

# Chapter 16

## Conclusions

Dénes Lóczy, Miloš Stankoviansky, and Adam Kotarba

This monograph could not have been completed without a long-term collaboration of geomorphologists in the countries situated within the Carpatho–Balkan–Dinaric region. The first and the most important step towards this collaboration was the founding of the *Carpatho–Balkan Geomorphological Commission (CBGC)* in 1963. The common objective of geomorphologists of member countries was the study of the mountain systems of the Carpathians and Balkanides (Stara Planina) and the adjacent depressions. The second milestone was the acceptance of the *Carpatho–Balkan–Dinaric Regional Working Group (CBDRWG)* in the International Association of Geomorphologists (IAG) in 2005. At the preparation of its proposal, on the basis of an initiative from some successor countries of the former Yugoslavia, the competence of the CBGC was broadened to cover the Dinarides too. Today 12 countries adhere to it, namely Austria, Bulgaria, Croatia, Czechia, Hungary, Macedonia, Poland, Romania, Slovakia, Slovenia, Serbia, and Ukraine. Apart from Austria all mentioned countries participated in the preparation of the present monograph.

---

D. Lóczy (✉)

Institute of Environmental Sciences, University of Pécs, Ifjúság útja 6,  
H-7624 Pécs, Hungary  
e-mail: loczyd@gamma.ttk.pte.hu

M. Stankoviansky

Department of Physical Geography and Geocology, Faculty of Natural Sciences,  
Comenius University in Bratislava, Mlynská dolina, 842 15 Bratislava 4, Slovakia  
e-mail: milos.Stankoviansky@test.fns.uniba.sk

A. Kotarba

Department of Geomorphology and Hydrology of Mountains and Uplands,  
Institute of Geography and Spatial Organisation, Polish Academy of Sciences,  
ul. Św. Jana 22, 31-018 Kraków, Poland  
e-mail: kotarba@zg.pan.krakow.pl

The monograph relies on several *publications* as predecessors. Some years after the foundation of the CBGC a two-volume monograph entitled *Geomorphological Problems of the Carpathians* was issued. The first volume was issued by Veda Publishers of Bratislava in 1965 and was dedicated to landform evolution in the Tertiary period. Its regional coverage extended over the territory of the Western Carpathians and Stara Planina, the contributors represented Czechoslovakia, Poland, Hungary, the Soviet Union (where the present Ukrainian Carpathians used to belong) and Bulgaria. The second volume was published as the No. 10 issue of the journal *Geographia Polonica* in Kraków in 1966 and dealt with landform evolution in the Quaternary. The same countries contributed, with the exception that Bulgaria was substituted by Romania. Both books assessed the state of research in the mentioned topics and summarized the results acquired until that time. Their authors found that neotectonic (Miocene and Pliocene) movements and selective erosion depending on climatic changes are the most important factors in the landform evolution of the Carpatho–Balkan system.

As far as the topics investigated are concerned, *geomorphic research* had different *focuses* in early times: mostly planation surfaces, river terraces and young tectonic movements, karst, glacial, glacialfluvial, periglacial, and aeolian landforms, river network changes and the expression of structural and rock properties (passive geological structure) in relief stood in the forefront. Investigations were closely connected to developments in *geomorphological mapping*. Mapping projects finally led to establishing geomorphological divisions in each country presented on national maps of geomorphological units, often included in the national atlases published at that time.

In the course of the 1960s, under the influence of the *Soviet* geomorphological school, the *morphostructural approach* became prevalent and strove to assess the course of relief evolution, taking into account the consequences of active geological structure or, in other words, the influence of tectonic movements on shaping landforms. This approach gradually acquired a predominant position in the geomorphology of most of the Carpatho–Balkan–Dinaric countries and manifested itself not only in mapping geomorphological divisions but also in the preparation of independent morphostructural maps of (group of) countries (e.g., the morphostructural map of the Western Carpathians). The most ambitious international mapping project was the preparation of the *Geomorphological Map of the Danubian Countries* starting from 1978, included in the *Atlas of Danubian Countries*, issued in Vienna, representing both morphostructural relief types and individual landforms. The map indicates the approximate geological age of the different landforms and this information, combined with the symbol of the legend representing the origin of the individual landforms, shows the morphodynamic character of the geomorphological unit. Thus, the map could also function as a starting point for studies on active geomorphic processes.

However, in some countries of the region investigations have traditionally focused on endogenic processes or, even more often, exogenic geomorphic processes are viewed from an overwhelmingly *geological perspective*: the impact of neotectonic movements on landform evolution, mass movements or fluvial erosion

processes controlled by rock quality. An alternative approach places more emphasis on *climatic circumstances*. Through the incorporation of the climatic environment a more complex evaluation of the physical background to landform evolution becomes possible.

Consequently, another important research direction of geomorphic investigation of participating countries that played a decisive part in the preparation of this monograph and was employed as an orientation principle is the *morphodynamic approach*. Though the beginnings of the study of some partial exogenic geomorphic processes date back to the past, their systematic research mostly began in the post-World War II period. Out of the Carpatho–Balkan–Dinaric countries such investigations became most popular in Poland. The Polish Carpathians was most thoroughly explored from this viewpoint and the findings of Polish geomorphologists served as a model for morphodynamic investigations in other countries. It is not a mere coincidence that at that time the CBGC working group for the unification of techniques of study of *present-day geomorphic processes* was chaired by a representative of Poland, T. Gerlach. The study of geomorphic processes was also intensively pursued in Romania and in some other countries like the former Czechoslovakia, Hungary and, to a considerable extent, also the Ukrainian (Carpathian) part of the former Soviet Union. This research direction was not really practiced in Bulgaria and the former Yugoslavia. In short, in the past and also today highly variable importance has been attached to the study of present-day geomorphic processes in the individual countries of the Carpatho–Balkan–Dinaric region. In some of them the morphodynamic approach have acquired predominance, while in the rest other directions in geomorphology have become more pronounced. Such developments can be explained by different traditions cherished during the historical evolution of geomorphic research and markedly different geomorphological schools.

This is the reason why the treatment of geomorphological research in the national chapters *cannot be homogenized*. However, it is nothing new for a publication of this type. We can soothe ourselves by citing some ideas from the Foreword to the first volume of the above mentioned monograph *Geomorphological Problems of the Carpathians* from 1965: “*Even though geomorphological studies in the individual Carpathian countries have had a long tradition and have been intensified within the last years, we still feel the need of a synthetic work on the subject. Research work went on rather isolately in the past, with various thematic aims, so that the results, even though they are considerable as to quantity, are rather heterogeneous and hard to use in a comparative study.*” Our predecessors also emphasized that “*it is not a work that would embrace the results of a coordinated international geomorphological study of the Carpathians, nor does this work pretend to give a complex synthesizing picture of the Tertiary genesis of the Carpathian relief. The aim of the publication is to give a general outline of the present-day situation in the knowledge of at least the fundamental features and development of the Carpathian relief, especially of the Western Carpathians, as this outline appears in the individual countries of the Carpathian region.*” The editors of the mentioned volume also claim that “*they want to express the wish that this publication will be a successful first step on the road to future international cooperation of Carpathian geomorphologists.*”

All that was said to describe the contents of the publication dedicated to the Tertiary relief evolution of the Western Carpathians and Stara Planina is even more valid for the present volume on the recent landform evolution of the Carpatho–Balkan–Dinaric area. The heterogeneity of national chapters, the disparities between them and the resulting *low* level of *comparability* reflect the *diversity of the traditions* of geomorphic research and the variety of approaches employed in the study of this rather extensive area. On the other hand, it can be regarded a success that so many countries could be involved in the project, in fact, much more than in the early years of the CBGC.

Naturally, the research of processes varied in character and intensity for the individual countries. In the countries which can be considered most advanced from this aspect a well-developed network of *research stations* was founded to serve the monitoring of current processes in selected catchments, in test areas of hillslopes or plot scale (e.g., Szymbark, Hala Gaşienicowa, Homerka, Łazy in Poland; Pătărlagele, Piatra Neamţ, Perieni–Bârlad in Romania; Csákvár, Aggtelek and Bodrogresztúr in Hungary, and others). The outcome of monitoring efforts is the estimation of the rate of recently active processes as described in most of the national chapters. For this purpose, in addition to monitoring itself, various field and laboratory measurements using a range of techniques and experiments proved to be instrumental. The spatial distribution of processes, their temporal course and behavior have also been analyzed in increasingly quantitative approaches. Processes were also evaluated as *geomorphological (natural) hazards*. Attention was also paid to documentation of geomorphic effect and environmental impact of particular extreme events. An important components of the study of processes was the assessment of the cumulative geomorphic effect of a series of consecutive (often poorly documented) events within the study period (decades, centuries) manifested in reducing surface convexities and increasing concavities associated with changes in the sediment budget.

The *processes* studied in the individual chapters can be referred into three groups on the basis how much space is devoted to them. In most chapters (in eight countries) gravitational (mass movements) and runoff processes (water erosion) are of outstanding *significance*, the second group represents fluvial and aeolian processes, treated in detail in six national chapters, while the third, periglacial (cryogene and nival), karstic (pseudokarst), and littoral processes, appear in three chapters. Biogenic processes are only assessed in one of the national chapters. Important sections of Part II focus on direct human interventions into the relief, a topic that is not missing from any of the national chapters. The history of geomorphological investigations in each country has strongly influenced decisions on the selection of topics and on the structure of the chapters. Countries with lesser tradition in morphodynamic research prefer to focus on landforms rather than on processes and not only on recent evolution but also long-term relief development in the geological past.

The *changes of the political and economic* order after World War II had a serious indirect impact on geomorphic processes. The general trend of transformation was similar in all countries of the Carpatho–Balkan–Dinaric territory: the nationalization of industry and agriculture. The new land use regulations had a crucial influence on the physical environment, unknown in Western Europe. As privately owned

arable plots were incorporated into collective or state farms, *accelerated soil erosion* ensued and sometimes reached catastrophic dimensions. The intensive erosional processes were analyzed by the geomorphologists of the CBD countries. The only exception is the Polish Carpathians, which have never been affected by the collectivization of agriculture and the resulting large-scale farming, but traditional small-plot cultivation survived to our days. Slovak, Czech and Hungarian scientists documented that intensive soil degradation was caused by human impact. This aspect of human intervention on recent landform evolution is clearly reflected in the national chapters of the monograph.

*Landslides* are the most common and spectacular forms of mass movement in the mountains and exert the greatest impact on relief in areas of active *young tectonics*. High seismicity and neotectonic activity in the flysch mountains is responsible for the most widespread landslides, first of all, in the Eastern Carpathian Curvature area of Romania and partly in Macedonia. In contrast, in tectonically stable areas of flysch mountains (i.e., the Polish and Ukrainian Carpathians, partly in Slovakia), the main factors triggering substantial mass movement types are heavy rainfall, high relief and suitable lithology.

In several countries geomorphic processes are studied in mutual interaction. Landform evolution depends on the interaction of various geomorphic agents like river undercutting and the landslides induced by this process; deep weathering and its corollary: deep-seated landslides on slopes where conditions are favorable. The significance of *inherited landforms* on present-day geomorphic processes is studied in several countries focusing on the remnants of glacial and periglacial landforms in the high mountains, like the Polish and Romanian Carpathians, the Bulgarian and Macedonian mountains and the Slovenian Alps.

The most intensive and abrupt *human intervention* into the physical environment is represented by river regulations, the constructions of dams and reservoirs as well as industrial plants. Some regions, rich in mineral deposits are extremely strongly affected by landform transformation and chemical pollution caused by extraction industries. This process is observed in each country but seems to have the greatest dimensions in Romania.

The share of the assessment of investigation of recent geomorphic processes in total geomorphic research of individual countries is also markedly reflected in the determination of the *length of the period interpreted as recent*, which is not uniform for all CBD countries. The shortest period is defined in the *Polish* chapter but it essentially means the time interval when high-intensity, extreme geomorphic events took place with catastrophic consequences for human society. Geomorphic and hydroclimatic events were mentioned in written sources from the last millennium, but relatively precise descriptions deriving from travelers and natural scientists and the conclusions were not published before the beginning of the nineteenth century. This explains why the 200 years time span had been decided on by the authors of the Polish chapter. The Polish geomorphologists have ample findings even for such a short period. The *Slovak* chapter assesses the effect of processes in the Carpathians within the last eight centuries, in lowland areas exclusively within the last two millennia. In *Hungary* recent geomorphic processes only refer to the past two or three

centuries, which is considered to be a convenient time period for their modeling (particularly in the case of accelerated water and wind erosion). The concept also includes present-day relief evolution and, thus, allows us to reveal future perspectives and points to the practical significance of actual geomorphological studies. In the southern countries where the morphostructural school has had especially strong tradition (like Croatia and Bulgaria) neotectonic movements are emphasized as the main drivers of landform evolution. Consequently, the time span investigated as recent is considerably longer.

In general, most of the contributing countries concentrate on the period of human interference. As to the last centuries, more national chapters refer to the influence of the Little Ice Age on the significant intensification of precipitation-induced processes and some of them on the influence of the above mentioned large-scale land use changes associated with collectivization in agriculture on the acceleration of water erosion.

Finally, some remarks on the *motivation* for writing a monograph on recent geomorphic processes. Several impulses have contributed to this decision. The first was purely emotional, the current generation wanted to honor with the book the predecessors who have laid the foundations of geomorphology in the Carpatho–Balkan–Dinaric area. On the other hand, they want to prove their abilities and not only in the fields studied by the teachers but also in topics of recent geomorphic processes which in their time was not quite common – and in some countries has not become widely investigated to our days either. Placing the CBDRWG under the “protecting wings” of the IAG, an organization that promoted our endeavor, we wanted to show that we had been accepted into this high-ranking international geomorphological body not without merits.

The editors leave it to the readers of this book to decide how successful they have been to fulfil their objectives. Perhaps the greatest achievement of the volume is the tremendous potential for mutual learning, enriching experience and influencing studies in the field of recent landform evolution, starting with the unification of terminology and finishing with the creation of international teams in thematic research. Each country has a chance to borrow methodological tools tested in other countries and to use the acquired experience of its partners to assess the same phenomena on their own territory. This particularly refers to neighboring countries, as the spatial distribution of operation of geomorphic processes is not limited by administrative boundaries. However, it can also concern countries that are farther away from each other, but show similar natural conditions and history of anthropogenic transformation.

It is easier to provide a comprehensive overview of research activities in the individual CBD countries than to summarize the regional variations of the individual groups of geomorphic processes. However, if there is a discrepancy between both attitudes (i.e., a marked gap between performed research and the topics with remarkable research potential) can be perceived as indicative of future perspectives and, possibly, the most promising fields of academic collaboration in the study of recent landform evolution.

Thus, in general, this book has a great chance to encourage geomorphologists of participating countries to look for ways to gradual *harmonization* of research of recent geomorphic processes and not only within individual evaluated megaunits, but perspectivevely in the whole Carpatho–Balkan–Dinaric area. Echoing again the statement of editors of the first volume of the monograph *Geomorphological Problems of the Carpathians* from 1965, we would like to express the wish that this publication will represent the next successful step towards an improved international cooperation between geomorphologists active in the landscapes of the Carpatho–Balkan–Dinaric region.