model was written in C programming language and designed to deliver a user-defined number possible solutions. A Combinatorial Principals method was used to identify the most probable solution with associated uncertainty based on source variability. The unique solution for each sample was characterized by the mean value and the standard deviation of the generated solutions and the lower goodness of fit value applied. This method is argued to guarantee a similar set of representative solutions in all unmixing cases based on likelihood of occurrence. Soil samples for the different potential sediment sources of the drainage basin were compared with samples from the reservoir using a range of different fingerprinting properties (i.e. mass activities of environmental radionuclides, elemental composition and magnetic susceptibility) analyzed in the < 63 μm sediment fraction. In this case, the 100 best results from 10⁶ generated iterations were selected obtaining a goodness of fit higher than 0.76. The preliminary results using this new data processing methodology for samples collected in the reservoir allowed us to identify cultivated fields and badlands as main potential sources of sediments to the reservoir. These findings support the appropriate use of the fingerprinting methodology in a Spanish Pyrenees basin, which will enable us to better understand the basin sediment production of the Barasona reservoir.