

5.6.12 Modelling Geomorphic Systems: Landscape Evolution

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Landscape evolution models (LEMs) present the geomorphologist with a means of investigating how landscapes evolve in response to external forcings, such as climate and tectonics, as well as internal process laws. LEMs typically incorporate a range of different geomorphic transport laws integrated in a way that simulates the evolution of a 3D terrain surface forward through time. The strengths of LEMs as research tools lie in their ability to rapidly test many different hypotheses of landscape evolution, to investigate the importance of particular processes by isolating them within a model, and to make quantitative predictions of geomorphic change within landscapes. LEMs can be applied to situations lasting from days to millions of years in real time, but reduce this to minutes or hours in model run-time. This chapter presents a brief introduction to the underlying principles of landscape evolution modelling, followed by an overview of the features of currently available, commonly-used models, and example applications from recent literature. Suggestions for dealing with common pitfalls in landscape evolution modelling, calibration, and confirming model predictions are also discussed.

KEYWORDS: numerical modelling, landscape evolution, fluvial, hillslope

Introduction

Landscape evolution models (LEMs) are quantitative tools used to simulate Earth surface processes and the evolution of the land surface. LEMs can be used to deduce whether hypotheses about landscape evolution are likely to be valid, by making quantitative predictions about their development. The earliest LEMs were conceptual and largely qualitative, such as the early pictorial landscape evolution diagrams by Gilbert (1880). Figure 1a. Gilbert's model contains many of the key components in a modern LEM. The background schematic depicts the effect of an uplift field alone on the landscape, and the foreground depicts the combined effects of uplift and erosion. Gilbert also recognised the important concept of boundary conditions in LEMs, stating that the base of the diagram represents a fixed sea-level in this case. These early models offered insight into the potential course of landscape evolution, and sowed the seeds

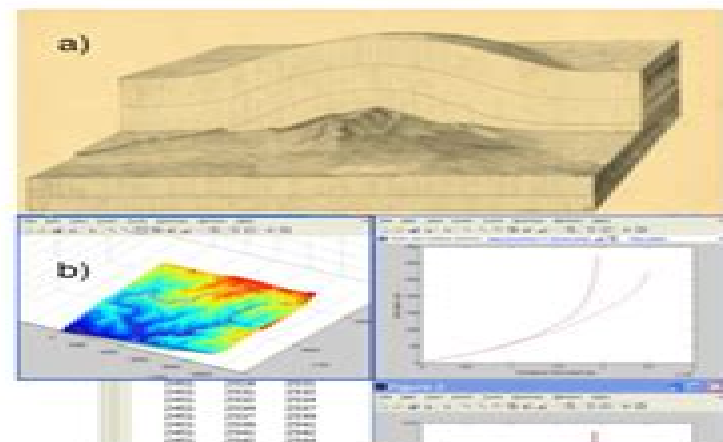


Figure 1. The evolution of LEMs. (a) The diagrammatic LEM of Gilbert (1880) compared to (b) a computer numerical model (CHILD, Tucker et al. 2001).

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