

## Quantitative evaluation of human and climate forcing on erosion over the last 2000 years in northern Italy

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Soil erosion is one of the main environmental threats affecting the Critical Zone (CZ) and represents an emerging concern considered as one of the geosciences/society central issues. Through time, the physical erosion is linked to both climate fluctuations and land-use. Understanding these forcing factors is key to improve our management of this resource, especially in mountainous areas where CZ erosion is highest. Only studies combining large spatial and temporal approaches allow to assess the effect of these forcing factors on soil erosion rates. Here, we apply a retrospective approach based on lake sediments to reconstruct the long-term evolution of erosion in alpine landscapes. Lake Iseo located in northern Italy acts as a natural sink for all the erosion products from a large watershed (1777 km<sup>2</sup>). This watershed is representative of the southern Italian Alps, where Holocene human activity and climate fluctuations are well known. The approach combines a source-to-sink method, using isotopic geochemistry ( $\epsilon\text{Nd}$ ,  $^{87}\text{Sr}/^{86}\text{Sr}$ ), with a multiproxy study of a lacustrine sediment section covering the last 2000 years. The applied methodology allows us to disentangle the role of climate and land use as erosion forcing factors through their differential impact on the various rock types present in the watershed. Indeed, its high-altitudinal part, the erosion of which is dominated by glacier advances and retreats, presents isotopic signature different from those of the sedimentary rocks located in the lower part of the watershed, where both human activities and precipitations impacted erosion through time. A chronicle of glacial erosion over the last 2000 years was produced. Once the climatic trend was highlighted, the signal of erosion of sedimentary rocks was investigated to understand the influence of humans. The past sediment yield inferred for sedimentary rocks exhibits the highest values at periods of intense human practices. Hence, since the late Roman Period, human activities seem to be the dominant forcing factor of the physical erosion in mountainous environment of northern Italy. This study presents the first reconstruction through time of sediment yield derived from lake sediments associated with sediment sources identification and quantitative evaluation of the erosion forcing factors.