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A review of runoff generation and soil erosion across scales in semiarid south-eastern Spain

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ABSTRACT

Climate, lithology, soil and especially, intense land use/cover changes, make SE Spain very vulnerable to runoff generation and water erosion leading to loss of nutrients and organic matter and to infrequent but devastating floods, reservoir siltation and mass failures. This susceptibility has led to heavy economic investment and research efforts since the 1980s, making this region a worldwide reference for understanding the hydrology and geomorphology of semiarid ecosystems. Runoff and soil erosion have been intensively studied throughout the last decades in various natural ecosystems as well as in abandoned farmlands. Research has considered a wide range of methods and spatial and temporal scales. This paper reviews the methods and data describing runoff generation and water erosion, synthesising the key processes involved, rates, thresholds and controlling factors from a scale-dependent perspective. It also identifies the major gaps in current knowledge to provide recommendations for further research towards solutions that reduce the negative impacts of erosion. Research in SE Spain has contributed significantly to a better understanding of the effect of spatial and temporal scale on runoff and sediment yield measurements, and highlighted the important role of distinct erosion and sediment transport processes, hydrologic connectivity, spatial and temporal patterns of rainfall, the occurrence of extreme events and the impacts of land use changes. The most effective ways and challenges to predict runoff, soil erosion and sediment yield at the catchment scale are also discussed.

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1. Introduction

The most important changes that soils have undergone during the past two centuries are the consequence of human communities which have accelerated soil erosion rates and rerouted nutrient flows (McNeill and Winiwarter, 2004). Such human impacts have been very intense in south-eastern Spain, a region with a long history of human settlement where anthropogenic land use changes have been especially drastic in the second half of the past century (Burke and Thornes, 2004), triggering soil erosion and leading to severe land degradation. These land use changes, along with its climate, with scarce and torrential rainfalls, steep slopes and the fragility of its soil (low levels of organic matter, aggregate stability and nutrients) make this region very prone to surface sealing, runoff generation and water erosion (García-Ruiz, 2010).

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This in turn leads to soil and nutrient loss, soil organic matter decline and infrequent but devastating floods, reservoir siltation and mass failures (Burke and Thornes, 2004). In this framework, soil erosion, by itself and also in its overriding role in desertification, has become a matter of public concern since the 1980s in SE Spain, and intense research has been done in the context of EU research projects (e.g. MEDALUS (Mediterranean Desertification and Use) I, II and III, MEDACTION, PESERA, RECONDES etc) and others supported by regional or national funds (e.g. LUCDEME: Fighting against Desertification in the Mediterranean). Heavy economic investment and research efforts have resulted in significant progress in understanding the hydrology and geomorphology of semiarid ecosystems, making the region a worldwide reference for soil erosion and hydrological research in semiarid environments. Most research has been done in natural ecosystems and recently abandoned farmlands (since about the 1960s) on which this review is focused, though, in SE Spain today, the main actual water erosion problems are associated with abandonment of