

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

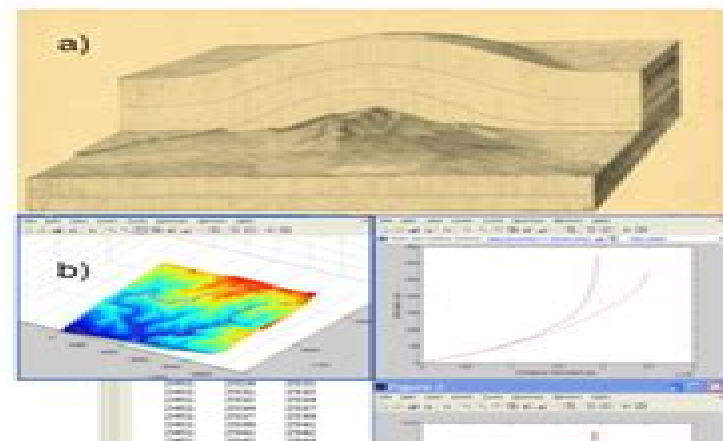


Figure 1. The evolution of LEMs. (a) The diagrammatic LEM of Gilbert (1880) compared to (b) a computer numerical model (CHILD, Tucker et al. 2001).

Modelling Geomorphological Systems

Kenneth J Gregory, Andrew S Goudie



Modelling Geomorphological Systems:

Encyclopedia of Geomorphology Andrew Goudie, 2013-04-15 Volume editor is the leading authority in the field Alphabetically organized in two volumes c 700 comprehensively signed cross referenced and indexed entries Detailed bibliographies and suggestions for further reading follow most entries Fully illustrated over 300 plates and line drawings Written by an editorial team of over 270 experts from over thirty countries Modelling Geomorphological Systems M. G. Anderson, 1988-07-04 Discusses a broad spectrum of topics in current modelling research in hillslope and river channel processes The book is designed to provide a coherent basis for understanding the potential range of modelling activity within hillslope and channel process investigations and to give readers an appreciation of the modelling challenges that still remain Topics cover research in specific areas of process study including equilibrium mathematical network and flow process models Also discussed are alternative modelling approaches within specific fields model validation and verification and the development of computer simulation as a significant and established element in geomorphological investigations

Integration of Computer Modeling and Field Observations in Geomorphology J.F. Shroder, M.P. Bishop, 2003-09-26 The integration of classic field gathered data with new computer models has allowed many new advances in geomorphology which the 31st Binghamton Millennium Symposium 2000 presents in this latest of the well known Binghamton book series the *Integration of Computer Modeling and Field Observations in Geomorphology* Conceptual models have been most commonly inferred from analyses of topography and investigator perspectives derived from fieldwork The main stumbling blocks to understanding surface processes their interactions temporal changes and resulting landforms are the difficulty of observation geological timescales involved spatial scale dependencies and the inability to attribute differences to either process or age Physically based computer models have thus become essential tools primarily because of their ability to explore spatial and temporal trends and to determine the sensitivity of physical inputs to change without the difficulties of identification and generalization associated with the complexity of field studies Thus the combination of both methods or the integration of field methods with computer modeling become a very powerful mechanism for robust understanding This new book presents topics on fluvial processes of overland and channelized flow in arid humid and periglacial areas of high and low relief as well as work on interlinked biogeographic and geomorphic fluctuations in alpine terrain and ground penetrating radar of coastal geomorphology Issues of long term evolution of drainage networks are addressed in natural systems as well as stream table environments and terrain analyses characterize surficial and subsurface geomorphic features by using GIS and remote sensing Botanical and biogeomorphologic controls of landforms are assessed along with issues of scientific visualization cartographic representation DEMs spatial analyses and scale dependencies **The SAGE Handbook of Geomorphology** Kenneth J Gregory, Andrew S Goudie, 2011-06-22 Geomorphology is the study of the Earth's diverse physical land surface features and the dynamic processes that shape these features Examining natural and anthropogenic processes

The SAGE Handbook of Geomorphology is a comprehensive exposition of the fundamentals of geomorphology that examines form process and applications of the discipline Organized into five substantive sections the Handbook is an overview of Foundations and Relevance including the nature and scope of geomorphology the origins and development of geomorphology the role and character of theory in geomorphology geomorphology and environmental management and geomorphology and society Techniques and Approaches including observations and experiments geomorphological mapping the significance of models process and form dating surfaces and sediment remote sensing in geomorphology GIS in geomorphology biogeomorphology human activity Process and Environment including the evolution of regolith weathering fluids flows and fluxes sediment transport and deposition hill slopes riverine environments glacial geomorphology periglacial environments coastal environments aeolian environments tropical environments karst and karst processes Environmental Change including landscape evolution and tectonics interpreting quaternary environments environmental change disturbance and responses to geomorphic systems Conclusion including challenges and perspectives and a concluding review The Handbook has contributions from 48 international authors and was initially organized by the International Association of Geomorphologists This will be a much used and much cited reference for researchers in Geomorphology Physical Geography and the Environmental Sciences

Recent Advances in the Modeling of Hydrologic Systems D.S Bowles,P. Enda

O'Connell,2012-12-06 Modeling of the rainfall runoff process is of both scientific and practical significance Many of the currently used mathematical models of hydrologic systems were developed a generation ago Much of the effort since then has focused on refining these models rather than on developing new models based on improved scientific understanding In the past few years however a renewed effort has been made to improve both our fundamental understanding of hydrologic processes and to exploit technological advances in computing and remote sensing It is against this background that the NATO Advanced Study Institute on Recent Advances in the Modeling of Hydrologic Systems was organized The idea for holding a NATO ASI on this topic grew out of an informal discussion between one of the co directors and Professor Francisco Nunes Correia at a previous NATO ASI held at Tucson Arizona in 1985 The Special Program Panel on Global Transport Mechanisms in the Geo Sciences of the NATO Scientific Affairs Division agreed to sponsor the ASI and an organizing committee was formed The committee comprised the co directors Professor David S Bowles U S A and Professor P Enda O Connell U K and Professor Francisco Nunes Correia Portugal Dr Donn G DeCoursey U S A and Professor Ezio Todini Italy

Tools in Fluvial Geomorphology G. Mathias Kondolf,Hervé Piégay,2005-01-28 In recent years there has been a marked increase in funding and employment in river restoration Methods in Fluvial Geomorphology provides an integrated approach to the interdisciplinary nature of the subject and offers guidance for researchers and professional on the tools available to answer questions on river management on very different scales Each chapter is organised to cover everything from general concepts to specific techniques Topics covered include evolution of methods guiding concepts a framework for

deciding when to apply specific tools advantages and limitation of the tools sources of data equipment and supplies needed and a summary table Provides the professional with a useful handbook covering all tools used in fluvial geomorphology Also provides valuable information on the advantages and limitations of the tools All chapters include case studies to give examples of the applications of the tools discussed

Fundamentals of Geomorphology Richard Huggett, Emma Shuttleworth, 2022-12-22 This revised and updated edition continues to provide a comprehensive introduction to the subject exploring the world's landforms from a broad systems perspective It covers the basics of Earth surface forms and processes while reflecting on the latest developments in the field Fundamentals of Geomorphology begins with a consideration of the nature of geomorphology including its relation to society process and form history and geomorphic systems and moves on to discuss Structure structural landforms associated with plate tectonics and those associated with volcanoes and folds faults and joints Process and form landforms resulting from or influenced by the exogenic agencies of weathering running water flowing ice and meltwater ground ice and frost the wind and the sea landforms developed on limestone extraterrestrial landforms and landscape evolution a discussion of ancient landforms Fundamentals of Geomorphology provides a stimulating and innovative perspective on the key topics and debates within the field of geomorphology Written in an accessible and lively manner it includes guides to further reading chapter summaries and an extensive glossary of key terms The book is also illustrated throughout with over 200 informative diagrams and attractive photographs all in colour It is supported by online resources for students and instructors

The Scientific Nature of Geomorphology Colin E. Thorn, 1996

Process Modelling and Landform Evolution Stefan Hergarten, Horst J. Neugebauer, 2006-04-10 This book presents approaches to landscape modelling not only from geography but also from various related disciplines especially from applied mathematics computer science and geophysics New methods of terrain representation analysis and classification are presented as well as short and long term process models The intention of the book is not to give a complete overview of these broad and complex topics but to stimulate interdisciplinary cooperation and to encourage scientists to consider the ideas of related disciplines

Selected Water Resources Abstracts, 1990

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