

## Erosion in a landscape evolution context: LISEM and LAPSUS

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### ABSTRACT

In many erosion studies only contemporary erosion is assessed, assuming this to be the direct or indirect effect of human influence. In geomorphological studies, erosion is viewed as a naturally occurring process in the context of landscape evolution. This study aims to bridge the gap between these contrasting views. In the study area (Guadalentin; SE Spain) two models are applied: the short-term, event-based model LISEM (Limburg Soil Erosion Model) and the long-term landscape evolution model LAPSUS (Landscape Process Modelling at Multi-Dimensions and Scales). LISEM needs relatively many and detailed input parameters and rainfall data. LAPSUS uses relatively simple process descriptions, input maps and average rainfall. Theoretically LISEM is expected to perform better than LAPSUS due to more detailed processes and input variables. However, spatial variability of the required characteristics is high in the study area, giving rise to high uncertainty in input and output. Therefore, LAPSUS may give better results despite the simpler process descriptions and input maps. Currently, this issue is being explored for the Guadalentin Basin on various spatial scales. Preliminary results will be presented when available. Eventually, we aim to combine the two models in a modelling framework adapted to the Guadalentin and assessing multiple scales.

**Keywords:** erosion modelling, landscape evolution, LISEM, LAPSUS

### INTRODUCTION

Landscapes in southeastern Spain have developed in response to tectonics, climatic fluctuations and, more recently, to human action. Erosion (e.g. by water) is one of the most important processes that shape the landscape. The natural erosion processes, instead of being constant, fluctuate in severity over time, driven by, among others, climate variability. Although to a lesser extent than the glacial-interglacial cycles, climate fluctuation is also known for the Holocene. Above this and possibly of more importance, local changes in base level have played a role in the erosional and depositional history of the area. In line, also naturally occurring erosion and sedimentation has not been constant throughout the Holocene.

In many studies, contemporary erosion is assessed (e.g. Vandekerckhove et al., 2000; Boix-Fayos et al., 2008; Lesschen et al., 2007; Romero-Diaz et al., 2007), in which the assumption is often made that this erosion is the direct or indirect effect of human influence. In our view, it would only be justified to conclude that (part of) observed erosion is due to human action if it is compared to the natural background erosion. This study assesses the contrasting views between contemporary erosion studies and geomorphological research.

In both fields, models are used as tools to study erosion and deposition processes and their effects on the landscape. An important difference between models used in contemporary erosion research and those used in landscape evolution is their timescale. Another important

issue is calibration: while this is possible for contemporary erosion models with a dataset comprised from fieldwork measurements, this is not as easily possible for landscape evolution modeling. As a consequence, model formulations in landscape evolution models (LEMs; Coulthard, 2001) that simulate erosion and sedimentation on the long term are necessarily strong simplifications of real world processes. On the other hand, erosion models that simulate contemporary erosion often comprise physically based equations. In this study, the landscape evolution model LAPSUS (Schoorl et al., 2000; 2002) and the erosion model LISEM (De Roo et al., 1996a,b) are applied to the same area.

The aim of this study is to bridge the gap between the contrasting views on erosion in studies assessing contemporary erosion and deposition on the one hand, and geomorphological research on the other. In the first, erosion is often seen as the direct or indirect result of human action, while in the second, erosion is viewed as a naturally occurring process. Two models, LISEM and LAPSUS, which differ in their set up, are applied to the same area to assess this concept.

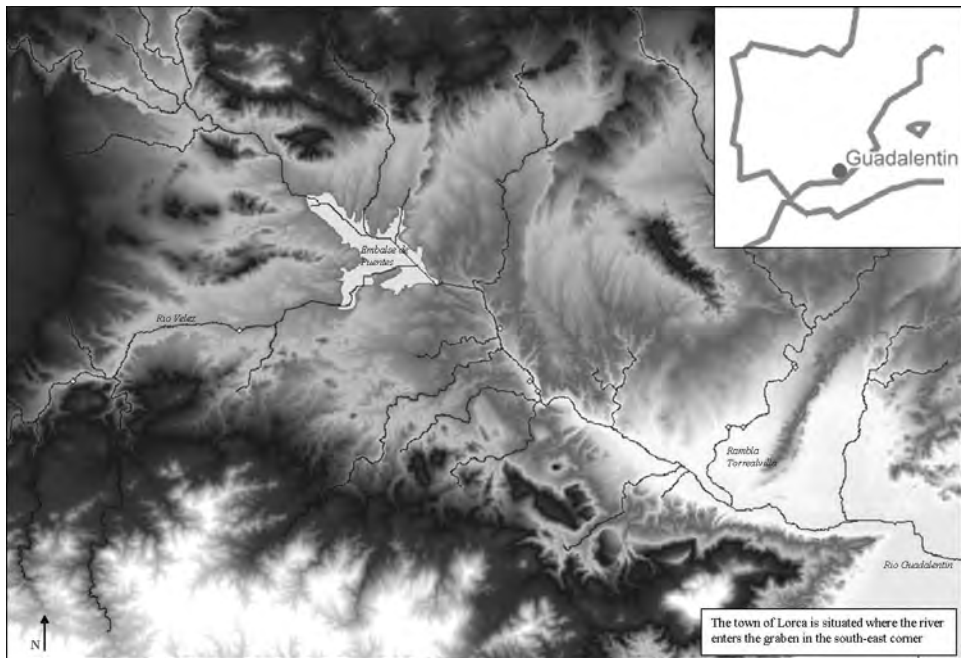


Figure 1: Location study area Guadalentín Basin.

### Study area

The upper Guadalentín Basin (Fig. 1) is located in Murcia, SE Spain and provides an excellent area to apply this concept of contrasting views between landscape evolution and contemporary erosion. Research into contemporary erosion has been carried out from various perspectives in the area. (Holocene) landscape evolution has not been assessed as much, but is being investigated at this moment.

Current climate in the Guadalentín Basin is semi-arid Mediterranean. Average annual precipitation is about 300 mm, with 75% of rainfall in spring (mainly April) and autumn (mainly October) and high annual variability (Navarro Hervás, 1991). Average annual temperatures are about 17°C, with lowest mean minimum temperatures of about 3 °C and highest mean maximum temperatures of about 34°C (Navarro Hervás, 1991). As a result of high temperatures and low precipitation, evapotranspiration exceeds precipitation during most

of the year, resulting in a moisture deficit (De Wit, 2006). Semi-natural vegetation in the research area consists mainly of natural shrubs (matorral, mainly *Stipa Tenacissima*) and forest (*Pinus Halepensis*). Land use is mainly dryland farming (cereals and almonds) and irrigated crops (olives, almonds and horticultural crops).

### METHODS

Two models that both simulate erosion and deposition in a spatially explicit way are applied to the Guadalentin area. One is the event-based erosion model LISEM, the other is the landscape evolution model LAPSUS. Necessarily, these models work on different timescales.

#### **LISEM: Event-based erosion model**

LISEM (Limburg Soil Erosion Model) is a physically-based model that simulates hydrology and sediment transport during and immediately after a single rainfall event (De Roo et al., 1996a,b). The model has relatively detailed process descriptions. Basic processes incorporated in the model are rainfall, interception, surface storage in micro-depressions, infiltration, vertical movement of water in the soil, overland flow, channel flow (in man-made ditches), detachment by rainfall and throughfall, transport capacity and detachment by overland flow. For infiltration, in this study the Green&Ampt option is used. LISEM uses the kinematic wave approach for routing of water downslope.

Input for the LISEM model consists of various maps: land use and vegetation related maps (4); catchment maps (5); soil surface maps (9) and infiltration related maps (5). Rainfall input is in the form of tipping-bucket rainfall record during the rainfall event to be simulated. Dependent on available data, a rainfall intensity (mm/h) value for every 1-10min is used.

#### **LAPSUS: landscape evolution model**

LAPSUS (Landscape Process Modelling at Multi-Dimensions and Scales) is a landscape evolution model simulating water erosion and sedimentation of soil based on redistribution of water using the multiple-flow algorithm (Schoorl et al., 2000; 2002). It uses relatively simple process descriptions. Process that can be included in LAPSUS are water erosion and deposition, landslide activity, creep, solifluction, physical weathering, frost weathering, tectonics and tillage. LAPSUS is a finite element model using sediment transport equations based on works of Kirby (1971) on the continuity equation for sediment movement (Schoorl et al., 2002).

Input for the LAPSUS model consists of four maps: DEM; a land use map; a soil depth map and a geology map. The land use and geology maps are used to implement different erodibility for different parent materials and for calculating tillage erosion respectively. Rainfall input is given as an average annual amount; timestep is usually one year.

### HYPOTHESIS AND DISCUSSION

As this research is currently being carried out, results are not available yet. We present here our hypothesis about model performance. Also, we discuss the concept of long-term vs. event-based erosion modelling.

Given the more detailed process descriptions in LISEM compared to the relatively simple process descriptions in LAPSUS one could hypothesize that LISEM would give better results. However, other issues that influence model performance, include:

- Required (detail in) input parameters;
- Spatial variability of the input parameters in the study area;
- Uncertainty in input and output;
- Spatial scale assessed.

Due to the high spatial variability and associated uncertainty in the research area for some of the input parameters of LISEM, it is possible that LAPSUS performs better. In this case, the uncertainty of input parameters could overrule the level of detail in process descriptions.

We realise that the two models are not intended to answer the same research question as we use them for in this case. However, it is the objective of this research to investigate, using these two types of models, whether we can bridge the gap between two approaches in erosion research (i.e. geomorphological view and contemporary erosion studies; see Fig. 2).

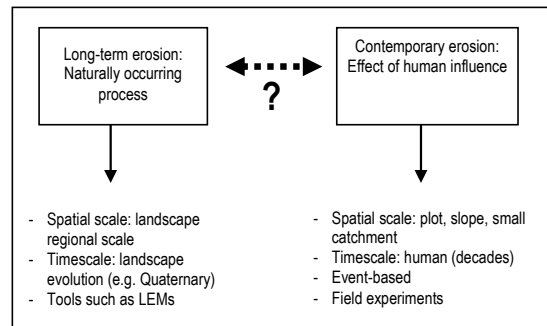


Figure 2: Conceptual bridge between modelling long-term and contemporary erosion.

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