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Małgorzata Wistuba

Slope-Channel Coupling as a Factor in the Evolution of Mountains

The Western Carpathians and Sudetes

Doctoral Thesis accepted by
University of Silesia in Katowice, Sosnowiec, Poland

 Springer

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Supervisor's Foreword

Numerous works have been published on the mechanisms of relief evolution in mountain areas but new questions and research problems still arise during field observations. One of these is the issue of determining the importance of coupling between geomorphic processes on slopes and fluvial erosion and deposition in valley bottoms for the evolution of montane relief at a general scale.

This thesis undertakes a comprehensive analysis of the links between slope and channel subsystems in small mid-mountain catchments so as to propose on that basis some generalisations and conclusions of broader importance, which would lead to the development of a schema for relief evolution in mid-altitude mountains. This objective was accomplished through studies in ten stream catchments located in the Western Carpathians and Sudetes in the Czech Republic.

The studies conducted have shown that mass movements on slopes, in particular landsliding, and fluvial erosion on valley floors of small, forested, mid-mountain catchments are coupled. When slope material is transported into valley floors, it enters river channels and causes feedback bringing on erosion at the foots of slopes. On the other hand, fluvial erosion occurring at the boundary between slopes and valley floors causes disturbance of the slope equilibrium and another generation of mass movements. Repeating cycles of landsliding and erosion cause the gradual transformation of V-shaped cross profiles of valleys into flat-bottomed ones and a gradual retreat and lowering of slopes.

The thesis contains an extensive and a diverse range of documentation on field and laboratory studies which were the basis for the generalisations later presented which frequently go beyond the previously recognised facts concerning the evolution of relief in forested mid-mountain areas of the temperate climatic zone. The thesis represents a new perspective in understanding relief, particularly within the study areas of the Western Carpathians and Sudetes.

The thesis is also of potential interest to all researchers dealing with the problem of geomorphic coupling because the results were obtained through the use of an original approach, never before applied in analyses on slope-channel feedback.

The occurrence, length and frequency of the cycles of slope-channel coupling were determined by means of dendrochronological dating. This results from the rapid recent development of dendrogeomorphological methods. In the thesis, the precise dating of erosion was applied through the analysis of wood anatomy in

roots. An original method, developed for the needs of the thesis, was also applied and described. The method allows the dating of mass movement activity on slopes using the eccentric growth of trees tilted by ground instability. Comparison of temporal patterns of mass movement on slopes and fluvial erosion on valley floors was key to proving the great importance of positive feedback between slopes and channels in the evolution of mid-altitude mountain landscapes. At the same time, the method of eccentricity analysis developed proved its value in landslide studies and shows great promise in scientific analyses of, e.g. triggering factors and the spatial pattern of landsliding, but also in practical applications, e.g. estimating landslide hazard and risk. Hence, the thesis presented is also a good example of scientific work in which a purely research problem was to be solved, but the tools developed for that purpose can also have practical application.

Sosnowiec, Poland, June 2014

Prof. Ireneusz Malik

Abstract

Coupling between hillslopes and river channels is often considered to be a fundamental aspect of the functioning of geomorphic systems. In this thesis, coupling between the delivery of slope material into valley floors and river erosion was considered to be a factor in the evolution of mid-altitude forested mountains, where the connectivity between slope and fluvial subsystems is, so far, poorly recognised.

The thesis describes geomorphological and dendrochronological investigations carried out in mid-altitude areas of the Sudeten Mts and Carpathian Mts to analyse temporal and spatial relations between slope and fluvial processes (landsliding and erosion in particular). Landsliding and erosion occurrence were dated using the annual rings of Norway spruce. Using an original dendrogeomorphic approach it was possible to determine the cyclic occurrence of landsliding and erosion in the catchments studied during recent decades. The results show that the processes studied are strongly interdependent. Fluvial erosion can trigger landsliding by undermining slope bases. Landsliding can intensify erosion by delivering slope material into valley floors.

The results of dendrochronological studies have permitted a better understanding of the relief observed in areas where landslides and erosion are coupled. A schema was established which describes the evolution of mid-mountain landscape. This was discussed taking into account the influence of geological setting, human impact, climate change and tectonic activity. Using the results obtained from the ten catchments analysed and data obtained from the literature review, a proposition was made that the established model may describe a general rule for the evolution of mid-mountain landscape.

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landscape zones of southern Poland and no 2011/01/B/ST10/07096 *Comparison of the record of geomorphic and non-geomorphic processes in the wood anatomy of trees growing in mountain areas.*

In 2011–2012, I received a postgraduate scholarship from the UPGOW project during thesis preparation (financed from the EU European Social Fund, Operational Programme—Human Capital).

Contents

| | | |
|----------|---|----|
| 1 | Introduction | 1 |
| 1.1 | Outline of the Research Problem | 1 |
| 1.2 | The Subject of the Study: Delivery of Slope Material into Valley Floors in the Slope-Fluvial System of Mid-Altitude Mountain Ranges of the Western Carpathians and Sudetes | 5 |
| 1.2.1 | Basic Terminology Used in the Thesis | 5 |
| 1.2.2 | The Structure of the Slope-Fluvial System | 7 |
| 1.2.3 | The Delivery of Slope Material to Valley Floors in Small Mid-Mountain Catchments in the Carpathians and Sudetes: The Current State-of-the-Art as a Basis for the Division of the Slope-Fluvial System | 8 |
| 1.3 | Research Objectives | 11 |
| | References | 12 |
| 2 | Materials and Methods | 23 |
| 2.1 | Methods for Analysis of Relief | 23 |
| 2.1.1 | Geomorphic Mapping | 23 |
| 2.1.2 | Terrain Profiles | 25 |
| 2.1.3 | Analysis of Aerial Photographs | 25 |
| 2.2 | Methods for the Analysis of Bedrock and Sediment Composition | 25 |
| 2.2.1 | Mapping of Surface Deposits | 25 |
| 2.2.2 | Lithofacial Analysis and Organic Carbon Content Analysis of Deposits in Valley Bottoms and Slope Bases | 26 |
| 2.2.3 | Analysis of Grain Roundness in Alluvia in Contemporary Stream Channels | 26 |
| 2.2.4 | Electrical Resistivity Tomography (ERT) | 27 |
| 2.3 | Methods of Analysing Past Environmental Change in Catchments | 28 |
| 2.3.1 | Analysis of Plant Macrofossils in Sediment Profiles | 28 |
| 2.3.2 | Analysis of Archival Maps | 30 |

| | | |
|----------|--|-----------|
| 2.4 | Methods for the Absolute Dating of Deposits, Landforms, Geomorphic Processes and for the Evaluation of Relief Dynamics | 30 |
| 2.4.1 | Radiocarbon Dating. | 30 |
| 2.4.2 | Dendrochronological Dating of Alluvial Terraces | 31 |
| 2.4.3 | Dendrochronological Dating of Landsliding on Slopes | 31 |
| 2.4.4 | Dendrochronological Dating of Erosion in Channels | 36 |
| 2.4.5 | Analysis of Precipitation Data and Analysis of the Conditions of Landsliding and the Occurrence of Erosion | 37 |
| 2.4.6 | Dendrochronological Dating of Debris Flow Activity | 38 |
| | References | 38 |
| 3 | Study Catchments | 41 |
| 3.1 | Introduction | 41 |
| 3.2 | Moravskoslezské Beskydy Mts. (Western Carpathians) | 43 |
| 3.2.1 | Environment of the Moravskoslezské Beskydy Mts. | 43 |
| 3.2.2 | Location and Main Features of the Catchments Analysed | 45 |
| 3.3 | Hrubý Jeseník Mts. (Sudetes) | 49 |
| 3.3.1 | Environment of Hrubý Jeseník Mts. | 49 |
| 3.3.2 | Location and Main Features of the Catchments Analysed | 51 |
| | References | 55 |
| 4 | The Delivery of Slope Material to the Valley Floors of Small Mid-Mountain Catchments: Record in Relief and Deposits | 59 |
| 4.1 | Record of the Delivery of Slope Material to Valley Floors in the Relief and Deposits of the Upper Catchment Zone. | 59 |
| 4.1.1 | Landsliding and Fluvial Erosion in the Valley Head of the Skalka Stream | 59 |
| 4.1.2 | Debris Flows in the Valley Head of the Černý Stream | 86 |
| 4.2 | Record of the Delivery of Slope Material to Valley Floors on the Relief and Deposits of the Middle Catchment Zone. | 93 |
| 4.2.1 | Landsliding and Fluvial Erosion in the Valleys of the Keprnický and Javořický Stream | 93 |
| 4.2.2 | Landsliding, Fluvial Erosion and Channelised Debris Flows in the Valley of the Suchý Stream. | 135 |

| | | |
|----------|--|------------|
| 4.3 | Record of the Delivery of Slope Material to Valley Floors in the Relief and Deposits of the Lower Catchment Zone. | 158 |
| 4.3.1 | Fluvial Erosion in the Mouths of the Slučí, Sokolí and Rudná Streams | 158 |
| 4.3.2 | The Flux of Slope Material Caused by Forest Management and Agriculture Recorded in the Mouths of the Škorňanský and Hartisov Streams | 174 |
| | References | 189 |
| 5 | The Evolution of Relief in Mid-Altitude Mountains as a Result of the Delivery of Slope Material to Valley Floors: Discussion | 191 |
| 5.1 | Course of Slope Material Delivery into Valley Floors in Small Mid-Mountain Catchments. | 191 |
| 5.1.1 | The Upper Zone of Catchments (Valley Heads) | 191 |
| 5.1.2 | The Middle Zone of Catchments. | 194 |
| 5.1.3 | The Lower Zone of Catchments (Outlet Fans) | 198 |
| 5.1.4 | The Variation of Coupling Between Slope and Channel Sub-systems in the Three Zones of Small Mid-Mountain Catchments. | 199 |
| 5.2 | Slope-Channel Coupling in Small Catchments as a Factor of Relief Evolution in Mid-Altitude Mountains. | 200 |
| 5.2.1 | A Schema of Relief Evolution in Mid-Altitude Mountains Through the Transformation of Valley Heads into the Middle Zone, and the Middle Zone into Outlet Fans | 200 |
| 5.2.2 | Proposed Schema of Relief Evolution in Mid-Altitude Mountains and Classical Models of Evolution of Hillslope-Valley Topography | 205 |
| 5.3 | Dependence of Relief Evolution in Mid-Mountain Areas on Selected Environmental Factors | 208 |
| 5.3.1 | Impact of Bedrock Composition on the Evolution of Relief in Small Mid-Mountain Catchments | 208 |
| 5.3.2 | The Impact of Human Activity on the Evolution of Relief in Small Mid-Mountain Catchments | 209 |
| 5.3.3 | The Impact of Climate on the Evolution of Relief in Small Mid-Mountain Catchments | 211 |
| 5.3.4 | The Impact of the Tectonic Regime on the Evolution of Relief in Small Mid-Mountain Catchments | 212 |
| | References | 213 |
| 6 | Conclusions | 219 |