A PROPOSAL TO STUDY GULLY EROSION ON SILICA SAND AND ARKOSE SLOPES IN CENTRAL SPAIN

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1. Introduction

A research project to be developed, granted by the Spanish Minister of Education and Science (project CGL2006-07207), aims to investigate gully erosion on silica sand and arkose slopes in Central Spain. The period of the study is from January 2007 to December 2009. In this abstract, we present the objectives and beginning of the this research project.

2. Geology and landforms

Two areas have been chosen to study gully erosion and sediment movement at the North Slope of the Guadarrama Mountains, in the Central System of the Iberian Peninsula (Segovia Province, Castille and Leon Region, Spain).

The first area is underlain by silica sand, shale and gravel sediments of Upper Cretaceous age. They form a depositional sequence, approximately 70 m thick, bounded by two erosional surfaces. The silica sands consist, mainly, of quartz, with a less proportion of feldspar and mica, these latter transformed to kaolin and smectite. These sediments are described as braided fluvial deposits and coastal fan deltas deposits (ITGE, 1991). The landforms under study are gullies and badlands underlain by the sediments above described. They occur on slopes of mesas and cuestas, capped by more resistant rocks, limestones and dolostones. Platforms and slopes of these mesas and cuestas are covered by a mixed holm oak and juniper forest, which is now recovering from centuries of overgrazing (Fig. 1).

The second area is underlain by arkosic sand sediments, with pebbles, cobbles and boulders of granite, gneiss and quartz, of Miocene age (ITGE, 1990). These sediments were formed in alluvial fan systems, emerging from the uplifting of the Guadarrama Mountain range to the south (ITGE, 1991). The landscape is characterized by dry cereal crops on rolling uplands, only dissected by the actual fluvial system. At the slopes of the valleys, gullies are developed (Fig. 2).

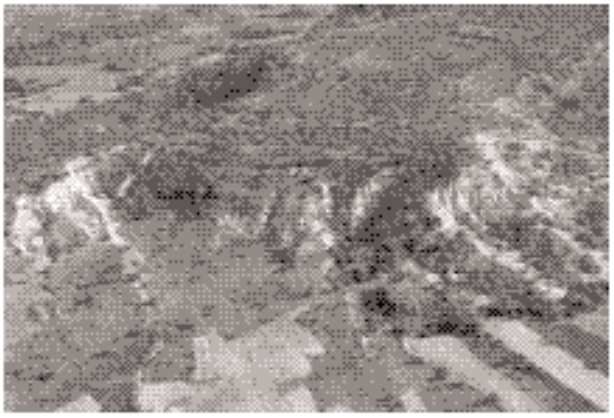

Fig 1. Aerial view of the gullies developed on silica sand slopes (in: Díez and Martín Duque, 2006).

Fig 2. Aerial view of the gullies developed on arkosic slopes (in: Díez and Martín Duque, 2006).

3. Research proposal

With this project, we mainly intend to characterize and quantify, in terms of type of activity, velocity and frequency, the active geomorphologic processes operation in the referred gullies. Specifically, we aim to:

1) Understand the origin and development of these gullies, and their evolution in historical times, since it has no been explained yet if they have a natural or human-induced origin.
2) Study their evolution in recent times (1946 to the present, through series of aerial photographs), in order to determine if the gullies are growing, shrinking, or have stabilized.
3) Characterize and quantify their current functioning, by establishing which geomorphologic processes are eroding and mobilizing the sediments within the gullies. What is the degree of activity, and the speed at which the processes of water erosion, piping, mass movements, and sediment transportation operate? To

IV International Symposium on Gully Erosion. J. Casalí and R. Giménez (Eds.)
 ISBN 978-84–9769-198-7

do so we intend to follow these approaches: (1) various dendrogeomorphic techniques to measure the amount and rate of both erosion of the interfluves and sedimentation in the collector drainages. In this respect, our team has already the experience and expertise of quantifying sheet erosion rates from the analysis of exposed Scots pine roots (Bodoque et al., 2005). (2) Installation of rods, erosion pins, pedestals and micro-profile devices to measure small changes in the topography of the gullies by both water erosion and mass movement. (3) Installation of sediment traps in the dry washes, to measure the amount of sediment yield. (4) Instrumentation to measure knickpoint migration within collector washes. (5) Detailed topographical surveys to quantify the modification of the area of the gullies' watersheds and mass movement processes within the gullies.

4) Identify the effects that the various distinct meteorological regimes have on the movement of sediment. By installing weather stations, and modelling the watersheds, to investigate the causes and frequencies of geomorphic activity. What season of the year produces the most erosion and transportation of sediment? What is the relation between meteorological conditions and distinct geomorphic processes and rates?
5) Determine how these processes affect vegetation dynamics. The presence of unstable substratum and the variation that occurs on the nature of the soil, once the gullies are formed, have striking effects on the vegetation.
6) As the main conclusion of the project, we intend to propose a model for the origin and development of the gullies, to explain in detail their geomorphic activity, and to determine the implications for the environmental management of the area.
7) Last but not least, we are interested on obtaining applicable conclusions for the land reclamation of mines and quarries on these terrains. Moreover on silica sand mines, common in the region. In the first area, there is a reclaimed silica sand mine, benefited from existing gullies, which reclamation project was developed by us, based on a geomorphic approach (Martín-Duque et al., 1998). Being able to integrate the knowledge of the gully dynamics with the reclaimed mine system would result in a highly potential for ecological restoration applications of this type of mining.

4. The beginning of the research project

It is our intention to start monitoring the geomorphic activity in the first place (objective 3), so that we can start gathering data, systematically, at the beginning of the 2007-2008 hydrological year (October 1st, 2007). In parallel with the gathering of the data, objectives 1 and 2 will be tackled. In order to assess the most suitable locations for starting the systematic monitoring of the geomorphic activity and sediment movement within the gullies, a detailed inventory of landforms and processes is being carried out during the first months of 2007. The inventory is being conducted by: (1) using a specific form, which includes information on physiography, morphometry, signs of active geomorphic processes, signs of stability (description of soils and vegetation) and the potential for installing devices to measure geomorphic activity (all that for each gully); (2) depicting detailed geomorphological sketches of the gullies. Simultaneously, a relational database connected to a geographical information system (GIS) is being constructed. The database provides the form information, along with graphical images (photos and sketches).

5. First assessment of scale of sediment movement

During the time that this proposal was elaborated, and during the beginning of the project, a first assessment of geomorphic activity within the gullies has been studied. The aim was to see what scale of sediment movement we will be working with. Therefore, a series of rods were driven into the ground of different dry washes of both areas, each one with washers levelling the bottom of the dry wash. Measurements were carried out after each storm or precipitation event. A two-year observation period now shows the following pattern of sediment movement: (a) *winter*, snowmelt processes are able to move high amounts of sediment trough the dry washes, with the deepening of the bottom of the gullies reaching depths up to 20 cm; (b) *spring*, hardly sediment movement through the beginning of the season, but the storms of May and June trigger the most intense geomorphic activity and sediment movement processes; intense storms on May 2007 produced the deepening of some drywashes up to 50 cm, and the formation of alluvial cones in almost each silica sand gully, some of them filling local roads with sand; (c) *summer*, general geomorphic inactivity; (d) *autumm*, low intensity of erosion and sediment movement.

Acknowledgements: The research project CGL-2006-07207 is financially supported by the Spanish Minister of Education and Science.

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