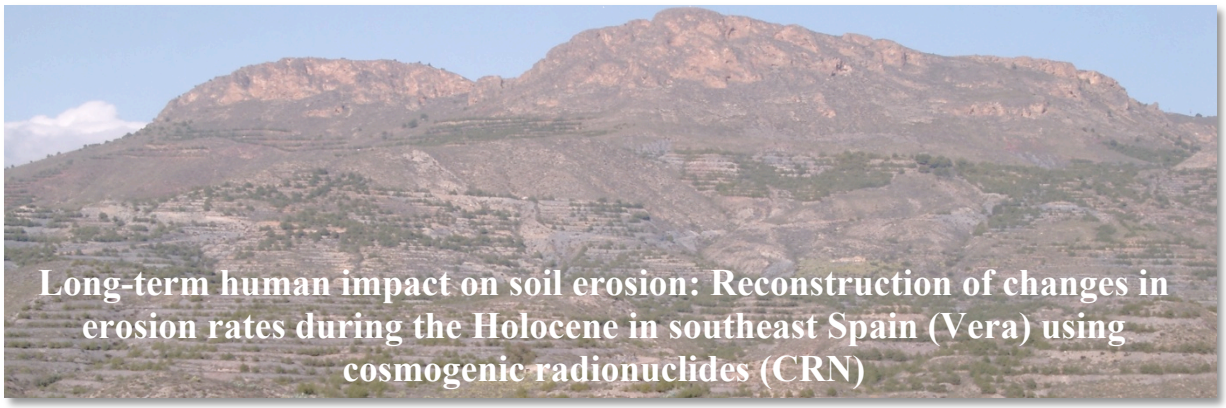

Long-term human impact on soil erosion: Reconstruction of changes in erosion rates during the Holocene in southeast Spain (Vera) using cosmogenic radionuclides (CRN)

CONTEXT

Our natural environment evolves dynamically through natural and anthropogenic processes. Environmental change has been accelerated during the last centuries due to (i) rapid increase of the population, (ii) an increasing level of consumption of natural resources, (iii) technologic innovations, and (iv) socio-economic development (Hooke, 2000). It has been reported that human activities have accelerated erosion rates by up to 100 times (Vanacker et al., 2007). Accelerated soil degradation and desertification are now considered to threaten future agricultural production.

The Mediterranean region is commonly reported as the European regions that is most affected by soil degradation. In various regions in Spain, Portugal, and Greece, about 60 % of the territory presents high risks of desertification. The degradation of Mediterranean soils has often been linked to inappropriate agricultural practices during the last decades (Martinez-Fernandez and Esteve, 2005). However, the Mediterranean region has been populated and cultivated since thousands of years by various civilizations, and the Mediterranean environment is the product of a long land use history (Blondel, 2006).

RESEARCH QUESTION

This research project aims to contribute to the understanding of the long-term impact of humans on erosion processes in the Mediterranean region. The main question that is driving this research is: '*Is the Mediterranean environment currently threatened by accelerated soil erosion following human occupation ?*

To address this research question systematically, we will work along two lines. First, long-term erosion rates for Southern Spain will be quantified based on concentrations of cosmogenic radionuclides in river sediments. Given the long occupation history of this region, we will test if these long-term erosion rates truly reflect 'natural' or 'geological' erosion processes. Secondly, the impact of humans on erosion will be analysed by comparing long-term with contemporary erosion rates. An 'erosion acceleration factor' will be calculated for Southern Spain.

METHODOLOGY

To analyse the long-term impact of humans on erosion, we selected a study area in Southern Spain (Almeria and Murcia Province). We are currently working in the Vera and Sorbas basins, located in the eastern part of the Betic ranges. The relief is quite contrasted between the Sierras and the basins. The average annual temperature is about 18 °C and the annual rainfall is about 250 mm. Three major river systems are crossing the study area: the Antas, Almanzora and Agua rivers.

We are particularly interested in the reconstruction of erosion rates in the mountain ranges, as erosion processes can be expected to be higher in these active tectonic ranges. We selected five mountain ranges for this study (the Sierra Cabrera, Sierra de Alhamilla, Sierra Almagrera, Los Filabres and Estancias, see Fig.1). These mountain ranges have had a different uplift history, and we can expect that they have different long-term erosion rates.

In total, about 20 catchments of about 10 to 50 km^2 will be selected. We aim to have a representative set of catchments that covers the spatial differences in long-term land use changes that are observed in the area. To constrain our study, we select catchments with similar climatic, geological and lithological settings.

In the 2007 field campaign, 11 catchments have already been selected and sampled (see Fig.1). Those samples have been taken carefully to be sure that the sediment collected integrates the different erosion processes in the catchment. Catchments with a high content of quartz-bearing lithologies (quartzite, gneiss, …) were preferentially sampled. All catchments have been characterized in the field, and the field information was digitised in ArcGIS.

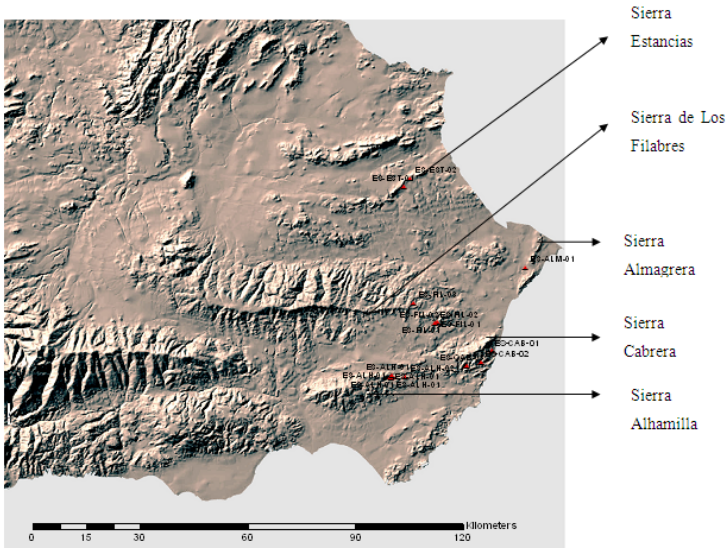

Figure 1 : Topographic map of Southeast Spain, with location of the 11 selected catchments.

Cosmogenic Radionuclides (CRNs)

Long-term erosion rates will be quantified using in-situ produced cosmogenic radionuclides (Fig.2). We are particularly interested in rare isotopes of Beryllium (10Be) and Aluminium (26Al) that are produced in-situ at the Earths surface by cosmic rays.

We will use a catchment-wide approach, and analyse the concentration of CRNs in river sediment. Based on the CRN concentration of the samples, we will infer average long-term erosion rates for the entire catchment.

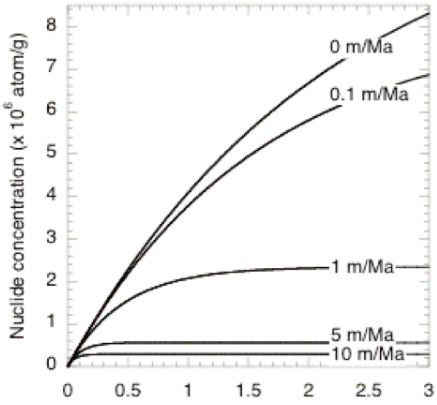

Figure 1: Increase in surface concentration of ^{10}Be with time for different steady-state erosion rates.

Geochemical lab procedures

Samples are now being processed in the cosmogenic isotope laboratory. Sediment samples are prepared for 10Be and 26Al analyses following the procedure of von Blanckenburg (1996).

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