

# Carpathians Environment Outlook *2007*





Published by the United Nations Environment Programme

Copyright © 2007 United Nations Environment Programme

ISBN: 978-92-807-2870-5

J.No: DEW/0999/GE

This publication may be reproduced in whole or in part and in any form for educational or non-profit purposes without special permission from the copyright holder, provided acknowledgement of the source is made. UNEP would appreciate receiving a copy of any publication that uses this publication as a source.

No use of this publication may be made for resale or for any other commercial purpose whatsoever without prior permission in writing from the United Nations Environment Programme.

#### DISCLAIMER

The contents of this volume do not necessarily reflect the views or policies of UNEP or contributory organizations. The designations employed and the presentations do not imply the expressions of any opinion whatsoever on the part of UNEP or contributory organizations concerning the legal status of any country, territory, city or area or its authority, or concerning the delimitation of its frontiers or boundaries.

#### Produced by UNEP/DEWA – Europe

United Nations Environment Programme  
Division of Early Warning and Assessment (DEWA) – Europe  
UNEP's International Environment House  
11, chemin des Anémones  
CH-1219 Chatelaine, Geneva, Switzerland  
<http://www.grid.unep.ch>

Printed and bound by Dimograf Printing House, Bielsko-Biała, Poland,  
for and on behalf of the United Nations Environment Programme



Project part-financed  
by the European Union

UNEP promotes environmentally sound practices globally and in its own activities. This publication is printed on 100% recycled chlorine-free paper using other eco-friendly practices. Our distribution policy aims to reduce UNEP's carbon footprint.



# Carpathians Environment Outlook *2007*

## Foreword

The Carpathian Mountain region is an excellent example of why the United Nations and its environment programme are of increasing relevance in the 21<sup>st</sup> century. Seven countries – the Czech Republic, Hungary, Poland, Romania, Serbia, Slovakia and Ukraine – share the natural and nature-based resources found within this mountain range.

The region, including the surrounding lowland plains represents a centre of extensive biological diversity and at the same time a unique and well-preserved cultural heritage in a locale that, while in the heart of the European continent, remains relatively under-developed and ‘unspoiled’.

However, it is also inescapable that the Carpathian Mountains are increasingly coming under pressure from encroaching economic and infrastructural developments ranging from new roads, holiday homes and ski resorts, to the exploitation of the region’s abundant water, minerals and timber resources.

The challenge facing the countries and communities of the Carpathians is the challenge facing countries and communities world-wide: namely the delivery of sensitive, sustainable and intelligent management of the biodiversity and ecosystems upon which so much wealth, livelihoods and economic prosperity depend.

The Carpathian Mountain region also faces the other major and common challenge of our age – climate change – alongside the urgent and pressing need to “climate-proof” economies against the likely impacts.

The United Nations Framework Convention on the Protection and Sustainable Development of the Carpathians, in which UNEP and its Regional Office for Europe has played an important role, is designed to meet these challenges.

The Convention has been signed by all seven Carpathian countries and ratified by six, and is now moving into the implementation phase. In order to support the Convention and its various agreements or Protocols, UNEP in cooperation with the seven countries has developed the *Carpathians Environment Outlook* or *KEO*.

The Outlook brings the most accurate and up-to-date science available on the status of the environment in this region and has also helped initialise a “KEO database” developed by the UNEP/GRID-Warsaw Centre. The KEO report is a source of knowledge that can evolve to support the new and developing needs of the Carpathian countries and relevant organizations in their quest to deliver common and concrete solutions to the challenges and opportunities now and in the years to come.



*Achim Steiner*

Achim Steiner, UN Under-Secretary General  
and Executive Director United Nations  
Environment Programme (UNEP)

# About this Report

## Who can use KEO?

Given that the development of the Carpathians Environment Outlook (KEO) was initiated and requested by governments of the Carpathian countries, it therefore follows that one of the main **target audiences** (i.e. users and beneficiaries) of KEO should be decision- and policy-makers working for the governments, especially Ministries of the Environment, of the Carpathian countries. Governmental authorities at all levels within the Carpathian region are further considered to be key target audiences. This also includes regional environmental instruments such as the Carpathians Framework Convention, one of the main reasons for embarking on the KEO project.

Additional key target audiences include the European Commission, international organizations (e.g. UNEP, UNECE, Ramsar Convention Secretariat), international financial institutions (e.g. World Bank, EBRD), private sector business leaders and associations, non-governmental organizations (NGOs) and academia (e.g. professors, scientists and students at universities within the Carpathian region).

The producers of KEO also encourage all members of the public (especially in the Carpathian region) to use the KEO Report and become more informed about environmental trends, policies and solutions that may affect them and their communities, as well as their decisions and actions.

## How should one use KEO?

The KEO Report is divided into five main chapters that are preceded by a number of shorter sections.

KEO begins with a **“Foreword”** written by Achim Steiner, Executive Director of UNEP, highlighting

the relevance of KEO for future sustainable development in the region. The section **“About This Report”** presents the structure and main themes developed within KEO, and **“About the KEO Process”** explains how the Report was developed and by whom. An **Executive Summary** then summarizes the entire contents of the Report.

Following these opening sections, **“Chapter 1: Background and Introduction”** begins with a description of the Carpathian region’s main geographical attributes. This includes various interpretations of the region’s area and boundaries, altitudinal zones, water bodies, climate, geology and biodiversity. This is followed by an examination of human influences in the region, with a retrospective look at its historical-political background and cultural heritage. The Chapter ends with a brief overview of the main pressures impacting the Carpathian environment as well as current responses.

**“Chapter 2: Socio-Economic Driving Forces”** begins with an overview of macro-economic and structural policies affecting the region, including issues such as economic growth, employment and structural change. This is followed by a detailed look at the economic driving forces and pressures related to the following sectors: agriculture, forestry, energy and industry, transport infrastructure, tourism and traditional livelihoods. An examination of societal driving forces and pressures ends this chapter with analyses of population trends, rural de-population and land abandonment and environmental democracy.

**“Chapter 3: State of the Carpathians’ Environment and Policy Measures”** represents the longest chapter in KEO. It is divided into nine sub-chapters, each concentrating on one key environmental component or theme in the Carpathian region. These include: species, habitat and landscape diversity; forest resources; land

resources; mineral resources; water resources; atmospheric pressures; waste and hazardous chemicals; environment and security; urban development and cultural heritage. Within each sub-chapter, the state and trends of the environment, as well as human impacts and responses are analysed and described. The first sub-chapter on Species, habitat and landscape diversity has been given particular attention due to its high environmental significance for the Carpathian region, countries and UNEP.

**“Chapter 4: Outlook 2005 to 2020: Three Scenarios for the Carpathian Region’s Future Development”** is meant to help government policy-makers and other stakeholders identify key environmental challenges faced by the Carpathian region, and to understand the economic and environmental impacts of the policies that could be used to address those challenges. It develops three main scenarios of environmental, social and economic developments up to 2020 – “Business as Usual”, “EU policy first” and the

“Carpathian Dream” – as well as the underlying economic and social factors that drive these developments. The scenarios are roughly analogous to those developed for UNEP’s GEO process, beginning with the GEO-2000 report.

**“Chapter 5: Conclusions and Options for Action”** is divided into three sub-chapters. The first and longest presents KEO’s overall conclusions with a focus on the region’s unique characteristics, socio-economic considerations and environmental issues. This is followed by a survey of current policies in the region and policy gaps and limitations. Finally, based on the contents of the Report, some “options for action” are provided to strengthen the future policy framework affecting the Carpathian region.

References for each chapter are included within the chapter texts, as well as in a full list of references at the end of each chapter. The KEO Report ends with lists of **“Acronyms and Abbreviations”** and **“Acknowledgements”**.



## About the Carpathians Environment Outlook (KEO) Process

The process to prepare the Carpathians Environment Outlook (KEO) was initiated by UNEP in March 2004, following a government's ministerial request for such a report. From the very beginning of the process, UNEP and the seven governments involved put great emphasis on assuring a participatory and "bottom-up" approach, to give both the process itself and the end product the greatest legitimacy possible within the timeframe allowed for the preparation and publication of this integrated environment assessment.

The KEO process is closely linked to and draws inspiration from its parent process which is UNEP's Global Environment Outlook (GEO), an integrated environment assessment (IEA) approach undertaken since the mid-1990s at the global scale, that involves hundreds of participants from all sectors: governmental, academic, civil society and NGOs, business/industry and other private sector, youth representatives and others. UNEP presents GEO as its "flagship series" on environmental state-and-trends reporting, and is constantly improving and refining the GEO process. Many other GEO-like reports have been prepared for various regions and countries of the world, including the Caucasus Environment Outlook (CEO; UNEP 2002). The fourth global GEO report "GEO-4" is to be published and launched in October 2007.

In terms of leadership, the entire KEO process was coordinated by UNEP's Division of Early Warning and Assessment (DEWA) European office in Geneva, along with UNEP's Regional Office for Europe (ROE) and its outposted Vienna-based office, which serves as the Interim Secretariat for the Carpathians Framework Convention (ISCC).

The first meeting to explore preparation of what became the "KEO Report" was held at the Hun-

garian Ministry of Environment and Water (MoEW) in Budapest, on 3-4 March 2004, with representatives of six of the seven Carpathian countries. Labelled as the "kick-off" meeting, it was used to discuss the concept of an IEA report for the Carpathians, and seek advice from mainly governmental participants as to their interest in, and the feasibility of having, such a report. Following this first exploratory meeting, it was always very clear that one of the main reasons for embarking on such a project, and the countries' direct interest therein, was to provide scientific support and underpinning to the UN Framework Convention on the Protection and Sustainable Development of the Carpathians (hereafter, the CFC). It is not an exaggeration, therefore, to state that the CFC was the *raison d'être* for the KEO report.

Following approval of the concept to develop such an IEA report for the Carpathians, all seven governments of the region were asked to formally name National Focal Points (NFPs) for the process, whose role was to act as advisors, participate in meetings and assure collection of relevant data from their countries to support the reporting process.

At the same time, a KEO Steering Group (S.G.) was established to guide and support the process, plan all aspects of the KEO Report and handle related logistical issues. The SG was composed of key persons from Carpathian governments (environment ministries), several major regional NGOs and UNEP. During the lifetime of the KEO process, the Steering Group met four times: in Warsaw (17-18 September 2004); in Vienna (7-8 July 2005 and 6-7 July 2006); and lastly in Poiana Brasov, Romania (19-23 March 2007).

The KEO Report was prepared in its entirety by scientific and governmental experts from the Carpathians countries. Different chapters and sections

of the Report were drafted by Chapter Lead Authors (CLAs), who were persons recommended by NFPs and selected by UNEP; all were from well-known scientific institutions or universities, or had direct experience with their assigned topics through work in government or academia.

In mid-2005, a Lead Data Centre (LDC) to assure the proper harmonisation, integration and dissemination of data sets provided for KEO analytic purposes was designated. For this role, UNEP's Global Resource Information Database (GRID)-Warsaw centre was selected and henceforth began development of the KEO Database, the forerunner of what is ultimately expected to grow into the KEO Information System, for future Carpathian regional reporting purposes and to support the CFC.

Finally, in early 2007 as the KEO reporting process entered its late stages, an Editor and Design specialist were selected, both of whom also have Carpathian regional roots.

During the lifetime of the KEO Report preparation, several key meetings of Carpathian stakeholders were held as milestone events in the

process. These meetings were: the First National Experts and NGOs Workshop held in Zakopane in the Polish Carpathians, (11-13 April 2005), which served to plan and reach agreement on the detailed contents of the KEO Report and related data/indicators; the Chapter Lead Authors (CLAs) Orientation meeting, held in Geneva (27 February 2006); the Regional Stakeholders' Consultation held in Banska Bystrica in the Slovakian Carpathians (18-20 October 2006), which served as a general review meeting with a broad range of regional participants from all seven countries, international organizations and NGOs; and the Final Authors' (and Steering Group) Meeting held in Poiana Brasov, Romania (19-23 March 2007), which mainly served to finalise most chapter drafts and plan for the launch of the KEO Report.

To summarise the KEO process, it was rich and varied and involved many participants, some of whom were involved from beginning to end, and some of whom changed along the way. For those persons from the region who may believe that "the journey is half of the pleasure", we would hope to welcome you on board for a second KEO report!

# Executive Summary

The Carpathians Environment Outlook (KEO) is a geographically integrated report on the state of, and trends related to, the environment of the Carpathian Mountains region, retrospectively over the past 30 years and forward to 2020. For KEO, an integrated environmental assessment (IEA) approach was carried out using the Driving Forces-Pressure-State-Impact-Response (DPSIR) methodology, a framework used to organize and classify environmental information in terms of the causal chain of human-environment interactions. The study is based on analyses of socio-economic and environmental processes and focuses on sustainable development issues, notably the economic efficiency and environmental effectiveness of policy actions. A certain level of diversity and flexibility in applying the DPSIR framework is apparent in different KEO chapters/sections, demonstrating the authors' own varying perspectives on and use of IEA.

## Physical characteristics

The Carpathian Mountains are the largest, longest and most twisted and fragmented mountain chain in Europe. Stretching like an arc across Central Europe, they cover parts of seven countries starting from the Czech Republic in the northwest, then running east and southwards through Slovakia, Poland, Hungary, Ukraine and Romania, and finally Serbia in the Carpathians' extreme southern reach.

A characteristic feature of the Carpathians' landscape is the typically small scale of land use patches. Except for large forest patches, areas of other land use types such as grasslands, pastures, agriculture and urban settlement are small. Together, these patches form a unique landscape 'grain pattern' with 'coarse' forest areas and 'fine' areas for other uses.

## Biodiversity

The Carpathian Mountains represent a link between the taiga of Northern Europe and the Mediterranean ecosystems of the south. They exhibit the largest pristine forests in Western and Central Europe, with the broadest primeval forests found in the Southern and Eastern Carpathians and in the Tatra Mountains. The great variety of endemic plants and animals characteristic of Carpathian ecosystems is an essential biodiversity component in Europe. The Carpathians have the richest community of large carnivores in Europe, including all of the large European predators, and their populations are still numerous and vital.

Many landscapes, habitats and flora and fauna show characteristic and unique features occurring solely or mainly in the Carpathian region. Many of these – endemic, alpine and relict habitats and species – are the result of long-term evolution, migration and adaptation processes that existed well before humans came to occupy the Carpathians. Among plant species, the most common and interesting group are the glacial relicts – species characterized by their alpine-arctic distribution pattern. Other interesting groups include species living on the edge of their geographical range, and 'archaeophytes' – migrants that entered the Carpathians following human settlement and agriculture. Similarly to vascular plants, there are also many endemic species of Carpathian fauna (mostly invertebrates).

The most important changes in nature were a consequence of the human presence in the Carpathians. Climate change is now resulting in changed habitats, a regression in the range of some species and an increase in that of others. Mass tourism favours the introduction of new invasive species into native habitats. Air and

water pollution, new infrastructural developments and the abandonment of traditional forms of land management are all having adverse effects on biodiversity in the region.

## History and Culture

The Carpathians have since centuries ago been at the contact point of empires, ethnic groups and cultures. The Carpathian area has been part of several states and empires. The current ethnic mix (Czechs, Germans, Hungarians, Poles, Romanians, Ukrainians, Slovaks and Serbs) is the reflection of a turbulent history.

Many traditions, artefacts, ruins, archaeological sites and monuments have been preserved from these earlier empires, cultures and peoples inhabiting the Carpathians since prehistoric times. Interestingly, the multitude of passes, depressions and valley corridors among the mountains facilitated inter-ethnic contacts and highlighted common ethnographic elements.

The first elements of a Carpathian culture date back to the Paleolithic and Neolithic Ages. Lower Paleolithic stone items such as chopping tools, as well as pottery, bronze and iron objects have been discovered in various mountainous and inter-montane sites. Highlights include the 22,000 year-old Venus of Mosavany statuette found carved into a mammoth tusk in Slovakia, and Sarmizegetusa in the former Geto-Dacian capital located in the Southern Carpathians, home to a solar monument similar to the one found at Stonehenge. In addition, many remnants from Roman times have been preserved, including the ruins of Roman settlements and roads. In the Northwestern, Southern and Southwestern Carpathians, Roman fortified cities (davae), mines and spas can be found.

The Carpathians and their surroundings have proven to be an environment attractive to settlement and human economic activities for ages. Major economic activities have been wood processing, mining, animal husbandry and agriculture, the latter mostly practiced in lowlands and mountain depressions.

Carpathian countries inherited significant and severe environmental problems from more than

40 years of communist rule. Their economies were much more polluting than economies in Western Europe. Many ‘hot spot’ areas existed with extreme pollution loads, environmental degradation and human health risks.

With the rise to power of the communist regimes, the natural resources of the Carpathian countries were forcibly exploited by Soviet-dominated enterprises. The collectivisation of agriculture, intense deforestation and implementation of centrally-based joint plans within the former Eastern Bloc’s Council for Mutual Economic Assistance (COMECON) framework had profound negative effects on the Carpathians’ environment. Over many decades under the centrally-planned system, a major and rapid conversion of farmland took place for the expansion of human settlements, industrial, mining activities and infrastructural development. Today, the seven Carpathian states are experiencing various forms of transition from the former centralised, communist system to a free market economy.

## Economy

Economic activity within the Carpathian region was determined in the last centuries by the natural environment, local customs, trade relations between tribal groups and the economic policies of the governments controlling the region. As in the past, the economy today is based on farming (closely associated with animal husbandry), forestry and mining, which remain predominant land uses. Compared to that of neighbouring lowlands, the economy of the Carpathians is far less developed. However, the situation varies considerably from region to region.

## Agriculture

Traditional agriculture based on seasonal pasturing in mountain meadows remains well-preserved in the Carpathians. However, cattle and sheep stocks have decreased significantly during the past decade. Since 1990, agricultural production experienced an overall reduction in intensity in terms of both crops and livestock. This was due in part to reduced domestic consumption following economic decline combined with the withdrawal of subsidies for fertilisers and other inputs. In many parts of the Carpathians,

much farmland was abandoned and large areas became fallow. The structure of the agricultural sector is now rapidly being reformed. This includes changes in land ownership and major shifts in traditional land use, even in marginal agricultural areas.

### Forestry

The forests of the Carpathians are a patchwork of deciduous, coniferous and mixed stands. The largest forest complexes are found in the Eastern Carpathians. In the Western and Southern Carpathians, substantial areas were deforested and converted to other land uses. In the foothill areas, forests are small and scattered and the landscape is dominated by other types of land use (agriculture, residential, infrastructure, etc.). Overall, young forests and deforested areas constitute over 50 percent of total forest area, while mature forests account for scarcely 11 percent.

Forestry remains an important economic sector in the Carpathian countries, particularly in Romania, Slovakia and Ukraine, although there are significant national and regional differences. Centuries of evolution and human impact changed the initial natural species composition, forest stand structure, size scale and character of the Carpathian forests. The forests, however, are still vital, with many virgin stands that are rich in species and are of high social, environmental and economic value for local people. Changes observed recently are in three main directions: the attitude of people to forest use, privatization, and the conservation status of forests. Significant restructuring of the sector is taking place, including the fragmentation of ownership.

One of the most important consequences of inappropriate agriculture and forest management (e.g. large clear-cuts) in mountain areas is soil erosion. Threats to soil cover in the Carpathians include those caused by natural processes, such as slope processes (erosion and landslides), and human activities such as pastures, forest management, tourism and recreation. Natural threats mainly affect areas above the forest zone where one can observe the highest intensity of geomorphologic processes.

### Energy

In general, power production in the Carpathian region relies mainly on fossil fuels, followed by nuclear, hydropower and renewable energy sources. Some Carpathian countries hold important fossil fuel reserves, although total proven oil and natural gas reserves are limited. The Carpathian countries remain highly dependent on imported oil and natural gas, mainly from Russia. The geo-strategic importance of the Carpathian region lies largely in the oil and natural gas pipelines traversing many of these countries on their way to Western Europe.

### Mineral Resources

Mining is a major economic activity in the Carpathians. The first impacts caused by large metallurgical mining sites date to antiquity, and have progressively expanded since feudal times. In the 19<sup>th</sup> century, the exploitation of industrial minerals, coal and hydrocarbons became very common, and such activities have continued to expand, but at a slower rate up to the present day.

Soils are the main receptor of mining contamination by the infiltration of residual and degraded industrial waters, as well as sedimentation of particles from the air. These deposits increase the soil's content of highly toxic chemicals, especially in the close vicinity of manufacturing sources. Their negative effects are propagated in the associated biotope, and sometimes even in the upper levels of underground waters. Among pollutants, residual water has proven to be the most polluting agent, with the greatest transport and contamination capacity through the extended river network.

### Water Resources

The common sources of water pollution are industrial wastewater, solid waste dumps and residues from the processing of mining ore and smelting operations. After 1991, as a result of pollution reduction measures, the percentage of "good-quality" rivers increased significantly in the Carpathians. Seepage from agricultural lands is responsible for most of the polluting elements identified in lakes and rivers. Excessive enrichment of soils with nitrogen, phosphorus and

ammonia leads to increased eutrophication of water bodies.

Generally, the Carpathians are situated in recharge areas, having potable waters of bicarbonate, calcium and/or magnesium types. Over 80% of human water consumption in the Carpathians is supplied by groundwater. Some of the main springs are bottled here as medicinal waters or used as carbonate-sparkling waters for spa cures.

### **Waste**

The amount of waste produced in the Carpathians is currently increasing, accentuating environmental damage such as water and soil pollution and the destruction of aesthetic and landscape values. In many places, uncontrolled dumping of wastes is greatly increasing, as old refuse dumps are full and there is a lack of acceptance of new sites being placed in or near local communities.

The greatest waste problem appears to be municipal waste, generation of which has significantly increased since the communist period. The import and mass utilization of non-recyclable materials has increased problems associated with waste management, especially at the local level, including a significant rise in the total amount of municipal waste. The existence of obsolete hazardous chemicals also remains a major issue. One emerging problem concerns new types of hazardous chemicals and the new unofficial 'hazardous waste market'.

### **Urban environment**

Since the fall of communism and over the last 18 years of transition, changes to the urban environment and its forms and structures have been significant. Cities and towns in all Carpathian countries have faced a variety of negative effects from urban development.

The most visible challenge is related to the processes of 'suburbanisation', urban sprawl and car use expansion. The common denominator for all these changes is the rapid shift from public transportation to individual cars, as mobility becomes a high priority at the individual level. Changes are most notable in the larger cities, but

the same tendencies have emerged in other municipalities. Transport is now the main cause of both air and noise pollution.

### **Emerging issues**

Current threats to biological and landscape diversity include climate change and anthropogenic impacts such as pollution, infrastructure development, unsustainable use of natural resources, loss of traditional livelihoods and mass tourism.

Climate change is likely to strongly affect hydrological and terrestrial biological systems through increased run-off and earlier spring peak discharge in many glacier- and snow-fed rivers; warming of lakes and rivers in many regions, with effects on thermal structure and water quality; and earlier timing of Spring events, such as leaf unfolding, bird migration and egg-laying. Biodiversity will also be affected by such changes. Furthermore, climate change would induce the migration of species and current life zones towards higher altitudes.

Environmental problems related to inefficient and unsustainable consumption of natural resources and accumulation of waste are also a major issue in the region. In many places, waste dumping is on the rise, sometimes dramatically. Key issues related to waste management in the Carpathian countries are the predominance of landfilling as a waste management option, and the problem of low recycling rates.

As for natural and technological risks and hazards, their diversity and importance is very high in the Carpathian region. Floods are the most challenging phenomenon for environmental security in the region. Several risk factors contribute to increased flood hazards in the Carpathians. One of the most important is the shape of the hydrographical network. The geological substrate consisting of rocks with low permeability, and the character of the relief caused by the young tectonics of the mountain range, are additional natural factors that contribute to the occurrence of floods in the region. Their negative impacts (economic and environmental) have a trans-boundary, regional or even macro-regional character.

## Future Development Scenarios

Many of the major environmental challenges Carpathian countries face in the early 21st century are of global or trans-boundary nature, including climate change, biodiversity loss, management of shared water resources, trans-boundary air pollution, and trade in endangered species and waste disposal. As a result, there is an increasing need for countries to work together in partnership to tackle these challenges.

The economic, political and/or social choices that are being made today will have effects on the environment far into the future. For many of these, the full environmental impacts will not be felt until long after such choices have been taken. KEO emphasizes that the next 15 years will be as crucial as the past 30 for shaping the future of the environment, and underlines three scenarios to explore what the future could be, depending on different policy and societal approaches.

The “Business as usual” scenario describes a future development/state in which globalisation and liberalisation forces are strong and propagate throughout the Carpathians. Multi-national enterprises with active government support dominate the division of power. Government policies are driven by the promotion of sustained economic growth, and the only measurement tool is profit maximisation. Due to rapid globalisation, traditional values gradually disappear. The cultural, ethnic and language diversity and the integration of the Roma population of the Carpathians are not acknowledged as important, and therefore local cultural associations do not survive due to cultural homogenisation. Regional disparities increase, and the depopulation of rural areas, especially the most remote ones, accelerates. The over-exploitation of natural resources, air and water pollution, and a lack of commitment to mitigate climate change cause major catastrophes within the region. Weather extremes (e.g. storms, heavy rains, heat waves) become more frequent, and cause great damage to both the economy and human health.

The ‘EU Policy First’ scenario considers the successful implementation of EU environmental regulations in the entire Carpathian region. Carpathian governments recognise the need for

stronger coordination of policy efforts and structural reforms. EU policies aim at maintaining and strengthening regional and social cohesion for the budget period 2013–2020; huge funds are available for sustainable, rural and agricultural development of the Carpathians, helping to decrease the social divide between rich and poor people, and decreasing regional disparities. Energy diversification and energy mix are a great concern, and particular attention is given to renewables and biofuels. Traditional air pollutant emissions are further reduced, while some improvements occur in urban air quality. Forest cover stabilises or slightly increases, and the share of unsustainable logging decreases. Trans-regional cooperation at all levels becomes stronger in environmental protection and nature conservation. The Natura 2000 network and other protected areas grow in size.

The ‘Carpathian Dream’ scenario assumes that pro-environment and anti-poverty policies are given highest priority and at a nearly unlimited cost. Policy-makers recognize that achieving environmental sustainability relies on a multitude of potential interventions undertaken by individuals, groups, organizations and institutions across different levels and sectors of society. Three broad categories of approaches to environmental sustainability are widely pursued, namely: the implementation of technological innovations; changing the structure of government, laws and/or the education system; and changing consumer behaviour. Behavioural changes lead to changed production and consumption patterns. Zero-energy houses and energy-efficient villages increase widely, as does the use of renewable energy sources (e.g. solar, heat pumps, wind, biomass). The economy of the region is characterised by qualitative growth accompanied by regional convergence. In the agricultural sector, organic farming and small-scale ecological and traditional agricultural methods are promoted, along with traditional/domesticated animal and plants species, old varieties and local products, and through local branding and advanced marketing systems. Nature conservation is deeply integrated into agricultural sectoral policies. Formerly indigenous but extinct species are resettled or reintroduced with support from local NGOs and governments. The total extent of protected areas

increases, green/migration corridors are established and strongly protected, along with gene banks which operate to preserve endangered species. Effective measures are taken to decrease habitat fragmentation.

### Policy options

The existing sustainable development strategies which are in place in each country cover the whole area of the country, and do not focus on mountain regions as such. Regional sustainable tourism strategies thus need to be designed and developed, taking into account the specificity of the mountain region and particular threats to which the mountain environment is exposed.

A main concern will be to preserve or develop a high-quality environment by means of sustainable natural resources and heritage management. In particular, this should be carried out by: developing joint incentives and actions for managing natural areas, protected areas and landscapes; developing joint actions for improving environmental quality (e.g. air, soil, water); developing and implementing joint strategies and policies for the sustainable use of natural resources and heritage; rehabilitation of degraded areas such as former mining sites, contaminated sites and brownfields; and sustainable development strategies, which should put more emphasis on assuring sustainable transport and energy-efficient transportation systems.

The EU's common policies and legislation will considerably influence the national policies of the Carpathian countries. Particular actions should be introduced by implementing sub-national and local plans, programmes and projects. A useful guideline for the creation of policies related to the Carpathian Region could be the "Policy Guiding Principles" in the renewed EU Sustainable Development Strategy.

On the sub-regional level, the Carpathian Framework Convention already unites the seven Carpathian countries in a unique partnership, and thus can be used as a vehicle to provide a trans-national framework for cooperation and multi-sectoral policy integration, an open forum

for participation by stakeholders and the public, and a platform for developing and implementing trans-national strategies, programmes and projects for environmental protection and sustainable development.

### Conclusion

The Carpathian Mountains region represents a unique and dynamic common living space (natural, cultural, political and socio-economic), both ecologically valuable and important in terms of its human heritage. The region has enormous ecological and economic potential and currently faces rapid environmental, social and political changes. The challenge is to preserve and fulfill the region's potential and specificity (uniqueness), while increasing its sustainability. This will require adapted, responsible actions, taking into account global, regional and trans-boundary contexts and linkages, in order to enhance both the Carpathian environment and human livelihoods.

The current development pattern in the Carpathian region is leading to losses of traditional knowledge, livelihoods, practices and values. It is therefore critically important that culturally sustainable and coherent policies be formulated and implemented for the Carpathians, in order to halt and reverse this trend before it is too late. Rural de-population menaces the traditional character of the Carpathians countryside. Policy measures must be implemented, and incentives developed, so that people remain in their villages as guardians of the landscape, traditional knowledge and livelihoods. Education, communication and public participation, together with environmental democracy, could represent a basis for a sustainable environment and development path in the Carpathians.

In order for Carpathian regional development to become sustainable, more environmentally-friendly practices and technologies will need to be implemented, along with appropriate policies to support sectoral developments such as renewable energy sources, sustainable forest management, sustainable tourism, organic farming and improved public transport.





# Table of Contents

<i>Foreword</i>	2
<i>About this Report</i>	4
<i>About the KEO Process</i>	6
<i>Executive Summary</i>	8
<i>Table of Contents</i>	15
<b>Chapter 1: Background and Introduction</b>	<b>17</b>
1.1 Main Geographical Features	22
1.2 Human Influences in the Carpathians	29
1.3 Modern-day Impacts on Environment and Current Responses	37
<b>Chapter 2: Socio-Economic Driving Forces</b>	<b>43</b>
2.1 Macro-Economic and Structural Policy Overview	45
2.2 Economic Driving Forces and Pressures	55
2.3 Societal Driving Forces and Pressures	77
<b>Chapter 3: State of the Carpathians' Environment and Policy Measures</b>	<b>89</b>
3.1 Species, Habitat and Landscape Diversity	90
3.2 Forest Resources	107
3.3 Land Resources	114
3.4 Mineral Resources	124
3.5 Water Resources	137
3.6 Atmospheric Processes	146
3.7 Waste and Hazardous Chemicals	157
3.8 Environment and Security	163
3.9 Urban Development and Cultural Heritage	172
<b>Chapter 4: Outlook 2020: Three Scenarios for the Carpathian Region's Future Development</b>	<b>189</b>
4.1 Methodological Approach	191
4.2 Driving Forces, Critical Uncertainties, Challenges and Fundamental Assumptions	193
4.3 Three Scenarios for the Carpathian Region	195
<b>Chapter 5: Conclusions and Options for Action</b>	<b>211</b>
5.1 Overall Conclusions	212
5.2 Current Policy Approaches	217
5.3 Future Policy Framework – Options for Action	220
<b>Annexes</b>	<b>225</b>
<i>List of Figures</i>	226
<i>List of Boxes</i>	227
<i>List of Tables</i>	228
<i>List of Maps</i>	229
<i>Acronyms and Abbreviations</i>	230
<i>Acknowledgements</i>	231



## Chapter One

# Background and Introduction



The Carpathian Mountains encompass many unique landscapes, and natural and cultural sites, in an expression of both geographical diversity and a distinctive regional evolution of human-environment relations over time. In this KEO Report, the “Carpathian Region” is defined as the Carpathian Mountains and their surrounding areas. The box below offers a full explanation of the different delimitations or boundaries of the Carpathian Mountain region and how the chain itself and surrounding areas relate to each other.

The Carpathian Mountains are the largest, longest and most twisted and fragmented mountain chain in Europe. Their total surface area is 161,805 sq km<sup>1</sup>, far greater than that of the Alps at 140,000 sq km. Stretching between 49°47’14” and 43°28’25” latitude North and 16°58’37” and 26°38’46” longitude East, their extension over 6° of latitude and 10° longitude has led to their exhibiting a great diversity of natural conditions.

Their total length of 1,500 km is greater than that of the Alps at 1,000 km, the Dinaric Alps at 800 km and the Pyrenees at 500 km (Dragomirescu 1987). The Carpathians’ average altitude, however, of approximately 850 m. is lower compared to 1,350 m. in the Alps. The northwestern and southern parts, with heights over 2,000 m., are the highest and most massive, reaching their greatest elevation at Slovakia’s Gerlachovsky Peak (2,655 m.).

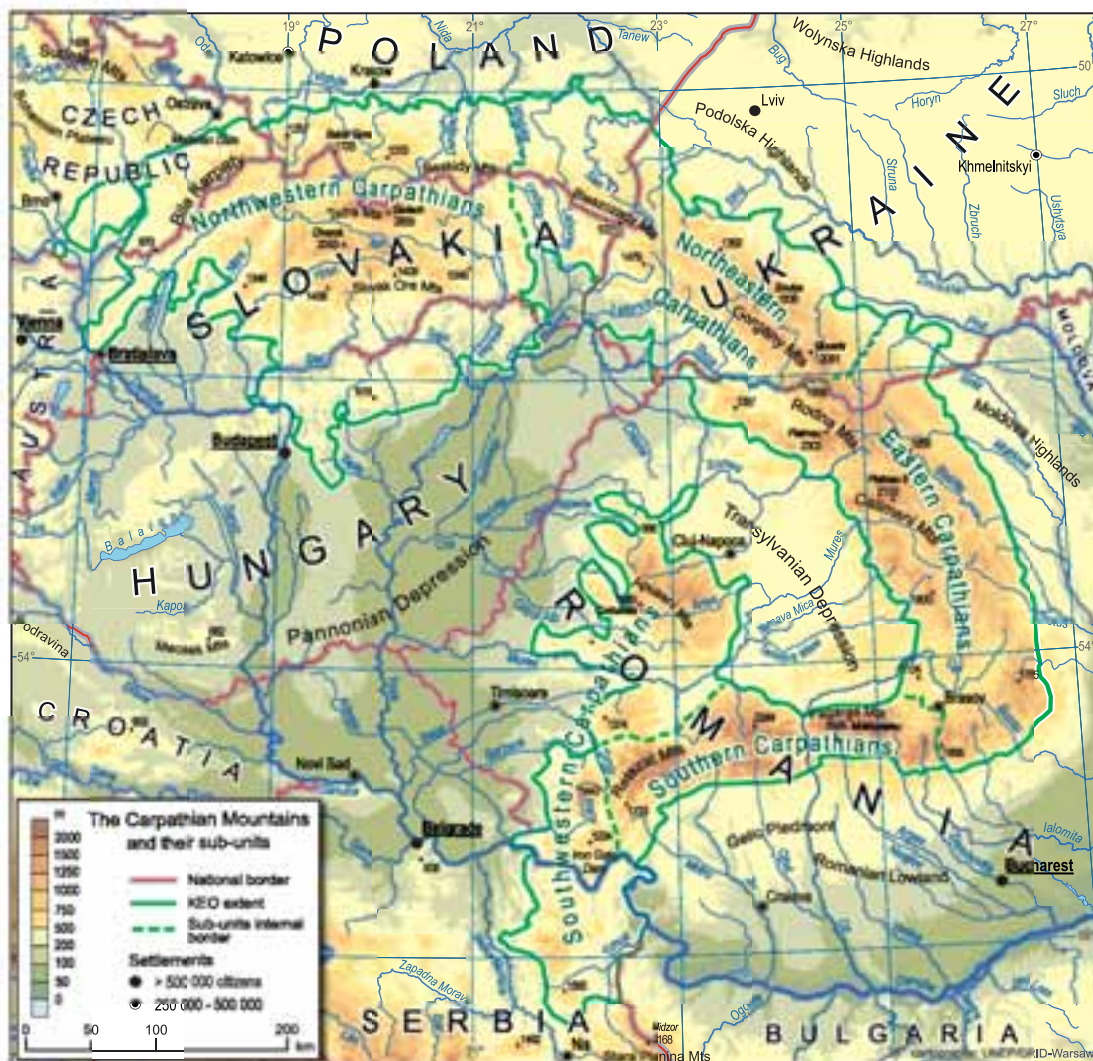
Stretching like an arc across Central Europe, they span seven countries starting from the Czech Republic in the northwest, then running east and southwards through Slovakia, Poland, Hungary, Ukraine and Romania, and finally Serbia in the Carpathians’ extreme southern reach (see Map 1.1, and Table 1.1 for country areas and populations in Carpathians). By some definitions, the westernmost tip of the Carpathians occurs in eastern Austria (“Hainburger Berge” Hill near Vienna; 480 m).

Table 1.1 Area and Population of the Carpathians by Country (EURAC 2006)

Country	National Proposals to the CFC			
	Area (sq. km.) in the Carpathians	Percentage of total Carpathians’ area	Inhabitants in millions	Percentage of Carpathians’ total population
CZ	7,124	4.4	1.46	8.4
HU	9,626	6.0	1.77	10.2
PL	17,263	10.7	3.47	19.9
RO	69,872	43.11	4.87	27.9
SK	35,050	21.66	3.80	21.8
Serbia	761	0.47	0.06	0.4
UA	22,109	13.66	1.98	11.4
Total	161,805	100	17.41	100

<sup>1</sup> The surface corresponds to the Carpathian countries’ National Proposals to the CFC (EURAC 2006).

Map 1.1 The Carpathian Mountains and their sub-units



The Carpathians represent the prolongation of the Alps to the east and northeast, from which they are separated by the Vienna Basin (see Map 1.2). Most of the Carpathians are located in the middle and the lower parts of the Danube River Basin, with the remainder in the Dniester, Vistula and Oder basins.

North of Vienna on Czech territory, the limit between the Carpathians and the Bohemian Plateau and Sudeten Mountains is represented by the Outer Carpathian Depressions (Dyjsko-svratecký úval, Moravian Gate Hornomoravský úval, Vyškovská brana), which are drained by the upper courses of the Morava and Odra rivers. To the south, the Carpathians extend into Serbian territo-

Map 1.2 The Carpathians in Europe



ry up to the Timok Valley, which separates them from the Stara Planina Mountains (> 2,000 m.).

The Carpathians' "outer" mountain side dominates to the east and south the East-European and Moesian platforms, which extend onto Ukrainian and Romanian territories, and which have shaped the arc-like pattern of the Carpathian Mountain chain. The Eastern and Southern Carpathians are bordered by the hilly region of the sub-Carpathians and by the large Getic

Piedmont to the south. On the "inner" mountain side, the large Pannonian Depression separates the Carpathians from the Alps and the Dinaric Mountains.

The Inner and Outer Carpathians are geological units which differ from the point of view of their geological evolution. The Inner Carpathians comprise crystalline, calcareous and conglomerate rocks, and include the Tatra Mountains, Eastern Carpathians and Southern Carpathians.

The Outer Carpathians (also called the Flysch Carpathians) are composed of sedimentary rocks (turbidite) and are located in the “external” part (northern and eastern) of the Northwestern, Northeastern and Eastern Carpathians.

In Romania, the Transylvanian Depression, although a mountain form (orogen) by geological structure, is considered to be a plateau surrounded by various Carpathian ranges with respect to altitude, make-up, landscape and density of settlement.

### Different Delimitations of the Carpathian Mountains Region

For the purposes of this KEO Report and analyses contained herein, the “Carpathian Region” is defined as the Carpathian Mountain Chain and its surrounding areas. The territory surrounding the Carpathians consists mainly of sediments of Carpathian origin whose formation is connected with the evolution of the Carpathian Chain itself. Sediments are eroded from the Carpathian area and transported by rivers to the lower, surrounding territories. The area includes folded hilly regions, piedmonts and depressions, among them the Transylvanian Depression. These environs are affected by the mountainous region, and natural and anthropogenic phenomena occurring therein, and in turn exert influences on the mountain zone itself. For example, the Carpathian Mountains are a significant orographic barrier influencing the climate and precipitation of the larger region, and river outflows have a major influence on the surrounding hilly regions and plains. One counter-example of influences on the Mountains is emissions from industrial sources, transport and urbanization in commercial and population centres located in close proximity, which have impacts on the flora and fauna of the Carpathian Mountains. Economic activities practiced in the mountain region are complemented by those of the lowland and urbanized population, who exploit the Carpathians’ natural resources. Thus the mountains themselves and surrounding areas must be viewed as a complex, holistic, unique environmental system.

The different delimitations of the Carpathian Mountain chain found in the specialist literature depend on the criteria used and the purpose of research. Most authors focus essentially on geomorphological criteria along with altitude. In some delimitations, complex environmental criteria and human activities are included.

In one of the first delimitations of the Carpathian Mountains found in a French Atlas, the following sub-units are depicted: Karpates Occidentales, Karpates Orientales and Alpes de Transylvanie (Levasseur 1886). In a synthesis of the physical and human geography of Central Europe, Jean Tricart, the well-known French geographer, highlighted the discontinuous character of oro-

graphic knots with peaks of over 2,500 m. and differentiated three orographic “ensembles”: the Tatra, the Maramures and the Transylvanian Alps (George and Tricart 1954a,b).

In one of his works published in Romanian, V. Mihailescu (1963), basing his considerations on geographical criteria, geomorphological and population aspects, distinguished the following Carpathian groups: 1. North-Western Carpathians; 2. Median Carpathians; and 3. South-Eastern Carpathians (3a-Eastern Carpathians, 3b-Southern Carpathians and 3c-Western Carpathians).

One of the classifications most frequently used and based on geomorphological and geological criteria is that of the Polish geographer Kondracki (1978), who distinguishes the following main groups: the Western Carpathians (Outer and Inner); the Eastern Carpathians (Outer and Inner); the Southern Carpathians and the Western Romanian Carpathians. The Carpathian area is shown to also include the surrounding hilly regions and depressions, among them the Transylvanian Depression.

In a synthesis on European mountainous space, the Hungarian geographer Székely (1968), integrating the Carpathian Chain into the Alpine-Himalayan mountain system, distinguished the following sub-divisions: the North-Western Carpathians, the North-Eastern Carpathians, the Eastern Carpathians and the Southern Carpathians. A similar delimitation is made also in this KEO Report (see Map 1.1), although in this case the Southern Carpathians are sub-divided into two units.

In the World Wide Fund for Nature’s (WWF’s) Carpathians Ecoregion Initiative (CERI), the delimitation of the Carpathians is based on complex criteria, mainly geomorphological (elevation, slope, exposition, geology) and ecological. The Ecoregion stretches along 210,000 sq. km. between Vienna and the Danube Gorges (i.e. the Iron Gate Dam between Romania and Serbia), including the Transylvanian Depression and much of the outer hilly regions (see Chapter 3, section 3.2, Map 3.4).





## 1.1 Main Geographical Features

### Altitudinal Zones

The very existence of the Carpathian Arc in Central Europe induces significant regional differentiations and a wide diversity of geographical conditions, due to the impacts of varying influences: oceanic in the west, Baltic in the north, continental in the east and Mediterranean in the south.

There are three major Carpathian altitudinal zones: the High Mountains (>1500 m.), Middle Mountains (600-1450 m.), and the Lower Mountains and Intra-montane Depressions (300-800 m.). Overall, the Carpathians are dominated by middle and low mountains (see Map 1.3).

#### High Mountains

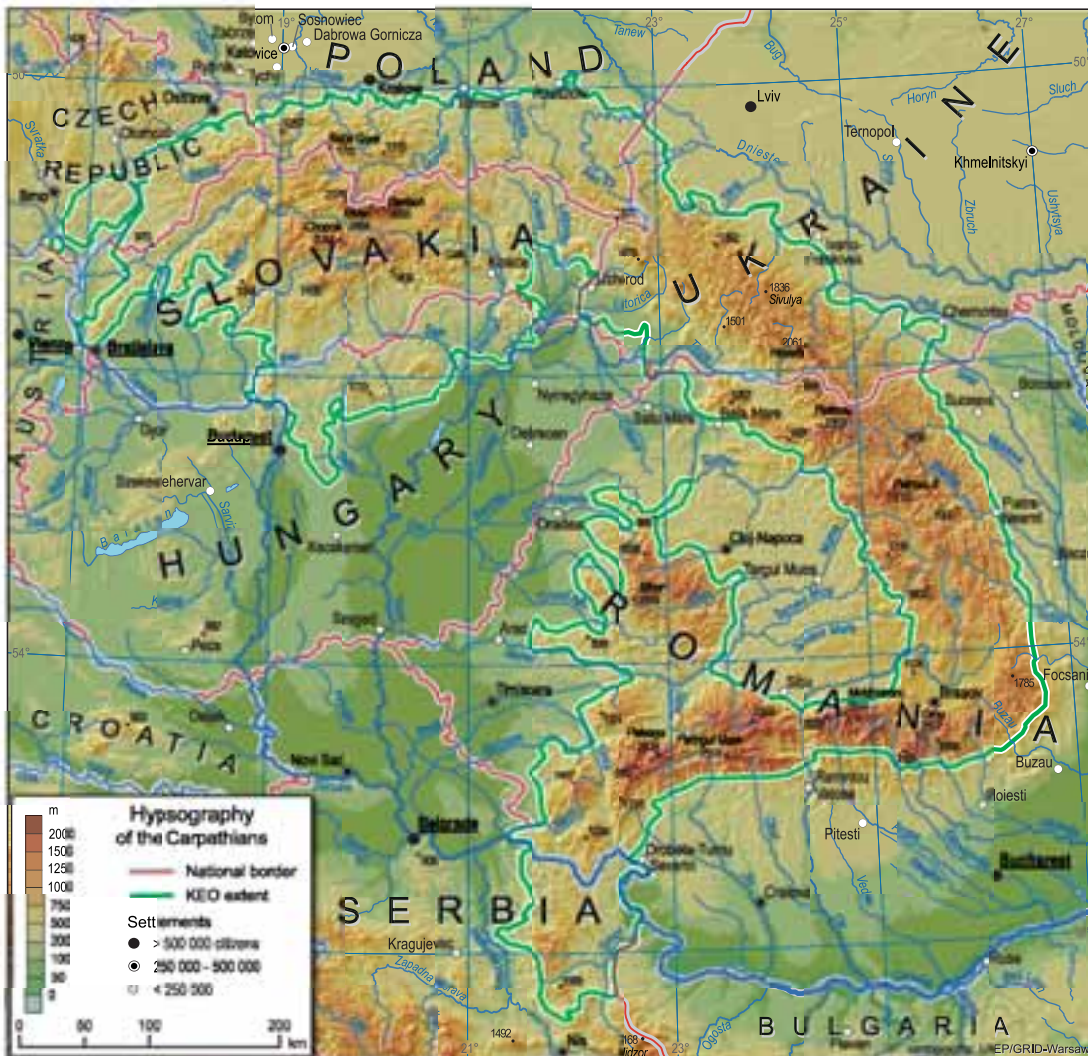
The high mountains begin above the timberline at 1,500 m in the Northwestern Carpathians, 1,600 to 1,700 m in the Eastern Carpathians and 1,800 m in the Southern Carpathians. This altitudinal zone consists of the **alpine belt** and the **sub-alpine belt**.

The **alpine belt** was molded by Pleistocene glaciation (cirques, troughs) with sharp crests and steep slopes affected by weathering, rockfall and snow avalanches. It is well-developed in the Tatra Mountains and the Southern Carpathians. The alpine belt itself is traditionally further divided into three altitudinal levels: sub-nival, with local perennial snow patches; alpine meadow; and dwarf pine. The Southern Carpathians in particular include old denuded surfaces with moderate slopes.

Alpine belt soils are dominated by inceptisols, entisols and cryogenic soils. The alpine pastures consist of plant communities with grasses and sedges, including many grass species (see Chapter 3, sections 3.1-3.3 for more details).

The **sub-alpine belt** (1100-1400 m in the north, 1400-1900 m in the south) consists almost exclusively of Norway spruce forests and dwarf pines underlain by podzols and brown acid soils. In the Bieszczady Mountains, Bukovské Vrchy,

Map 1.3 Hypsography of the Carpathians



Polonina Rowna, Polonina Krasna and Swidowiec in the Eastern Carpathians, there is no sub-alpine zone, and the timberline of dwarf beech, at a height of approximately 1,200 m, directly borders the alpine meadows and thickets of green alder.

### Middle Mountains

The middle mountains zone lies between 600 and 1100 m in the north, and 650 and 1450 m in the south, also corresponding with the forest belt. The great diversity of relief is related to the underlying geological structure, while the main process on the forested slopes is the formation of soils on debris-covered terrain.

There are large climatic variations between the upper and lower parts of the middle mountains. On average, annual temperatures range between 1.5°C and 2°C in the upper parts and between 4°C to 6°C in the lower parts. Precipitation ranges from 1,000 to 1,400 mm in the upper and 600 to 800 mm in the lower parts.

The Central European and Boreal forest ecosystems found there comprise the greatest area of the Carpathians. The three vegetation belts within the middle mountains are spruce, deciduous mixed with conifers, and beech (Pădurile României 1981).

### Low Mountains and Intra-Montane Depressions

The altitudinal zone with low mountains and intra-montane depressions (from 300 to 800 m) have a landscape severely affected by human activities. Large slope areas exhibit sheet and gully erosion and mass movements. Annual average temperatures vary between 6°C and 9°C,

with temperatures from May to August between 16°C and 18°C and the growing period lasting 180 to 190 days. Average annual precipitation is from 600 to 800 mm., and the main soil types are brown podzolised soils and podzol soils.

Forests of the foothill zone were to a large extent replaced by arable fields and meadows, so that only small forest islands have remained among farmlands.

## Rivers and Lakes

About 90% of the rivers which drain from the Carpathians flow into the Black Sea. Many, such as the Vah, Tisza (with its tributaries the Mureş, Someş and Criş), Olt, Siret and Prut lie within the Danube River Basin. In the east, the main river running into the Black Sea is the Dniester. To the north, the Vistula and the Oder flow into the Baltic Sea.

The high mountain zone includes numerous lakes situated in cirques and glacial valleys. The largest glacial lakes, such as Morskie Oko (35 hectares), are located in the Northwestern Carpathians, an area where Quaternary glaciers have their broadest extent. The Eastern and Southern Carpathians host over 200 glacial lakes, mostly in the Retezat (Bucura, Zănoaga) and Făgăraş Mountains. The Sfânta Ana lake is situated in a volcanic crater. Some small lakes are formed in karst depressions (Ighiu lake in the Apuseni Mountains) or in landslide-dammed locations (Lacul Roşu in the Apuseni Mountains).

Many water storage reservoirs are found on rivers, the largest occurring on the Danube at the

Iron Gate Dam between Romania and Serbia. Others include the Bistriţa, Argeş and Olt in Romania, the San in Poland and the Osana in Slovakia (as an example, see Figure 1.1).

Figure 1.1 The Eastern Carpathians, Izvorul Muntelui storage-lake



© Ft. Andreescu

Table 1.2 Carpathian River Basins and their characteristics (EURAC 2006)

River	Total drainage area (km <sup>2</sup> )	Drainage area within the Carpathian Ecoregion (km <sup>2</sup> )	Proportion of the total Ecoregion (%)	Affected Carpathian countries	Estuary
Danube	817,000	180,095	85.7	All Carpathian Countries	Black Sea
Vistula	194,000	21,054	10.0	Poland, Slovak Republic, Ukraine	Baltic Sea
Oder	125,000	1,772	0.8	Czech Republic, Poland	Baltic Sea
Dniester	76,860	7,336	3.5	Ukraine	Black Sea

# Climate

## Overview

The climate of the entire Carpathian Mountains arc is temperate-continental, with more extreme conditions (continental climate) increasing as one moves from west to east.

Temperature, precipitation and wind (major climatic indicators) change with altitude. The high mountain zone has a cold and moist climate with temperatures of +2°C to -2°C and precipitation of 1,800 to 2,000 mm/year in the Northwestern Carpathians. In the Eastern, Southern and South-eastern Carpathians, precipitation ranges from 1,400 to 1,600 mm/year. The highest quantities of precipitation in the Carpathians are recorded in the High Tatra Mountains at 2,000 to 2,400 mm/year.

Snow cover is present 150 to 220 days of the year in the high mountains. The present Carpathian climate no longer favours the presence of mountain glaciers which were active during the Pleistocene. Currently, some small perennial patches of snow do occur in the Tatras, as well as in the Rodna Mountains. The area of perennial snow is currently shrinking due to rising average annual temperatures in the Carpathians, an apparent sign of climate change in the region (see Chapter 3, section 3.6).

The Carpathian Mountain chain also functions as an important obstacle to the circulation of air masses over Europe. By their position, the Carpathians act as a barrier between the harsher continental climates of the east and the milder, oceanic ones in the west, boreal in the north and Mediterranean in the south. These general characteristics vary in terms of radiation and the circulation of air masses, directly reflected in plant associations and in soils, and indirectly in all the natural components of the mountainous environment.

## Climate change

The Third Report of the Intergovernmental Panel on Climate Change (IPCC) revealed that 20th century global warming registered a rise of temperature of  $0.6 \pm 0.2^\circ\text{C}$ . The last decade of the 20th century is considered to be the warmest since instrumental observations began (1861). There is strong evidence that global temperature increase in the 20th century surpassed natural climate variability over the last thousand years. Natural changes featured a warm period (11th-14th centuries) and a cooling interval known as the Little Ice Age (15th-19th centuries). According to the most recent projections of the IPCC, the average temperature on Earth could rise from 1.4 to 5.8°C above the 1990 level by 2100, with higher values expected in the Northern Hemisphere (IPCC 2001).

In the Alps, the timberline may advance by up to 500 to 600m (100 m with every 0.6°C temperature rise). Extrapolating these data to the Carpathians may be instructive. In 20th century Romania, the annual average temperature rose by 0.2°C, at a much faster pace after 1960 (Busuioc 2003). A temperature increase might result in the modification of altitudinal belts, mainly in the possible extension of the temperate forest realm.

Global warming has intensified extreme phenomena such as torrential rainfalls, lengthy droughts and sudden snowmelt. Such extreme phenomena, along with enhanced erosional processes, landslides and floods are often further augmented by deforestation in various Carpathian areas. Flooding as a hazard has some of its most serious impacts on settlements, transportation and agriculture. Floods are generated by prolonged heavy rainfall, snowmelt or both. Local flash floods resulting from heavy convective rains are frequent in summer but are restricted to small catchments, particularly in the Eastern Carpathians.

## Geological History and Geomorphological Units

### Overall Geology

The Carpathian Mountains, the eastern continuation of the Alps, are a young mountain chain (Demek 1983). The present-day relief is the outcome of the alpine orogenesis, although Palaeozoic and Mesozoic landforms exist as well. Compared with the Alps, the Carpathians have lower altitudes and are more fragmented by tectonic depressions and transversal valleys.

The major factors which have contributed to the formation of the Carpathian-Pannonian system are the convergence of the Adriatic and Eurasian plates, collision with the Alps and lateral escape of crustal wedges towards the east and north, subduction and rollback of the Eurasian plate and the shape and structures of the Eurasian margin with its northwest trending faults (Visarion and Sandulescu 1988).

The Carpathian Folded Belt consists of a complex Alpine nappe pile of crystalline units and Upper Palaeozoic-Mesozoic sediments, with a Lower Cretaceous-to-Tertiary sedimentary cover. The structure itself includes the domain of the regions active during the Mesozoic and Cenozoic, regions folded in the Alpine Orogenesis (Sandulescu 1984).

### Five Mountain Groups

Transversal valleys and low mountain areas and depressions divide the Carpathians into the following mountain groups: (1) Northwestern Carpathians in the Czech Republic, Slovak Republic, Hungary and Poland; (2) Northeastern Carpathians in Poland and Ukraine; (3) Eastern Carpathians in Romania and Ukraine; (4) Southern Carpathians in Romania; and (5) Southwestern Carpathians in Romania and Serbia.

**(1) The Northwestern Carpathians** represent the highest part of the Carpathian Arc and consist of mountain ranges and massifs separated by intra-montane basins. Their central part is formed by the Tatra Mountains with altitudes

over 2,000 m built of crystalline and Mesozoic sedimentary rocks. Slovakia's Mount Gerlachovsky is the highest at 2,655 m. The High Tatra Mountains show a typical alpine relief with extensive glacial landforms. The outer part is shaped by flysch mountains with altitudes of 1,000 to 1,700 m and characterised by a folded nappe structure, while the inner part is represented by the volcanic massif of the Central Slovakian Mountains. In the south, one finds the Mátra and Bükk mountains surrounded by low piedmont areas alongside the contact line with the Great Hungarian Plain.

**(2) The Northeastern Carpathians** unfold between the Dukielska Passage (Poland) and the upper sectors of the rivers Tisza and Ceremusch (a tributary of the Prut River in Ukraine). The maximum altitude is found at Goverla Peak at 2,061 m. These are middle and low mountains, fragmented by numerous valleys and depressions and home to many human settlements. Their eastern part, the most extended, consists of Cretaceous flysch and Palaeocene deposits corresponding to the east of the Beskidy Mountains and the 'Forested Carpathians' (Lisyti Karpaty). In the west, the Vihorlat Mountains display several isolated summits with Neocene volcanic features.

**(3) The Eastern Carpathians**, which extend between the upper Tisza River in Ukraine and the Prahova River in Romania, present three longitudinal morphostructural sectors. The eastern outer side, with altitudes of 1,000 to 1,800 m, is built of Palaeocene and Cretaceous flysch deposits with a complicated folded and nappe structure. In their southeastern part lies the Vrancea seismogenic area. The central part displays discontinuous crystalline massifs partly covered with sedimentary Mesozoic rocks, reaching its highest altitudes in the Rodna Mountains (2,303 m). The western part, with its highest altitude in the Călimani Mountains (2,100 m), corresponds to the longest Neocene volcanic chain in Europe, with well-preserved extinct volcanoes.

**(4) The Southern Carpathians**, or so-called ‘Transylvanian Alps’, rise from 1,800 to 2,500 m to the 2,543 m Moldoveanu Peak in the Făgăraş Mountains. They extend from east to west between the Prahova and the Timiș-Cerna valleys and are formed predominantly from crystalline rocks with secondary Mesozoic sedimentary rocks. The upper part of the massifs, the Bucegi, Făgăraş, Parâng and Retezat, feature Alpine-type glacial landforms and vast denudation surfaces.

**(5) The Southwestern Carpathians** extend into Romania and Serbia and show a very complex block and fold-faulted structure. They are very fragmented by numerous tectonic depressions and reach altitudes of 700 to 1,500 m. The highest point is Curcubăta (1,847 m) in the northern part (Apuseni Mountains) built of a mosaic of crystalline, flysch and Neocene eruptive rocks. The central and southern parts (the Banat and Serbian mountains) consist predominantly of crystalline rocks with a large karstified limestone syncline.

## Landforms and Geological Monuments of Note

The Carpathians are home to many interesting landforms and geological monuments such as the Iron Gate (see Figure 1.2), one of the largest gorges in Europe, caverns and landforms shaped by erosion on volcanic rocks, and massive orographic knots (over 2,000 m) which alternate with middle and low mountains. Certain fossil-rich sites of international importance represent standardised stratigraphic reference points for various geological periods, while a number of other sites are considered natural monuments.

Significant national parks and biosphere reserves include: Duna Ipoly and Bükk and Aggtelek (Hungary); Djerdap (Serbia); Tatra, Pieniny, Babia Gora and Bieszczady (Poland); Retezat, Rodna, Piatra Craiului and Ceahlău (Romania); Tatras, Poloniny and Polana biosphere reserves, Low Tatras, Malá Fatra, Slovensky raj and Pieninský (Slovakia); and Uzhansky National Park, part of the ‘Eastern Carpathians Biosphere Reserve’ which is shared by Poland, Slovakia and Ukraine.

Limestone areas hold many caves, including Domica and Dobšinská ľadová in Slovakia; Aggtelek in Hungary; and Cloșani, Cioclovina and Scărișoara in Romania. There are also cave glaciers such as the Scărișoara Cave Glacier in Romania’s Apuseni Mountains and the Dobinska Cave in Slovakia, important for reconstructing Quaternary climates. The karst plateau Padiș in the Apuseni Mountains is one of the most complex in Europe.

Figure 1.2 The Danube Gorge in the Iron Gate Natural Park



The Northwestern Carpathians exhibit impressive alpine relief with large glacial cirques and valleys carved by glaciers from the Quaternary Period, some of them on the northern side coalescing with the continental ice sheet. The western side of the Eastern Carpathians presents the longest volcanic chain in Europe, no longer active today, featuring a multitude of fumaroles<sup>2</sup>, mofettes<sup>3</sup> and over 2,000 mineral springs used in well-known

<sup>2</sup> A fumarole is a hole or vent in the ground near a volcano that emits steam and gases such as carbon dioxide, sulphur dioxide, hydrochloric acid and hydrogen sulphide.

<sup>3</sup> Volcanic discharges consisting primarily of carbon dioxide, often associated with other vapours, representing the final phase of volcanic activity.

spas. On the eastern and southern side, adjacent to the Carpathians over a distance of 550 km., is a hilly region with altitudes of 300-800 m, consisting mostly of folded and faulted Neocene molasse<sup>4</sup> deposits with densely populated depressions. On salt deposits there are plateaus dotted with sinkholes, lakes and caves.

<sup>4</sup> Terrestrial deposits (i.e. non-marine alluvial and fluvial sediments) eroded from a nascent mountain chain and deposited in a foreland basin, especially on top of flysch.

The Southern Carpathians, also known as the Transylvanian Alps, boast the largest alpine and sub-alpine pastures in Europe and environment for intense transhumant sheep herding. The pasture lands, which cover extended hanging plateaus, were studied in the early 20th century by the French geographer Emmanuel de Martonne, who introduced for the first time in Europe the landscape evolution approach of the American geographer William M. Davis.

## Biodiversity

From a bio-geographical point of view, the Carpathian Mountains represent a link between the taiga of Northern Europe and the Mediterranean ecosystems of the south. They include the largest pristine forests in Central and Western Europe, with the greatest original European forests located in the Southern and Eastern Carpathians (Romania) and in the Tatra Mountains (Slovakia).

The rich variety of endemic plants and animals, characteristic of Carpathian ecosystems is an essential biodiversity component in Europe. The area has many large carnivores (e.g. the brown

bear, lynx and wolf) facing extinction in other mountain chains in Europe. Many bird species, such as the imperial eagle, Ural owl and black grouse are protected.

The Carpathians were put on the WWF “Global 2000” list of major ecoregions in need of biodiversity and habitat conservation. Since 1999, the Carpathians were also included in the “Carpathian Ecoregion Initiative (CERI)” geared to the integrated conservation of their natural and cultural heritage and sustainable, cross-border development.



## 1.2 Human Influences in the Carpathians

### Historical-Political Background

#### Early times up to 20th century

Located in the heart of Europe, the Carpathians have since centuries ago been at the contact point of empires, ethnic groups and cultures. The Carpathian area has been part of several states and empires. The current ethnic mix (Czechs, Germans, Hungarians, Poles, Romanians, Serbs, Slovaks and Ukrainians, and minority groups such as the Roma) is the reflection of a turbulent history.

In ancient times, the conquest of Dacia by the Roman Empire in AD 105 was marked by the construction of fortified cities (*davae*), spas and health resorts (e.g. Herculaneum). Even after the Romans' withdrawal south of the Danube from 270-275, their language of Latin-Romanian was to be preserved in the Southern, Southwestern and Eastern Carpathians. The inhabitants of Dacia were known as *Getae* in Greek writings, and *Dacians* in Roman documents.

Beginning in the 4th century, the process of migration of peoples gained momentum. The Huns crossed the Carpathians and settled in the Pannonian Plain. As the Visigoths withdrew from the southern part of the Eastern Carpathians, they left a treasure hoard (the so-called "Hen with the Golden Chickens") containing 22 pieces of gold, found at Pietroasele (in Buzău County, Romania) (Constantiniu 2002). The 6th and 7th centuries marked the massive migration of Slav populations (the Eastern Slavs i.e. Ukrainians; and the Western Slavs i.e. Poles, Slovaks and Czechs) and their gradual settlement across the Carpathians.

During the 8th and 9th centuries, the Carpathian territory with its surrounding plains and tablelands, experienced the passage of other migratory populations including Petchenegs, Cumans and Tartars. Many of these were assimilated with other cultures in the region.



From the 11th to 13th centuries, in order to secure the borders of the Hungarian Kingdom against the inroads of migratory populations, the western side of the Eastern Carpathians was colonized with Szecklers (a population mix of steppe migrants, who had followed the Hungarians on their way to Europe) and Saxons (from Flanders, Luxembourg, the Mosel and Rhine regions, and from Saxony, as brought in by the Hungarian kings) (Atlas Istorico-geografic 1996). From the 16th to 19th centuries, the Kingdom of Hungary fell under Habsburg domination, subsequently forming the dual Austro-Hungarian monarchy which lasted from 1867 to 1918.

### The 20th century until present

The First World War mirrored the conflicts smouldering within the multi-national Austro-Hungarian Empire. Czechs and Romanians sought autonomy, the various southern Slavic territories aimed at the unification of their Habsburg-dominated lands with the Kingdom of Serbia (independent, although occupied at the time), and Russia pursued its own political goals in the Balkans (Kinder and Hilgemann 2002a,b). The proclamation in 1916 of the Autonomous Polish Kingdom, which led to its breaking away from the Austro-Hungarian empire without Galicia, and its later evolution illustrate the national aspirations of peoples in the Carpathians.

The treaties concluded at the end of the First World War sanctioned, among other territorial changes, the foundation of Yugoslavia and Czechoslovakia. During the interwar period, some border changes took place in the Carpathian area between Hungary and Czechoslovakia (Linchutz 2000, cited by Jansky et al. 2004).

For a short period of time (1940-1946), Northern Transylvania was annexed by Hungary under the 1940 Vienna Diktat. Bessarabia and Bucovina were occupied by the Soviet Union and integrated into its territory. After the Second World War, the redrawing of borders left most of the Northeastern Carpathians under Soviet rule.

Major historical and political changes took place during the last three decades. The Carpathian countries were members of the Council for

Mutual Economic Assistance (COMECON) and the Warsaw Military Pact (except for Yugoslavia), and Ukraine was part of the Soviet Union until breaking away in 1991.

With the rise to power of the communist regimes, the natural resources of the Carpathian countries such as wood and ores began to be forcibly exploited by Soviet-dominated enterprises. The collectivisation of agriculture, intense deforestation and implementation of centrally-based joint plans within the COMECON framework had profound negative effects on the Carpathian environment.

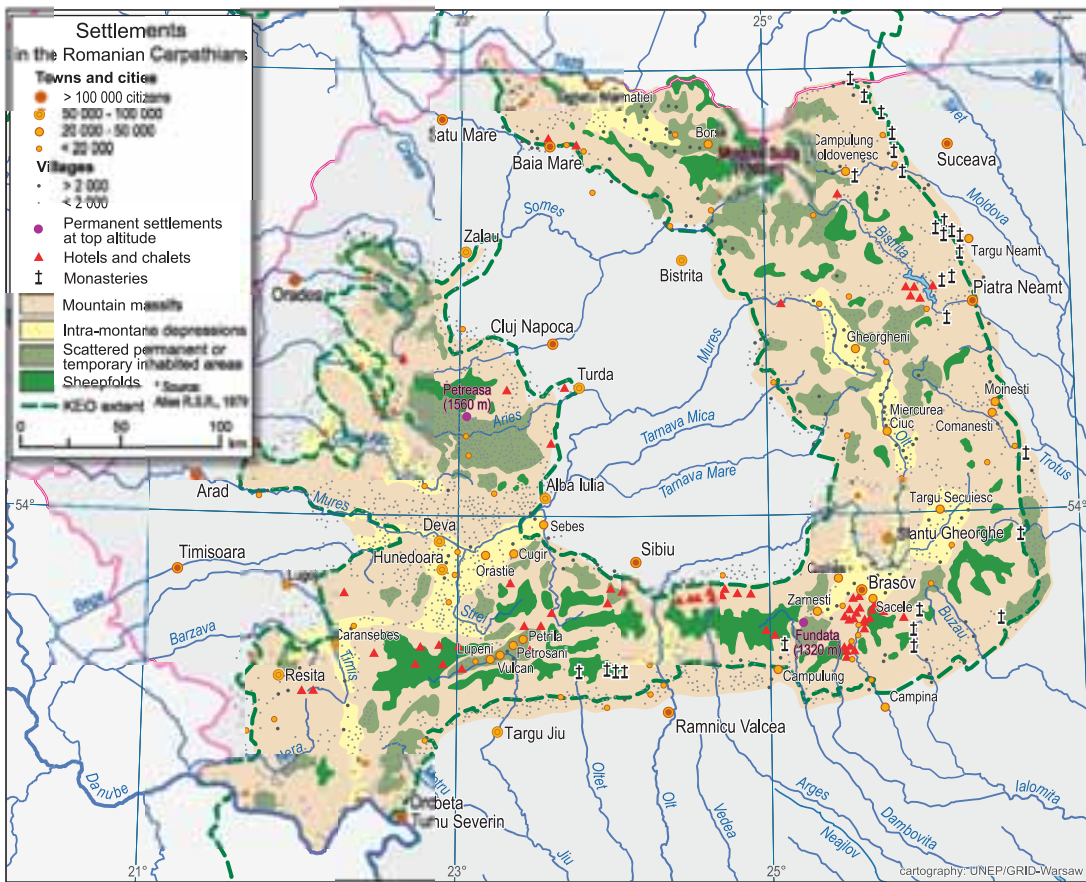
All the Carpathian countries, albeit at a different pace, have undergone a significant political, economic, social and environmental transformation in the past 15 years. In most countries, radical political changes occurred in 1989 to 1991 that resulted in free elections in various forms and the establishment of pluralistic democracies and separated branches of power.

In 1993, following a political decision, Czechoslovakia was split into two independent countries, the Czech Republic and Slovak Republic. In 1991, Ukraine broke away from the Soviet Union. During the 1990s, the former Yugoslavia gradually lost its territorial integrity, and a series of Balkan wars took place.

Since the early 1990s four countries (the Czech Republic, Hungary, Poland and Slovakia) began their integration process with the European Union that culminated in membership on 1 May 2004; Romania joined the EU on 1 January 2007. Serbia is participating in the stabilisation and association process, while Ukraine is a part of the EU's recently developed "Neighbourhood Policy".

Today, the seven Carpathian states continue to experience various forms of transition from centralised communist to free market economies. They shelter 16 to 18 million people, where lowlands and valley corridors have high population densities and intensely utilized trans-Carpathian traffic routes. Numerous settlements are located on summits and plateaus up to 1,600 m, but densities are significantly greater at 500-1,100 m altitude (see Map 1.4).

Map 1.4 Settlements in the Romanian Carpathians



## Cultural Heritage

### Overview

Many traditions, artefacts, ruins, archaeological sites and monuments have been preserved from the many peoples, cultures and empires that have come and gone in the Carpathians since prehistoric times. Interestingly, the multitude of passes, depressions and valley corridors facilitated inter-ethnic contacts and helped to develop and reinforce common ethnographic elements. Many sites are used for touristic purposes (see Map 1.5).

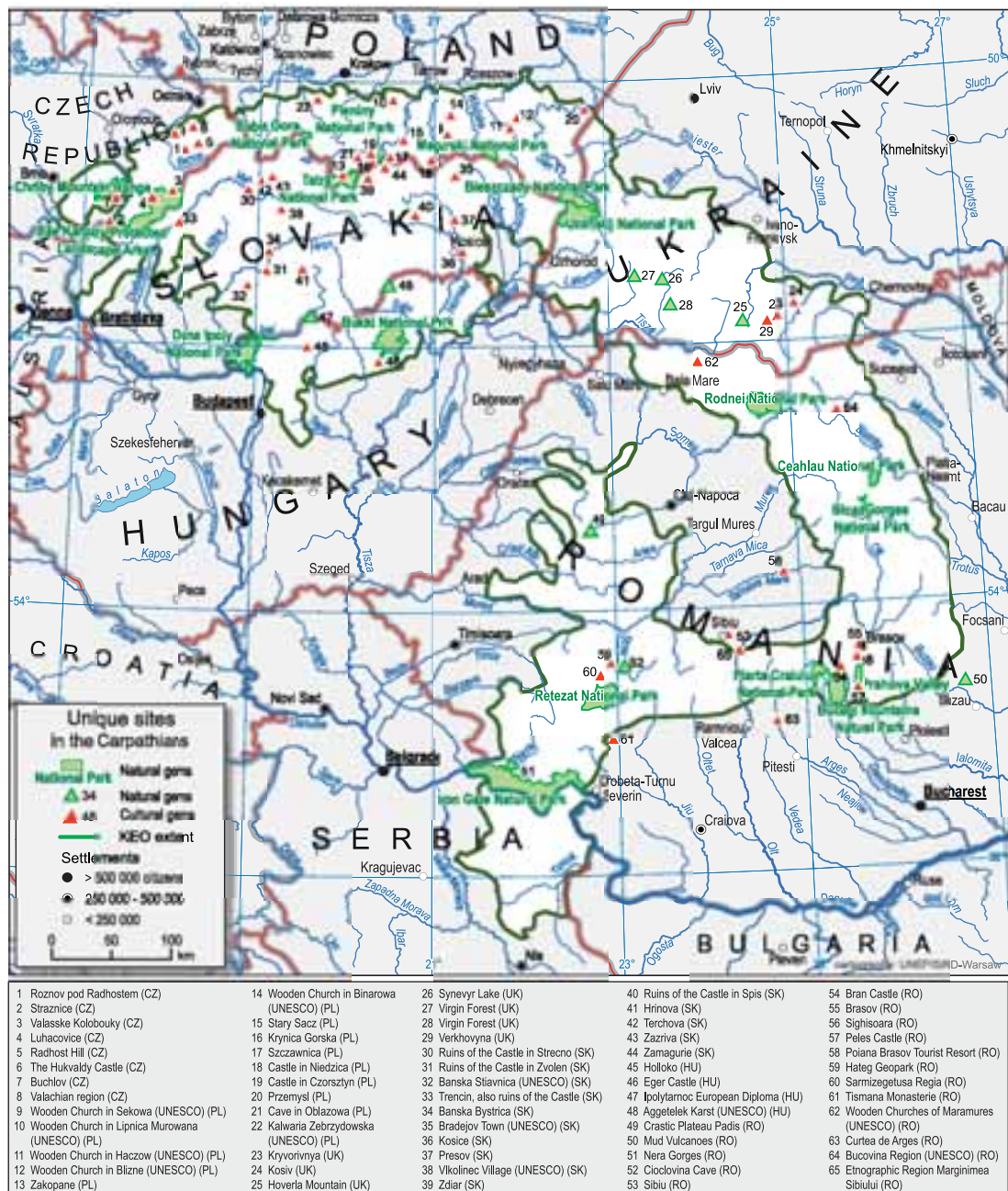
A complete human mandible, dated over 35,200 years ago, was discovered in Peștera cu Oase (Cave with Bones) in the Banat Mountains. This is the oldest fossil remnant of a modern human

in Europe (Quiles et al. 2006). Many bear (*Ursus Spelaeus*) skeletons can be seen in Peștera Urșilor (Bears' Cave) in the Apuseni Mountains, while the Hațeg Geopark in the Southern Carpathians shelters dinosaur fossils.

The Carpathians and their surroundings have proved to be an attractive environment for settlement and human economic activities for ages. Major economic activities have been wood processing, mining, animal husbandry and agriculture, the latter mostly practiced in lowlands and mountain depressions (see Figure 1.3).

The first elements of a Carpathian culture date back to the Palaeolithic and Neolithic Ages.

Map 1.5 Unique sites in the Carpathians



Lower Palaeolithic stone items such as chopping tools, as well as pottery, bronze and iron objects have been discovered in various mountainous and depression sites in the Carpathians. Highlights include the 22,000 year-old *Venus of Mosavany* statuette found carved into a mammoth tusk in Slovakia (Lacica 2002). Another is *Sarmizegetusa*, in the former Geto-Dacian capital located in the Southern Carpathians, home to a solar monument similar to the one found at Stonehenge.

Many remnants from Roman times have been preserved including the ruins of Roman settlements and roads. In the Northwestern, Southern and Southwestern Carpathians, Roman fortified cities (*davae*), mines and spas (e.g. Herculanium) can be found. At Drobeta Turnu Severin are the ruins of the bridge built in 103-105 by Apollodorus of Damascus at the point where the Romans crossed the Danube downstream of the Iron Gate (see Figure 1.4).

Figure 1.3 The Carpathians seen from space



In medieval times, traditional occupations included raising livestock, coal mining and agriculture, one result of which was forest area reduction. From the 12th to the 15th centuries, population density was about nine to ten inhabitants per sq km, concentrated mostly on the hill-sides. Beginning in the 14th and 15th centuries, Wallachian shepherds inhabited the northern Carpathians, in the territories of what are today Poland and Slovakia. This was also the time of the Carpathian civilization of woodworking and the related development of handicrafts.

The first paper mills appeared in the Carpathian lowlands in the 16th century. In the 17th and 18th centuries, when wood increasingly became an export commodity, extensive tree-cutting

became a common practice. This intensified after the Adrianople Peace Treaty of 1829, which concluded the war between Russia and the Ottoman Empire, when wood and wooden products were in great demand abroad. Another period of severe deforestation was connected with post-1920 land reforms that led to the expansion of pastures and arable land.

The villages in the Bile Karpaty, a Protected Landscape Area and Man and Biosphere Reserve situated in the east of the Czech Republic along the border with Slovakia, preserve many old Wallachian traditions such as folk dancing and music, and musical instruments such as the *cymbalo* (dulcimer).

Figure 1.4 The bridge built by the Romans downstream of the Iron Gate (Southwestern Carpathians), A.D. 103-105 (Istoria Românilor 2001)



### Traditional settlements

In many existing Carpathian settlements, the ethnographic traditions of the Hungarians, Poles, Romanians, Ruthenians, Slovaks, Szecklers, Transylvanian Saxons and Ukrainians can still be observed. Traditional village architecture is

features, as well as original ethnographic and folklore elements.

In Roznov pod Radhostem, Straznice and Valasske Klobouky in the Czech Republic, there are open air museums of folk architecture. In Hungary, the Old Village of Hollókő and its surroundings and Tokaj Wine Region Historical Cultural Landscape are important tourist destinations. In Poland, old wooden churches, including the Orthodox churches in Bieszczady and Beskid Niski and traditional wooden architecture in Zakopane, exemplify Polish wood culture.

Figure 1.5 Traditional handicrafts, potters from Horezu town



© FI. Andrescu

fitted to local landforms. Rural settlements in the Carpathian Mountains contain numerous elements of traditional architecture such as old houses and wooden churches with specific local

In the Slovak Carpathians there are many villages such as Liptovská, Teplička, Detva, Hriňové, Terchová, Zamagurie with a traditional agriculture and attractive cultural landscapes. Eastern Slovakia is home to Vlkolinec village, a UNESCO cultural heritage site, and wooden churches from Osturná, Ždiar and Podbiel with open air museums.

In the Ukrainian Carpathians, the Hutsul culture is well preserved in Kryvorivnya, a village in the Kosiv centre of folk handicrafts and in Verkhovyna town (former Zhab'ya – the capital of Hutsulshchyna). Some villages in Romania's Apuseni, and the Vrancea and Maramureş mountains, are famous for their artistic and artisanal products (see Figure 1.5).

## Sibiu through the ages

The present town of Sibiu, Romania, sits atop the former site of the Roman settlement known as Cedonia. In 1191, Saxon colonists founded a new town there and named it Cibinium, after the name used by the Roman population who inhabited these places in earlier centuries. In 1223, the town was baptised Villa Hermanni and in 1366 it became known as Hermanstadt. In the 15th century, it became the capital of the Transylvanian Saxons and was known as a major handicraft and trading centre surrounded by fortified walls and bastions. In 1599, the Romanian Prince Michael the Brave defeated the Hungarian army near this place and for a short time united Transylvania with Wallachia and Moldavia. In the 18th century, the town had four printing-houses, and the renowned Brukenthal Museum was founded in 1817.

Sibiu, the Cultural Capital of Europe in 2007, today has many Renaissance and Gothic style buildings, some of them with important cultural functions such as the History Museum, Old Town Hall and Franciscan Church with Gothic architecture. It is home to the largest German community in Romania, and has a highly multi-ethnic character with Magyars, Slovaks, Ukrainians and Roma living side by side with Romanians and Germans. South of the town in the Southern Carpathians, people from numerous settlements (Răşinari, Sălişte, Jina, etc.) are engaged in shepherding, a very old tradition there.

## Castles and monuments

Mountain depressions and valley corridors shelter medieval castles and ruins. In the Southern Carpathians, castles are seen at Sinaia and Bran (Figure 1.6), built in a variety of styles (Gothic, Baroque, Renaissance, Neo-Classical). Many other monuments dating to the Middle Ages can be found in the medieval cities of Braşov and Sibiu.

Figure 1.6 The Bran Castle in the Rucar-Bran Corridor



In Poland, medieval monuments in the cities of Stary Sacz and Przemysl, the traditional spas in Krynica Gorska and Szczawnica and the castles in Niedzica and Czorsztyn (from the Pieniny area) are important cultural heritage sites.

In the historical centers of some of the mountain towns in Slovakia such as Banská Štiavnica, Bardejov, Banská Bistrica, Prešov, Bratislava and Levoča, there are attractive medieval monuments such as the Church of Our Lady, Barbican, Bratislava Castle and the Old Town Hall. Some of the most important medieval castles and ruins are located in Devin Spiš, Zvolen and Krásna Hôrka.

The Hukvaldy castle, the second largest in the Czech Republic, was destroyed by fire in 1762, but the gothic castle of Buchlov is well-preserved. Cultural heritage sites, such as Lednice-Valtice Cultural Landscape and Castle and Gardens of Kromeriz (Czech Republic) are particularly valuable due to their architecture and setting.

In Hungary, the Eger castle is well-known as the site of one of the largest battles against the Ottomans. The Castle of Diósgyőr (near Miskolc) belonged to the then-queens of medieval Hungary. Sárospatak (at southern foothill of Zemplén Mountains) is known by its famous Rákóczi castle and fortification built in the early 13th century by King Endre I.

## Religious traditions

In many places, religious festivals contain elements of pre-Christian traditions. In the Czech Republic on Radhost Hill is the statue of Rade-gast, the pagan god of crop abundance and harvest.

In the Southern and Eastern Carpathians people preserve numerous pre-Christian beliefs, praying to the Geto-Dacian gods to bring or stop the rain, chase away disease and evil and secure abundant crops. Many cultural-religious traditions connected with transhumant shepherding are practiced by local peoples mainly during two seasons: in winter, when the Wolf (the embodiment of darkness and cold) reigns supreme, and in summer, when the Horse (the personification of light and warmth) is master of the realm (Ghinoiu 2005).

The presence of the primeval forest has engendered many traditions and legends which Mircea Eliade, a famous Romanian historian of religion, fiction writer and philosopher, named “Cosmic Christianity”. Cosmic Christianity is a peasant-centred religion and popular theology built on the significance of religious folklore and reflecting the life of common people. Cosmic symbols and folkloric themes such as Water, Tree and Vine were passed on to the Church, giving them sacramental meaning. Illustrative, too, is a Christian-linked liturgical service held in the open and not in a church, invoking one’s living in harmony with nature.

## The Monasteries of Bucovina

In Romania, the original painted churches of Bucovina, as well as Tismana and Horezu monasteries, and the peasant strongholds and fortified churches found at the contact line with the Transylvanian Depression, are sites of great cultural value.

Many monasteries and churches from Bucovina, a province in the north of the Eastern Carpathians, such as Voroneţ, Moldoviţa, Suceviţa, Humor and Arbore, are listed as UNESCO Mankind Heritage protected sites. Frescoes, representing biblical scenes, saints, apostles and martyrs cover the inner and outer walls of these monuments. The churches were built using a triconch plan with a combination of Byzantine and Gothic vaults (the ‘Moldavian vaults’) (Vătăşianu 1974). The painted frescoes used tempera to preserve their 15th-century brightness, thereby making an original contribution to world art.

The best-known monastery is Voroneţ built by Ruling Prince Stephen the Great in 1488, known for the exquisite beauty of its blue paint (the ‘Voroneţ blue’) which won it the name of “Sistine Chapel of the east”.

The Humor Monastery depicts the Devil in the guise of a woman, the painter having drawn his inspiration from a local legend, while the Putna Monastery (1466-1470) boasts an impressive 17th-18th century decoration, the hall-mark of Moldavian Baroque. The Monastery houses a museum displaying important exhibits of Eastern Christianity.

The fortified Moldoviţa Monastery (1532) has a famous painting on its northern wall that is “The Siege of Constantinople”. Numerous rural settlements, known for their outstanding ethnographic and handicraft traditions, are found in the neighbourhood of the Monastery. One of them, Marginea Village, is famous for its black pottery.



## 1.3 Modern-day Impacts on Environment and Current Responses

### Impacts from the Communist Period

Carpathian countries inherited severe environmental problems from more than 40 years of communist rule, as their economies were heedless of environmental impacts and thus far more polluting than in the rest of Central and Western Europe. Many environmental “hot spot” zones were created having extreme pollution loads, environmental degradation and related human health risks. The Stalinist period which lasted until 1956 was especially harmful, encouraging Central European countries to choose their “own road to socialism” with an overriding slogan of “man is master of nature”.

The industrial structure of these countries was dominated by over-sized and heavy industry. Steel, chemicals, mining, heavy machinery and energy were dominant economic sectors in this region, while the military-industrial complex enjoyed special priority. Some of the chemical works and metallurgy plants were located in narrow, poorly ventilated Carpathian mountain

valleys or basins. Nearly every town had at least one environmentally-harmful factory. Another typical result of the ill-planned industrial structure was a high, inefficient consumption of energy, mainly generated by low-quality and highly-polluting fuels. In addition, there were no incentives to introduce efficient or environmentally-friendly technologies. Degraded areas around mining sites and heavy pollution produced by the chemical and steel industries were also common.

“Industrial(-scale) agriculture” also degraded the environment. Hygienic problems stemmed from large-scale breeding farms which were not adequately equipped with sewage systems, protective green space or other mitigating infrastructure. The heavy use of industrial fertilizers and pesticides had serious impacts on life in soils, underground waters and the entire biosphere, including the health of local inhabitants.



The previously-existing process of deforestation was accelerated during the communist era when forest cutting was intended to clear terrain for agriculture and as a necessary step to continue the process of forced industrialization.

In some parts of the Carpathians, another typical feature was Soviet-style urbanization based on large, agglomerated settlements. These mostly

concrete panel block buildings are still one of the most visible urban legacies of the past regime. Conceptual, legislative, organizational and technical ignorance of the scope of problems, such as communal waste, caused the proliferation of thousands of unsanctioned rubbish dump sites. In most countries, there was also a general absence of ecological education.

## Current Key Environmental Concerns

In general, human-related pressures on the Carpathians are currently greater than in other mountain ranges of Europe. In addition, in the face of globalisation, the Carpathians exhibit great fragility and the mixed blessing of limited accessibility (Jodha 2005).

This is due partly to the large variations among the countries in terms of development levels, their stage of accession to the EU, economic transition and the management of resources. From a start in 1989, the transition to market economies in the Carpathian countries has posed a specific challenge to mountain areas which is, quite simply put, how can development take place in an environmentally sustainable way?

While there is cause for optimism in regard to a number of environmental indicators for the Carpathian region (such as emissions of major air and water pollutants, air and water quality indicators, industrial and agricultural waste production, clean-up of hazardous and toxic waste sites, and reduced natural resource consumption) which show mainly positive trends, there are many areas where vast improvements remain to be made and many related issues of concern. The following is a list of the current major driving forces and pressures, and associated environmental problems, that need to be addressed:

- Issues related to environmental security, and particularly global climate change and its re-

gional/local manifestations; these include floods, landslides, windstorms (which can have major impacts on forests and infrastructure) and drought.

- Land use change and deforestation, related erosion and links to enhanced effects of or caused by hydro-meteorological phenomena. In some cases, uncontrolled deforestation and illegal logging have resulted in major damage to landscapes.

- Significant development of individual car transport and related environmental impacts.

- Implementation of new construction projects (e.g. large dams, highways, factories, harmful mining technologies, mountain winter-sport resorts).

- A significant rise in the total amount of municipal waste, and enhanced problems of waste management at the local level, stemming from improved economies/increased consumerism and the import and wide utilization of non-recyclable materials.

- In relation to unsustainable land development, the growing pressure of some interest groups (such as developers), combined with the relatively weak position of some environment ministries and other regulatory authorities at the international, regional, national and local levels.

The following Chapter 2 describes these current driving forces and pressures in detail as they occur across the Carpathian region and its varying human and natural landscape.

## Existing Responses (e.g. policies and programmes)

### Pre-CFC

The state of and development trends in the Carpathian environment, described in detail in Chapter 3, are influenced by such driving forces and pressures mentioned above. On the more positive side, there are also existing legislation, policies and programmes, at the international and European, as well as Carpathian regional and national levels, which are designed to respond to current environmental impacts and problems. These include, among other response measures: international treaties; multi-lateral environmental agreements; European Union (EU) legislation, directives, strategies and funds; national environmental legislation, programmes and strategies; and of course Carpathian regional and local development plans, programmes and strategies, the foremost instrument of which is the United Nations Framework Convention on the Protection and Sustainable Development of the Carpathians (Carpathians Framework Convention, or CFC for short).

The involvement of civil society, including non-governmental organisations (NGOs), academia (universities, academies, schools), pro-active individuals and the mass media is also a positive trend within the Carpathian region. These groups all help to create awareness of environmental issues and sustainable development, and not only generate but disseminate new knowledge and educate the broad public and society in general.

A number of key current policy instruments are introduced here and expanded on in later chapters of this KEO Report. Among the most prominent existing measures are:

### The Carpathian Framework Convention

The only instrument focused exclusively on the Carpathian region itself is the Framework Convention on the Protection and Sustainable Development of the Carpathians, elaborated on the Alpine Convention model, at UNEP's initiative,

and signed in Kiev in May 2003. An important role is played by the UNEP Interim Secretariat for the CFC in Vienna, which is working to develop synergies among policy-makers, the general public and different international organizations active in the Carpathian region.

### Other legislation and conventions

The new regulations targeting the environment are basic to improving the quality of the environment and to promoting cooperation among the Carpathian countries.

Even though countries of the Carpathian region have adopted new environmental legislation since the 1990s, there are areas in which this legislation is ineffective in preventing environmental damage from taking place, and particularly in protecting natural resources against over-exploitation.

Environmental legislative processes have yielded mixed results. Modern legislation has been adopted and is EU-compatible in the Visegrad countries (e.g. the Czech Republic, Hungary, Poland and Slovakia), and later in Romania as well. In Serbia and Ukraine, however, the degree of compatibility with EU norms differs.

Protected areas in Serbia and Ukraine fall under the EMERALD network of the Pan-European Network of Protected Areas based on the Bern Convention. Both the EMERALD and Natura 2000 (see below) networks are based on the Bern Convention and are interconnected.

The Convention on Biological Diversity (CBD) must also be mentioned as a tool of international cooperation for the Carpathian region, given that the Carpathians are considered to be one of the 200 most important world biomes.

### EU-specific

The accession of the Czech Republic, Hungary, Poland, Slovakia and Romania to the EU has

imposed requirements on these countries to adopt all EU legislation (*acquis communautaire*) including those directives related to matters of the environment. This includes the areas of air quality, waste management, water protection, nature protection, industrial pollution control, risk management, genetically modified organisms and nuclear safety. One benefit is that the new Member States to the EU can learn from the collective experience of the earlier EU Members. EU legislation requires that many earlier and current environmental problems be resolved with an eye towards long-term sustainable management of natural resources and the environment.

For the five Carpathian EU member countries, the Directives and Regulations issued by the EU meant a step forward regarding international cooperation on the Carpathians. Noteworthy among such policy instruments are those involving cross-border cooperation, namely the Water Framework Directive and the Birds and Habitats Directives, for which the Natura 2000 Network was established as one response mechanism.

The Water Framework Directive includes primary means and targets for the protection of water resources and aquatic ecosystems. The main water categories must reach a “good quality” state by 2015, based on water resources management of each Carpathian basin and a rigorous monitoring system.

The European Strategy for Soil Protection put forward in 2006 includes actions to prevent future degradation, and also to restore degraded soils.

The European Neighbourhood Policy, based on programmes such as INTERREG III and the

Technical Assistance to the Commonwealth of Independent States (TACIS), are helping extend EU experience into the Ukrainian and the Serbian Carpathians. In view of this policy, the Djerdap National Park in Serbia and the Iron Gate Natural Park in Romania, as well as the Maramureş National Park in Romania and the Marmarosky National Park in Ukraine, and the Eastern Carpathians Trilateral Biosphere Reserve (Ukraine, Poland and Slovakia) will strengthen cooperation at the EU’s borders.

The European Environment Agency (EEA), based in Copenhagen, Denmark, plays a key role in reporting on the state and trends of the (pan)European environment along with the organisation of relevant data and information flows, including much of the Carpathian region. The EEA is a major source of value-added information, reports and analyses (including on policy) for decision-makers in the EU and other European countries.

### Protected Areas

Protected areas of global and European interest include 33 national and natural parks and 42 landscape areas and landscape parks totalling 13% of the total Carpathian area.

Sustainable development of the mountain space implies the establishment of systems of protected areas (national parks, natural parks, nature reserves and biosphere reserves). Bringing the management of protected areas in line with international regulations, and primarily with the EU *acquis*, calls for the ecological reconstruction of degraded areas and for permanent efforts to identify and protect valuable landscapes and biodiversity.

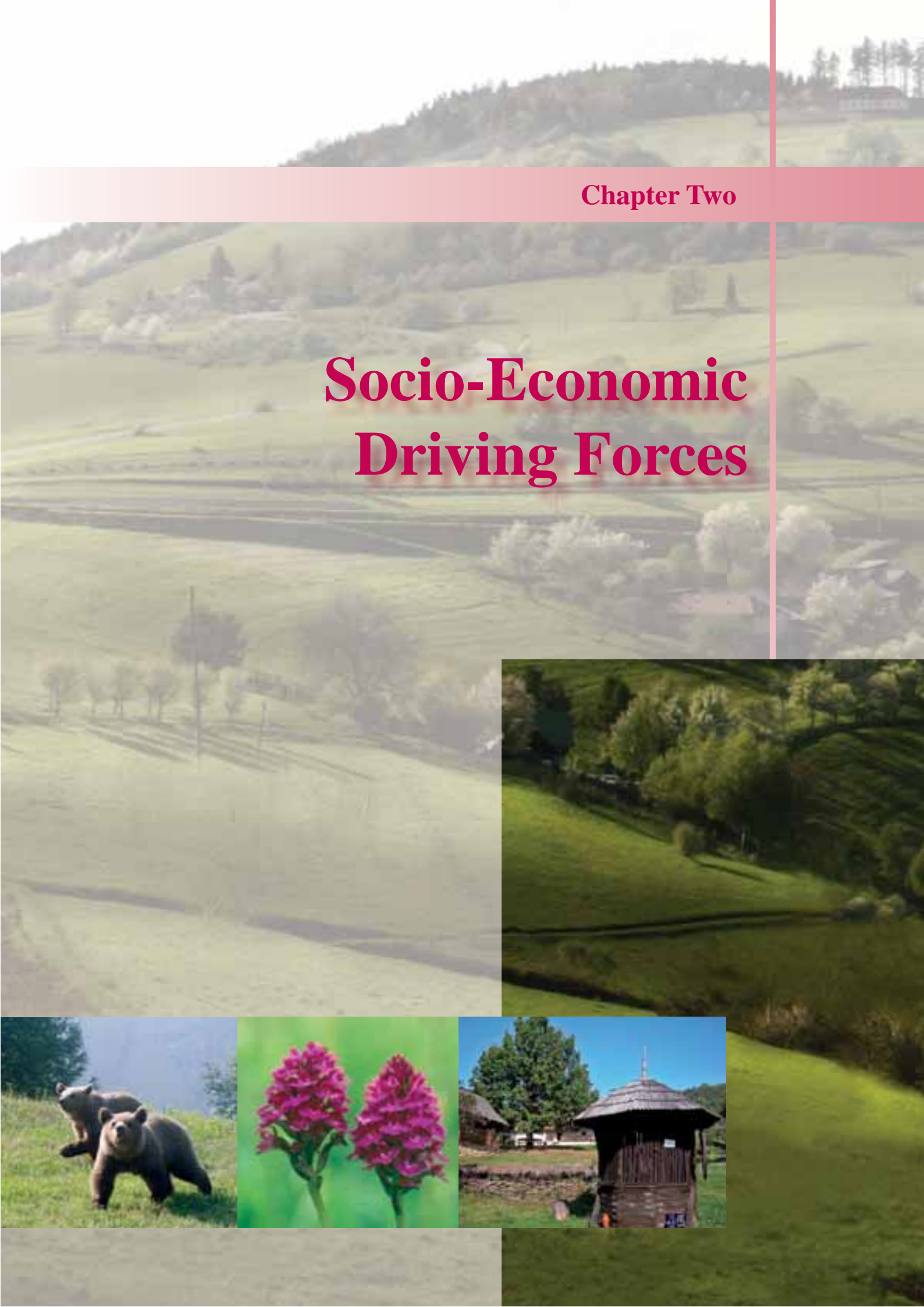
## References

- \*\*\* (1970). *Atlas of the Danubian Countries*
- \*\*\* (1981). *Pădurile României, Studiu monographic*. Ed. Academiei Române, Bucharest
- \*\*\* (1996). *Atlas Istoric-Geografic*. Ed. Academiei Române, Bucharest
- \*\*\* (2001). *Istoria Românilor*. Vol. I, II, Ed. Enciclopedică, Bucharest
- Bălțeanu, D., Badea, L., Buza, M., Niculescu, Gh., Popescu, C., Dumitrașcu, M. (eds) (2006). *Romania. Space, Society, Environment*. The Publishing House of the Romanian Academy, Bucharest
- Bălțeanu, D., Șerban, M. (2005). *Modificările globale ale mediului – o evaluare interdisciplinară a incertitudinilor*. Ed. C.N.I. Coresi, Bucharest
- Busuioc, A. (2003). *Schimbări climatice – perspective globale și regionale*. Sesiunea Științifică Anuală a INMH, Bucharest
- Carpathian Ecoregion Initiative (2001). *The Status of the Carpathians*.
- Carpathian Ecoregion Initiative (2005). *The Carpathian Mountains*. <http://www.carpathians.org/carp.htm>
- Demek, J. (1983). Carpathian Mountains. In *Geomorphology of Europe* (ed: C. Embleton), Verlag Chemie, Weinheim
- Dragomirescu, Ș. (1987). Carpații și sistemul muntos alpin. In *Geografia României – Carpații Românești și Depresiunea Transilvaniei*, vol. III, Ed. Academiei Române, Bucharest
- George, P., Tricart, J. (1954a). *L'Europe Centrale I*. Tome Premier Géographie physique et humaine, ORBIS, Presses Universitaires de France, Paris
- George, P., Tricart, J. (1954b). *L'Europe Centrale II*. Tome Second Les États, ORBIS, Presses Universitaires de France, Paris
- Horváth, F. (1993). Towards a mechanical model for the formation of the Pannonian basin. *Tectonophysics* 226, 333-357
- IPCC (2001). *Climate change 2001: The scientific basis*. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change (eds: J.T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, C.A. Johnson), Cambridge University Press, Cambridge and New York
- Jansky, L., Murakami, M., Pachova, N.I. (2004). *The Danube – Environmental Monitoring of an International River*. The United Nations University Press, Tokyo
- Jodha, N.S. (2005). Economic globalization and its repercussions for fragile mountains and communities in the Himalayas. In *Global Change and Mountain Regions* (eds: U.M. Bugmann, M.A. Reasoner)
- Kinder, H., Hilgemann, W. (2002a). *Atlas de Istorie Mondială – de la începuturi până la Revoluția Franceză*. Vol. 1, Ed. Enciclopedia Rao, Bucharest
- Kinder, H., Hilgemann, W. (2002b). *Atlas de Istorie Mondială – de la Revoluția Franceză până în prezent*. Vol. 2, Ed. Enciclopedia Rao, Bucharest
- Kondracki, J. (1978). *Karpaty, Wydawnictwo Szkolne i Pedagogiczne*. Warsaw
- Lacika, J. (2002). *Slovakia – Tourist Guide*. Bratislava
- Lencewicz, S., Kondracki, J. (1962). *Geografia Fizyczna Polski*. Państwowe Wydawnictwo Naukowe, Warszawa
- Levasseur, E. (1886). Tracés Oro-Hydrographiques (Apennins, Karpates, Pyrénées et Plateau De Castille). In *Petit Atlas de L'Europe (Moins la France)* (eds: E. Levasseur, Ch. Perigot), Paris
- Mihăilescu, V. (1963). *Carpații Sud-Estici de pe Teritoriul României, Studiu de Geografie Fizică cu privire Specială la Relief*. Editura Științifică, Bucharest
- Naum, T. (1962). Vulcanokarstul din Masivul Căliman (Carpații Orientali). *Anal. Univ. București, Ser. Științ. Nat. Geol. Geogr.* 32, 143-179
- Nefedova, T. (1992). Use of environment and resultant problems in Central & Eastern Europe. In *Atlas Ost-undSudosteuroopa* (ed: P. Jordan), Osterreichisches Ost- und Sudosteuroopa-Institut Vienna, 1.2-G4
- Quilès et al. (2006). *Cave bears (Ursus spelaeus) from the Peștera cu Oase (Banat, Romania): Paleobiology and taphonomy*. C.R. Palevol, Elsevier
- Ruffini, F.V., Streifeneder, T., Eiselt, B. (2006). *Implementing an international mountain convention – An approach for the delimitation of the Carpathian Convention area*. European Academy of Bolzano, Institute for Regional Development
- Săndulescu, M. (1984). *Geotectonica României*. Ed. Tehnică, Bucharest
- Săndulescu, M., Visarion, M. (1988). La structure des plateformes situées dans l'avant-pays et audessous des nappes du flysch des Carpathes orientales. *St. Tehn. Econ.* 15, 62-67
- Székely, A. (1968). Európa koszorúja : a Kárpátok ; Európa központi katlanja : a Kárpát-medencevilág. In *Európa I. kötet* (eds: S. Marosi, B. Sárfalvi), Gondolat, Budapest
- Turnock, D. (2002). Ecoregion-based conservation in the Carpathians and the land-use implications. *Land Use Policy* 19, 47-63
- Tasser, E., Tappeiner, U., Cernusca, A. (2005). Ecological Effects of Land-use Changes in the European Alps. In *Global Change and Mountain Regions* (eds: U.M. Bugmann, M.A. Reasoner)



Chapter Two

**Socio-Economic  
Driving Forces**



The Carpathian countries have undergone significant political, economic, social and environmental transformations during the past 15 years. Their industry, agriculture and transport sectors were originally developed at accelerated rates, increasing pressures on the environment. In the late 1970s and during the 1980s, some economic contraction occurred, when the rate of economic growth declined and external debt reached extremely high levels. In the early 1990s, GDP, industrial production and agricultural output fell significantly; diminishing economic output led to a significant reduction of air and water pollution. In most countries, the recent economic recovery did not lead to major increases in such pollution again. This decoupling process is the result of economic and technological modernisation and stricter enforcement of new environmental regulations. The economy today is based on farming (closely associated with animal husbandry), forestry and mining, which remain predominant land uses.

Over decades under the centrally-planned system, there was a very strong and rapid conversion of farmland for the expansion of human settlements, industrial and mining activities, and infrastructural development. During the last 10-15 years, agricultural production, including plant production and animal husbandry, has decreased in the Carpathians and huge areas have reverted to fallow land. In the beginning of the 1990s, a sharp decline of agricultural production was accompanied by a decrease in the use of pesticides and fertilisers. With the increase of production since 1994, fertiliser consumption resumed, but the use of pesticides remains very low.

Forestry is a major economic sector in the Carpathian countries. Under communist regimes forests were over-exploited, with the total harvest

exceeding the annual increment. Forests are getting younger and thinner, while extensive clear-cutting has resulted in accelerated runoff during heavy rainfall. Currently, there is a general trend toward stabilisation of forest extent in the Carpathians. The process of industrial decline in many areas of the Carpathians has had beneficial effects through recovery from former pollution levels. However, forests will remain vulnerable, as poverty leads to extensive illegal logging for heating purposes (firewood).

The Carpathian countries are highly dependent on imported oil and natural gas, mainly coming from Russia. Over the past decade the Carpathian countries have restructured and downsized their coal industries by closing down inefficient (deep) mines and reducing the coal mining labour force. The geostrategic importance of the Carpathian region lies in the oil and natural gas pipelines traversing most of the countries on their way to Western Europe. In general, power production in the Carpathian region relies mainly on fossil fuels, followed by nuclear, hydro and renewable energy sources.

The ageing of the population and growing inequality between rural and urban areas are major concerns in the Carpathian region. In addition, increasing poverty and high unemployment rates are the greatest social problems in most areas. This situation occurs for many reasons, and efforts to enhance the quality of rural life must include improvements of agricultural production, employment, infrastructure and housing. One of the main current threats is the process of abandonment of agricultural lands and traditional farming practices, a phenomenon reflecting a post-war trend of rural depopulation and marginalisation of wide agricultural regions, especially affecting mountain areas.



## 2.1 Macro-Economic and Structural Policy Overview

### Economic Growth: 1970s until 1990s

**B**etween the 1970s and early 1980s, the industry, agriculture and transport sectors in most Carpathian countries had relatively high economic and investment growth rates. During the 1980s, when an economic contraction occurred, overall growth declined and external debt reached extremely high levels.

At the end of the 1980s, after the collapse of the Soviet Union, the Carpathian countries lost their traditional economic and external trade ties and began the transition from planned to market economies.

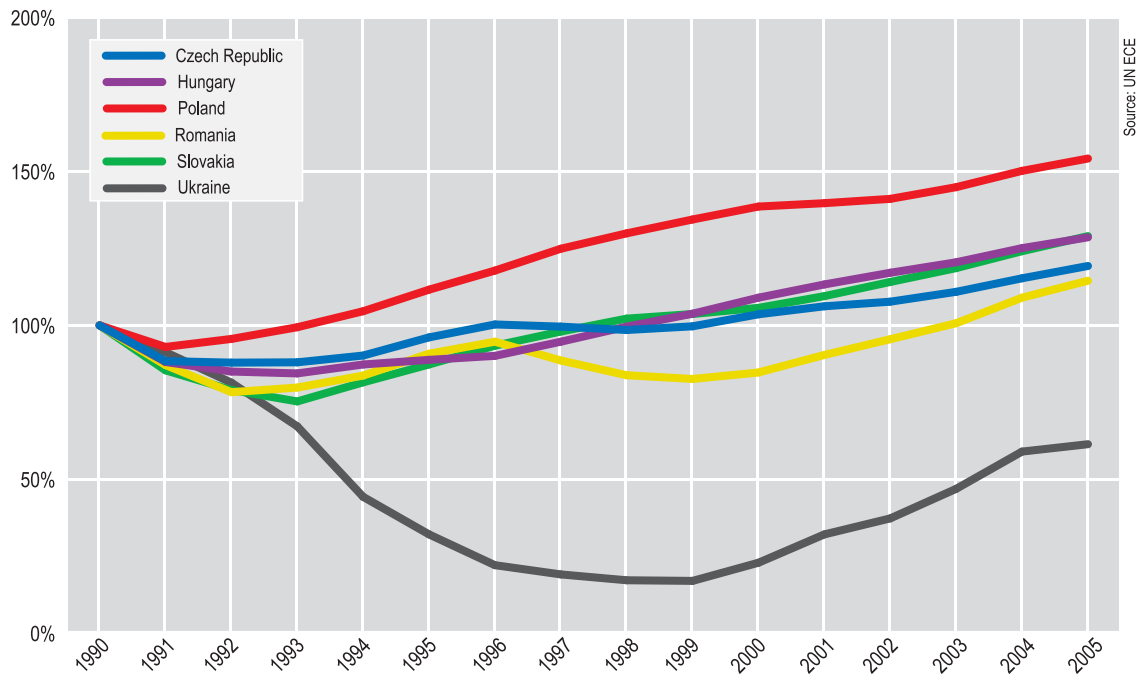
In all Carpathian countries, the changes were followed by some ten years of economic decline, rising inflation rates (especially in Romania and Ukraine), increasing poverty and decreasing life expectancy. In the early 1990s, GDPs, industrial

production and agricultural output fell significantly. All countries also faced population decline and population loss through migration.

The countries experienced significant differences in GDP growth rates. The highest was reached by Poland followed by the other three Visegrád countries (Czech Republic, Hungary and Slovakia). Romania witnessed two economic depressions in the early and late 1990s. Post-communist Ukraine observed nearly a decade of steep economic decline. In 2005, Ukraine was the only Carpathian country which did not reach its 1990 level of economic output. Generally, in the late 1990s, some countries reached the same levels of economic output they had experienced in the late 1980s. Others still face recovery and stabilization (see Figures 2.1 and 2.2).



Figure 2.1 GDP growth rate at prices and PPPs of 2000, 1990–2005



## Post-EU Membership

Since joining the EU, the Czech Republic, Hungary, Poland, Slovakia and Romania have had strong economic growth, improved labour markets and, in most cases, low inflation.

Export performance has improved in most of the new EU economies, exceeding expectations. Following an early exceptionally rapid pace of economic expansion, the pace of regional growth slowed but still remains significantly higher compared to that of the EU-15. At the same time, industrial output growth has been decelerating.

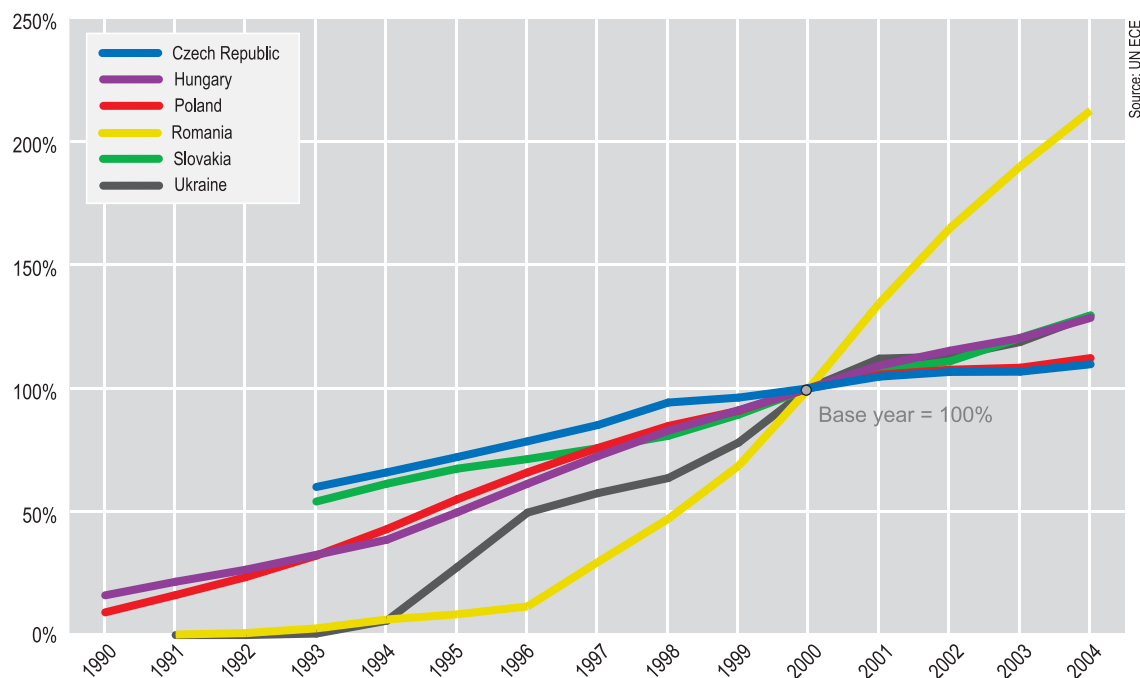
The five new Carpathian members continue to outperform the EU-15 by a wide margin, proving themselves to be functioning market economies. They competed so successfully for foreign direct investment (FDI) and jobs, on the basis of significant labour cost and corporate tax advantages, that enlargement has caused some friction with some of the original EU-15, the majority of which have imposed temporary restrictions on

labour mobility. The evidence therefore clearly shows the new members' abilities to cope with the full pressure of competition within the single EU market of 457 million residents (383 million of which are in the EU-15). It should also help them to reach considerably higher average real per capita income levels.

In the short term in the EU-10<sup>1</sup>, economic indicators point to steady growth as a whole, with the possible exception of Hungary among Carpathian countries. In the short and medium term, the noticeable rise of FDI inflows and the accelerating pace of economic integration in the post-accession period should support solid supply-driven GDP growth and the improving export performance of the foreign-controlled business sector.

<sup>1</sup> On 1 May 2004, 10 new countries have joined the European Union: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia.

Figure 2.2 Consumer price index, 1990–2004



Source: UN ECE

## Recent Regional and Country Figures

One can find at least two very visible axes of development in terms of GDP per capita across the Carpathian region. From higher to lower, the first goes from northwest to southeast, and the second from west to east. The most developed areas are located in the Czech Carpathians and Bratislavsky Kraj, with over €6 000 per capita, as well as in Northern Hungary with 5 000 to €6 000 per capita. In most of the Romanian Carpathian counties, this figure is below €2 500 per capita (see Map 2.1).

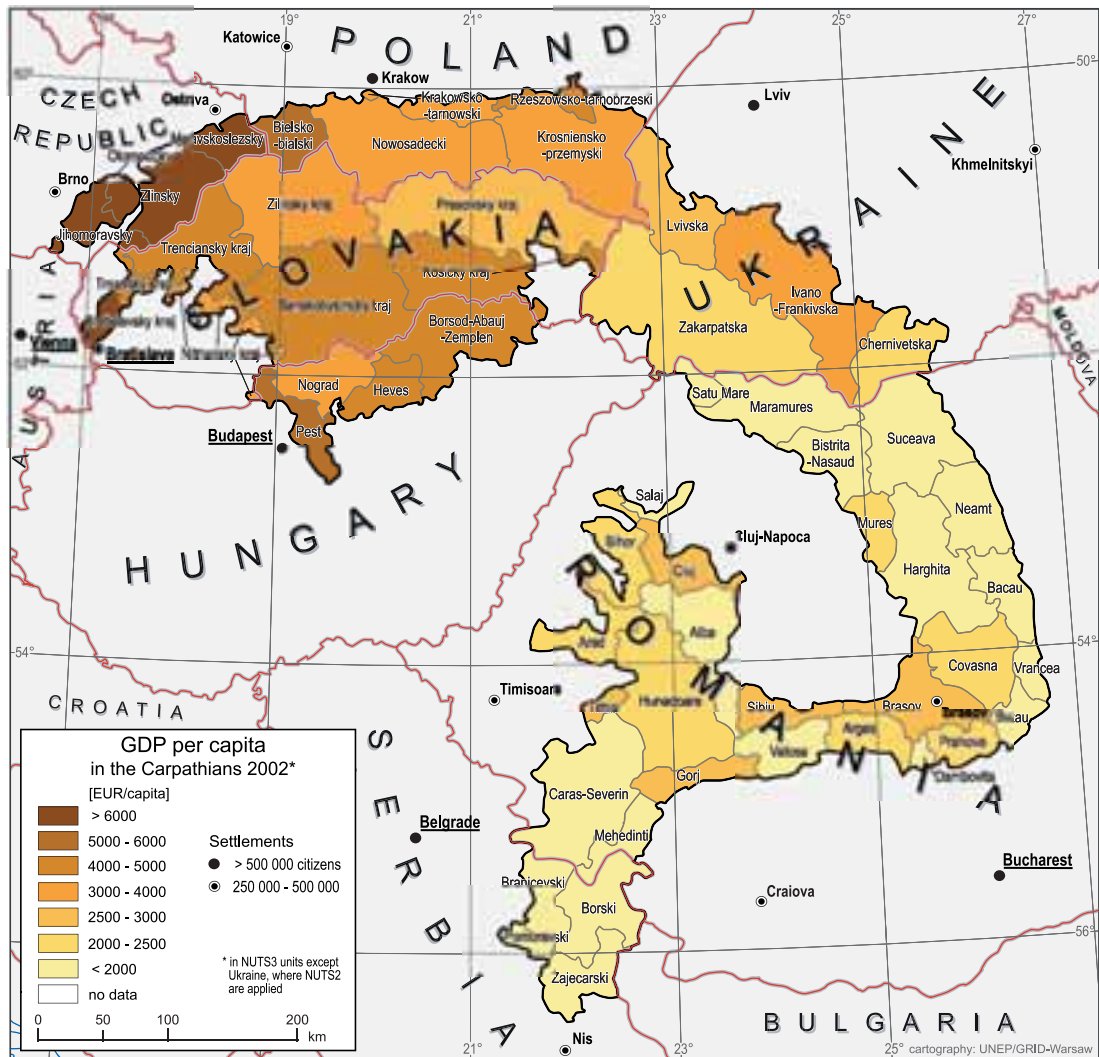
Poland is the largest economy among the seven Carpathian states, accounting for nearly half of regional output. Economic growth in Poland increased sharply until 2004 and has remained at a comparatively high level, with expectations for strong output growth in the short term. However, due in part to the dampening impact of ongoing fiscal tightening, the growth rate

may remain well below five per cent (UNECE 2005).

In the Czech Republic and Hungary, which account for 20 per cent and 16 per cent of Central European economic activity respectively, patterns of growth were similar. In both economies, dynamic export growth was based on FDI-induced improvements in productivity and quality, solid investment expenditures and decreasing consumption due to moderate wages and gradual fiscal consolidation.

Slovakia, accounting for nine per cent of regional output, grew strongly in 2004, mainly driven by domestic demand. GDP growth continues at a brisk pace, driven by private consumption based on rising real wages and employment, as well as robust fixed capital investment. Furthermore, imports have risen faster than exports.

Map 2.1 GDP per capita in the Carpathians, 2002

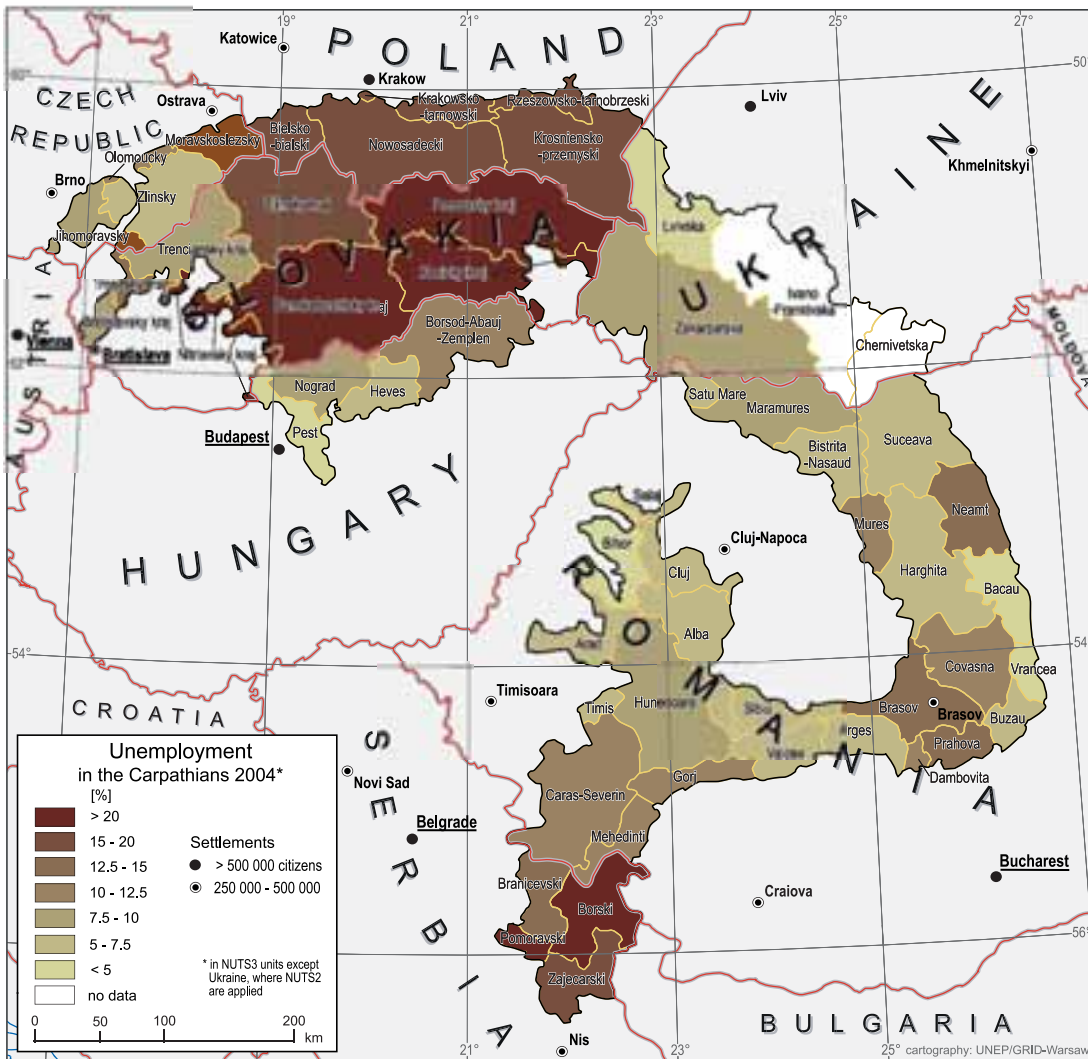


## Employment

Unemployment generally remains high and persistent, with most countries unable to achieve a significant reduction in their high rates of unemployment – a reflection of the structural nature of the problem in most of the new EU-10 countries. Relative to the target of the Lisbon agenda ('EU jobs and growth policy' adopted during an EU Summit in 2000), employment rates remain comparatively low as they do for other EU countries.

At the same time, employment in the new EU member states (except in Hungary) has generally been rising faster than in the rest of the EU, although there was a marked deceleration in several countries. An upturn in employment growth in Poland helped lift the regional average. Sustained economic growth has helped to lower unemployment, although the correlation between the rates of output growth and unemployment remains weak.

Map 2.2 Unemployment in the Carpathians, 2004



Changes in employment, while significantly different across countries, generally reflect the cyclical position and momentum of each economy, differences in the sectoral composition of economic growth and the varying ability of markets to cope with the adjustments imposed by economic transformation (see Figure 2.4 and Map 2.2).

In 2005, Poland and Slovakia had the highest unemployment rates (17.7 per cent and 16.4 per cent respectively). Czech, Hungarian and Romanian unemployment rates were between 7 per cent and 8 per cent. Ukraine shows the lowest rate (3.6 per cent in 2003).

With the exception of Hungary, Romania and Ukraine, female unemployment exceeds that of

Figure 2.3 Poorest quintile's share in national income or consumption

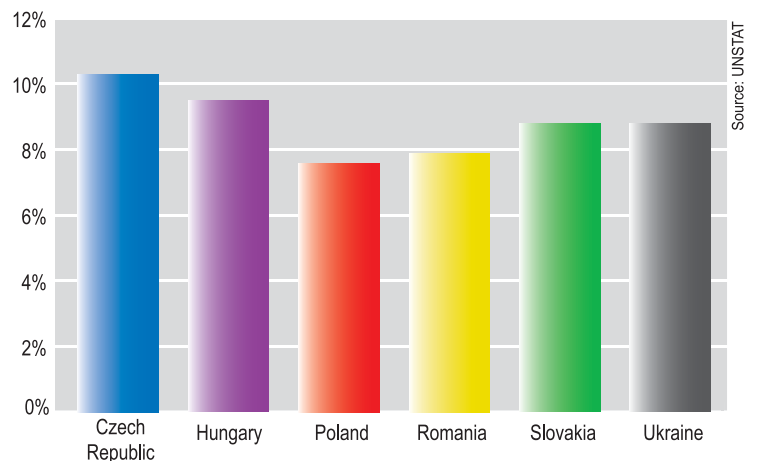
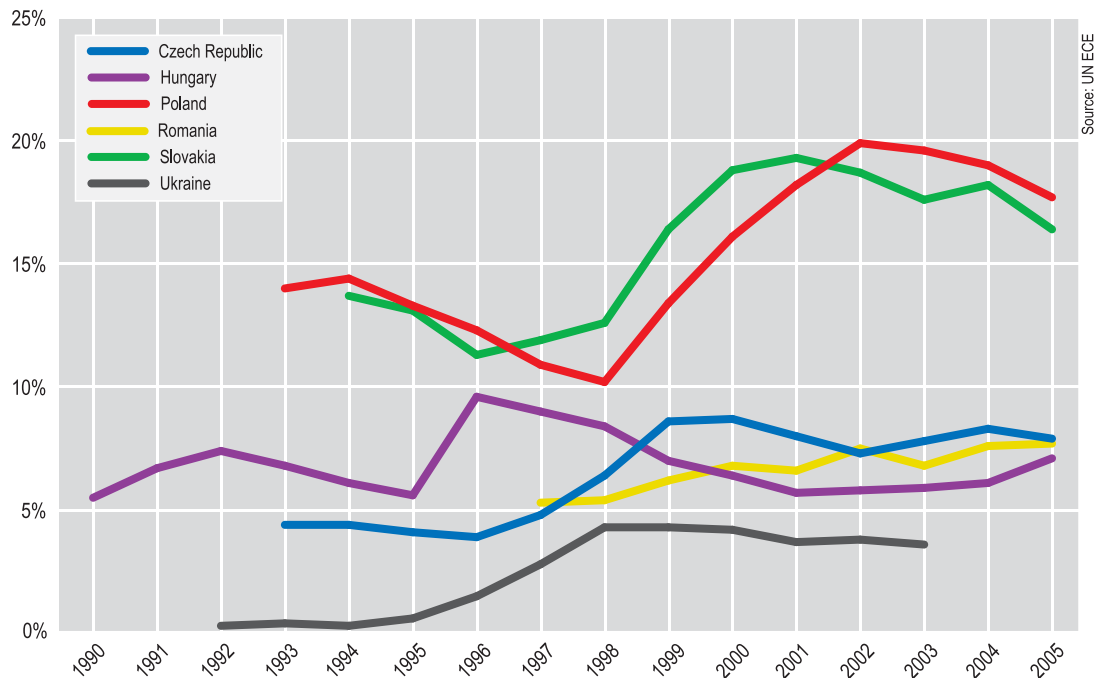


Figure 2.4 Unemployment rate in the Carpathian countries, 1990–2005



males. In most countries, unemployment is more severe for both sexes among young people. In recent years, the unemployment rate under the age of 25 has reached worrying levels in Hungary, Poland, Romania and Slovakia. For

example, in 2005 in Poland, nearly 36 per cent of all youths did not have jobs. In Hungary and Romania, the jobless rate for youths is three times higher than the national average unemployment level.

## Structural Changes

Over the past decade, the national economies of the Carpathian countries have been significantly restructured. For example, the expansion of the service sector, except for the last two years, exceeded the growth rate of all the other sectors and currently accounts for over 60 per cent of the GDP in most countries. Hungary has the most robust service sector followed by Poland, Slovakia and the Czech Republic. The GDP share of the service sector in Romania, Serbia (together with Montenegro until 2006) and Ukraine, while still high, lags behind at around 50 per cent (see Table 2.1).

Agriculture still plays an important economic role in Romania, Serbia and Ukraine. For the

Visegrád countries, the GDP share from agriculture was under four per cent in 2003.

Looking only at the Carpathian areas of the countries, economic activity in the last centuries was determined by the natural environment, folk customs, tribal relations and the economic policies of the governments that had control of the region. As in the past, the economy and land-use today are based on farming (closely associated with animal husbandry) and forests. Compared to that of neighbouring lowlands, the economy of the Carpathians is far less developed. However, the situation varies considerably from country to country and region to region.

Table 2.1 Structural changes in the Carpathian countries, 1995–2003

Percentage of GDP

	1995			2003		
	agriculture	Industry	services	agriculture	industry	services
Czech Republic	4.7	41.9	53.4	3.4	38.4	58.2
Hungary	6.8	30.9	62.3	3.7	30.7	65.5
Poland	6.7	37.8	55.5	3.8	31.4	64.8
Romania	20.9	40.3	38.8	12.9	37.8	49.3
Serbia and Montenegro	19.3	37.8	42.9	21.1	32.1	46.8
Slovakia	6.0	38.2	55.8	3.9	32.0	64.0
Ukraine	15.0	41.3	43.7	12.0	35.3	52.7

Source: UNECE, OECD

## Foreign Direct Investment (FDI)

Foreign Direct Investment (FDI) in the Carpathian countries has increased. However, these inflows (as a percentage of GDP) remain significantly below the levels from several years earlier when the majority of privatisations were undertaken. For many of these countries, a significant portion of their current FDI is not new equity investment but rather reinvested earnings. The EU remains the largest source of FDI in the region, with Russia and the U.S. providing additional investments.

A turning point is that some new EU Carpathian states have reached the level of per capita income which permits domestic enterprises to undertake significant FDI abroad. However, other than Hungary, such outflows are not yet sizeable. In Hungary, only 15 firms account for 80 per cent of total FDI outflow. The outward FDI of Hungary and Slovakia is also concentrated in the region. Research suggests that investment abroad may be beneficial for economic development by improving integration into the world economy – as a result, government assistance in promoting outward investment may be desirable.

## Decoupling Impacts on the Environment

Between the 1970s and 1980s, healthy economies in the Carpathian countries also meant significant environmental pressures. However, the pre-1989 period did not show adequate concern for the environment or the potentially negative consequences of human activities.

In the early 1990s, significant reductions in GDP and industrial and agricultural output contributed

to reducing overall environmental pressures, especially air and water pollution and agricultural chemical use, and improving the state of the environment.

In most Carpathian countries, the latest economic recovery did not lead to a similar growth in environmental pressures. This ‘decoupling’ process resulted mainly through economic and

## The Informal Economy

The existence of a business sector outside the official economic system is a phenomenon that is present in all types of economies. At the same time, the notion of informal (also referred to as unofficial, hidden, shadow and unobserved) economic activity is very broad. The broadest concept is that of the “non-observed economy”, which refers to all productive activities that are not captured in the source data used for the compilation of national accounts.

The non-observed economy is assumed to comprise three main components: “underground production” (activities that are legal by their nature but are concealed for tax evasion purposes); “informal activities” (legal production activities characterized by a low level of organization, typically based on unofficial relationships); and “illegal activities” (those banned by law or illegal when performed by unauthorized persons). Here, the term “informal economy” is used as the equivalent to the “non-observed economy”.

There is abundant evidence that both the size and types of informal economic activities increased significantly in economies undergoing the process of transition from planned to market. While the most widely acknowledged reason for the emergence of the informal economy is tax evasion as well as deficiencies in the tax system, the causes of its growth in the transition economies are more complex, and some of them relate to the specificities of the transition process.

The deep and prolonged transformational recession during the early years of transition was accompanied by massive job losses. Real household incomes collapsed as a result of declining real wages and shrinking employment. Given the inability of the economy to generate a sufficient number of jobs in the formal sector, and in the absence of adequate social safety nets, switching to informal economic activity was a survival strategy for many individuals. The inadequate institutional environment and the inability of governments to provide adequate services also contributed to the growth of the informal sector. Overall, despite some decline in recent years, the informal sector still makes an important con-

tribution to total production and employment in the Carpathian countries.

The estimates suggest considerable inter-country differences in the size of the informal sector – Ukraine, Serbia and Montenegro and Romania have much larger informal sectors than do the Czech Republic, Hungary, Poland and Slovakia. The latter group of countries are among the most advanced in implementing systemic and market reforms and, on average, their real per capita incomes are considerably higher, partly reflecting the fact that they have achieved much higher rates of economic growth during the past 15 years. Nevertheless, all the former centrally planned economies still have larger informal sectors than do the developed market economies (as reflected in the OECD average).

This suggests that the informal sector of the economy in the former centrally planned economies is likely to diminish as reforms progress and real per capita incomes increase. Indeed, well-functioning product, labour and capital markets are likely to support more job creation in the formal sector of the economy. The strengthening of the institutional environment and the provision of good public services, together with reforms that reduce the corporate tax burden, should improve the incentives for businesses to pay taxes. In turn, these changes should also support sustained economic growth, which is the key factor for both net job creation and a rise in real per capita incomes.

Although income from informal activities can help to cushion some segments of the population from the strains of transition and cope with poverty in the short-term, reliance on such activities cannot be regarded as a sustainable longer-term solution. Besides, the informal economy has significant costs in terms of foregone tax revenues, which increases the risks of triggering a vicious circle of even higher tax rates. It also breeds unfair competition that distorts product and labour markets, which, in turn, undermines the benefits of structural reform for private sector development.

(Source: UNECE 2005)

technological modernisation and stricter enforcement of new environmental regulations (see Figure 2.5). The most spectacular examples relate to reductions of traditional air pollutants such as sulphur dioxide and nitrogen oxides – clearly showing the recent effects of major switches from coal to natural gas as a key energy source.

At the same time, there is a clear difference between the northwest and southeast sections of the Carpathians, manifested in different state and foreign direct investments, unemployment rates, poverty levels and ethnic tensions. In the

northwest, developmental threats to the environment, for example from hunting and tourism, are greater. At the same time, forests are expanding in part due to reduced farming pressures, and mass tourism is a concern only in some areas.

In the southeast, development pressures are much weaker. But poorer regions with high unemployment generate other threats to the environment, for example the illegal cutting of newly restituted forest lands. Recent legislation (2000) in Romania could eventually increase the concentration of private property into fewer hands, and raise overall poverty. This in turn could

Figure 2.5 Decoupling of GDP from air emissions



result in high tree-cutting levels similar to the experiences encountered during Romania's first privatisation round in the early 1990s.

The existence of an informal economy (see box above) probably has many negative environmental consequences such as the disposal and

international transport of illegal waste, transboundary movement of second-hand products (e.g. refrigerators, old cars), illegal logging for export to western European countries, illegal trade of endangered flora and fauna, and a general avoidance of environmental regulation and rules.



## Conclusions

The Carpathians are now confronted by a mix of challenges which require coordinated management. The continued decoupling of environmental pressures from economic growth requires an integrated approach to the management of consumption and production patterns including a more efficient use of resources. This could include a shift toward a knowledge- and service-based economy which may decrease demand for natural resources and promote waste minimisation. Policies aimed at directly integrating the environmental impacts of consumption and production patterns into the entire product life cycle are also needed.



## 2.2 Economic Driving Forces/Pressures

### Agriculture

#### Pre-transition

Over many decades under the centrally-planned system, there was generally a very strong and rapid conversion of farmland for the expansion of human settlements, industrial and mining activities and infrastructural development. Many river valleys were developed such as the Bistrița in Romania, Váh in Slovakia and Sajó in Hungary.

At the same time, the lower-altitude sections of the Carpathian sub-basins were subject to centralised, intensive agricultural methods which significantly altered the traditional agrarian structure of the region. In the 1960s, these methods were used to drain wetlands, destroy forests, increase soil erosion and dramatically alter the Carpathian landscape. In general, the original mosaic of small farm fields, grasslands, wetlands and shrubby terraces was transformed into vast farm fields covering hundreds of hectares, and led to substantial reductions in biodiver-

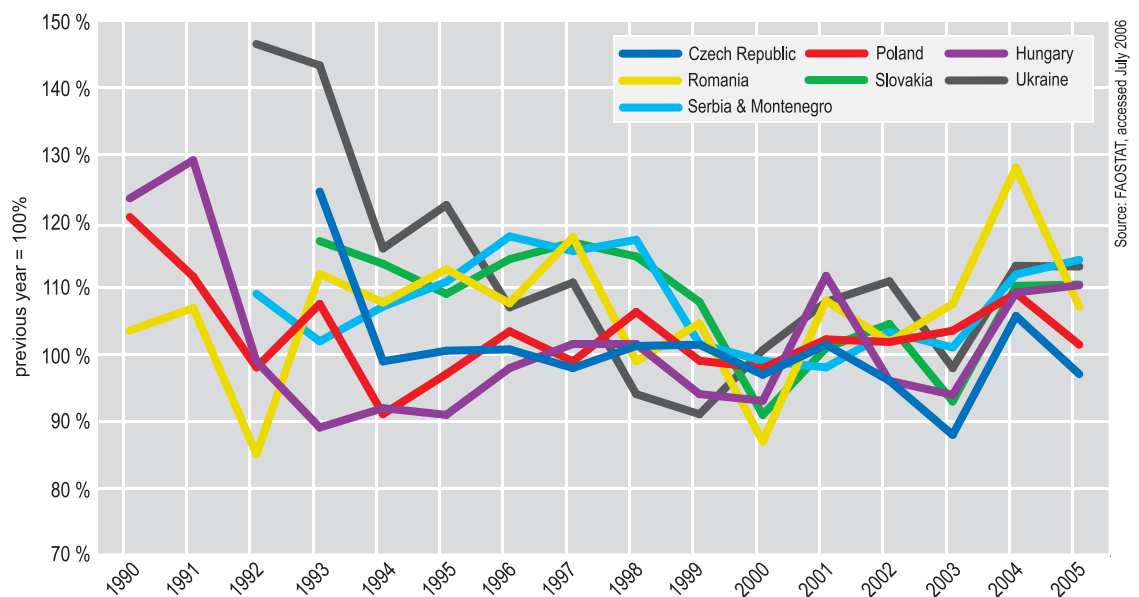
sity. Poland was an exception where the preservation of small-scale private farming was the result of a strong subsistence mixed-farming mentality.

Most of the rest of the Carpathians, remote from leading markets, were marginal to development plans, which thereby helped to preserve biodiversity. Furthermore, socialist collectives used a particular “specialisation” approach, whereby specific areas were used for specific purposes. This control-based, as opposed to market-based, approach tended to reduce arable farming (defined here as farming crops, cereals and vegetables) in mountain regions, excluding Slovakia where the development of arable farming in mountain regions was supported. Overall, total arable land area remained stable between the 1950s and 1990s.

#### The transition period

Agriculture and forestry are now the dominant forms of land-use in the Carpathian Mountains.

Figure 2.6 Agricultural production index in Carpathian countries, 1990–2003



However, significant variations can be seen across countries and regions (see Figure 2.6). For example, compared to other countries, the Slovak part of the Carpathians has twice the proportion of arable land but less forest cover. And in Romania, there is a high proportion of grasslands which is a result of extensive grazing in mountain areas.

Large differences can also be seen among agricultural labour forces in the Carpathian countries. For example, the number of small holders in Slovakia is very low with agricultural production concentrated in large cooperatives and enterprises, while Poland is dominated by small farming parcels.

Since 1990, agricultural production experienced an overall reduction in intensity in terms of both crops and livestock. This was due in part to reduced domestic consumption following economic decline combined with the withdrawal of subsidies for fertilisers and other inputs. In many parts of the Carpathians, many farmlands were abandoned and large areas became fallow.

In the Carpathian countries, the structure of the agricultural sector is now rapidly being reformed. This includes changes in land ownership and major shifts in traditional landuse, even in marginal agricultural areas.

Valuable semi-natural agricultural lands are being intensified or abandoned. Throughout the region, unwise agricultural practices include not adequately taking into account climatic and soil conditions for crop cultivation and livestock farming. Modern agricultural equipment is either not readily available or appropriate in mountainous areas such as those in the Maramures region of Romania. Bad practices have also significantly aggravated the incidence of landslides and mudflows, exacerbating deforestation's contribution to erosion over the last few decades.

In general, agricultural lands do not have an optimal structure, with cereals occupying a much too important position, considering the soil and climatic conditions in the Carpathians (UNEP 2004a). Lower parts of the Carpathian sub-basins are used mainly for cereals production such as wheat, maize and barley. In the middle altitudes, potatoes are a typical crop dominant in Romania, Slovakia and Poland.

In the Ukrainian Carpathians, agriculture has limited importance owing to unsuitable natural conditions, producing only small amounts of grain, meat and milk for domestic needs. In both Romania and Ukraine, de-industrialisation and unemployment have forced many to farm on

a subsistence basis, working only to feed themselves without receiving wages.

### Carpathian Livestock

Traditional agriculture based on seasonal pasturing in mountain meadows remains well pre-

served in the Carpathians. However, cattle and sheep stocks have decreased significantly during the past decade (UNEP 2004a). In some traditional grazing areas, densities are falling below the level required to maintain species-rich grasslands and traditional orchards ('semi-managed areas' represent areas where humans have tradi-

Table 2.2 Livestock change in Carpathian countries, 1995–2004

*1000 heads*

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
<i>Cattle</i>										
Czech Republic	1988.8	1865.9	1700.8	1657.3	1573.5	1582	1520.1	1462	1428	:
Hungary	928	909	871	873	857	805	783	770	739	723
Poland	7193	6958.1	7028.8	6455.2	6092.6	5723	5498.8	5421	5276.8	5200.2
Slovakia	929	892	803	705	665	646	625	608	593	540
Romania	3051.1	2870.4	2799.8	2877.8	2897.1	2811.7	:	2870.8	:	:
Ukraine	19624.3	17557.3	15313.2	12758.5	11721.6	10626.5	9423.7	9421.1	9108.4	7712.1
<i>Pigs</i>										
Czech Republic	4016.2	4079.6	4012.9	4000.7	3688	3593.7	3440.9	3429	3308	:
Hungary	5032	5289	4931	5479	5335	4834	4822	5082	4913	4059
Poland	20342.7	17696.7	18496.7	19275.4	18223.9	16991.5	17494	18997	18439.2	17395.6
Slovakia	2076	1985	1810	1593	1562	1488	1517	1554	1443	1149
Romania	5848.4	4797.4	4446.8	5058.1	5145.4	6588.8	:	8259.7	:	:
Ukraine	13945.5	13144.4	11235.6	9478.7	10083.4	10072.9	7652.3	8369.5	9203.7	7321.5
<i>Sheep</i>										
Czech Republic	134	120.9	93.6	86	84.1	90.2	96.3	103	104	:
Hungary	977	872	858	909	934	1129	1136	1103	1296	1397
Poland	608,1	506,2	467,5	422,4	372	336,8	331,1	332,2	331,3	310,8
Slovakia	428	419	417	326	340	348	316	316	326	321
Romania	8121	7656,8	7251,2	7312,4	7446,9	7466,4	:	7238,4	:	:
Ukraine										
<i>Equids</i>										
Czech Republic	19,2	19,1	20,7	22,7	23,8	25,8	20,9	21	20	:
Hungary	71	70	:	:	:	75	60	63	62	67
Poland	635.8	568.8	557.9	560.9	551.5	549.7	545.7	329.6	333.1	321
Slovakia	10	10	10	10	9	10	8	8	8	8
Romania	858.1	864.5	860.3	879.4	896.8	833.1	:	992.1	:	:
Ukraine										
<i>Poultry</i>										
Czech Republic	27875.4	27572.7	29035.5	30222.2	30784.4	32043.4	29946.8	23435	24337	:
Hungary	35659	32435	35665	35995	31244	37016	43279	40909	47268	41330
Poland	51739,6	56315,3	54737,5	54250,1	54553,9	53261,1	55582	53446,4	146321,1	130289
Slovakia	13382	14147	14222	13117	12247	13580	15590	13959	14217	13713
Romania	69143	70075.6	71413.3	77378.9	76616.3	89454.7	:	82407.0	:	:
Ukraine	164900	149700	129400	123300	129500	126100	123700	136800	147400	142400

Source: Eurostat

Map 2.3 Livestock units in the Carpathians, early 2000s



tionally influenced the landscape, giving rise to species adapted to those new landscapes) (see Table 2.2).

In Romania, even though grazing remains common, threats exist from the further marginalisation of poor quality lands to scrub if incentives are not introduced to maintain sheep stocks.

In the early 2000s, the density of livestock units (LSU) in the Carpathians was the highest in the regions of Chernivets'ka, Ukraine and Malopolskie, Poland (over 180 LSU per sq km). The lowest were in Észak-Magyarország (Northern Hungary) and Vest Romania (West Romania) (under 60 LSU per sq km) (see Map 2.3).

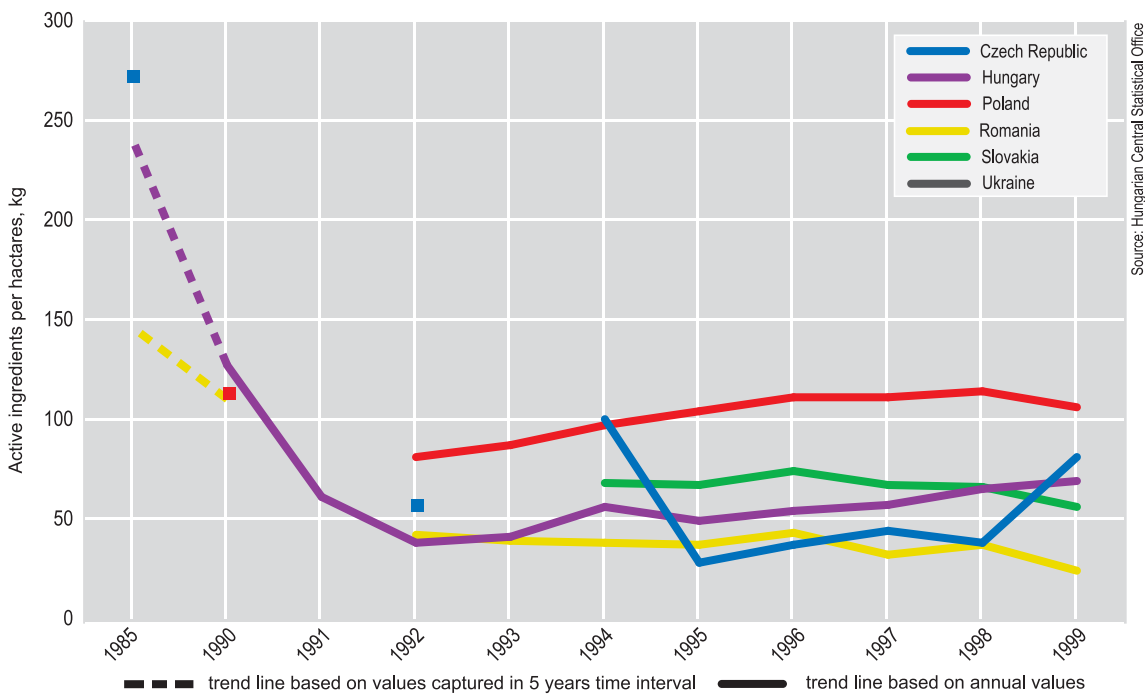
### Fertilisers and pesticides

Fertiliser consumption in the Carpathian countries increased sharply during the 20 years up to 1980. From 1980 to 1990, the consumption of the three key nutrients used in fertilisers – nitrogen, phosphorus and potassium – stabilized as optimal levels were reached.

In the beginning of the 1990s, a sharp decline of agricultural production was accompanied by a decrease in the use of pesticides and fertilisers. From 1989 to 1993, total nutrient consumption drastically fell from over eight million to about three million tonnes. Since then, fertiliser consumption in the region has fluctuated between 3.2 and 3.6 million tonnes of nutrients per year (IFA 2006).

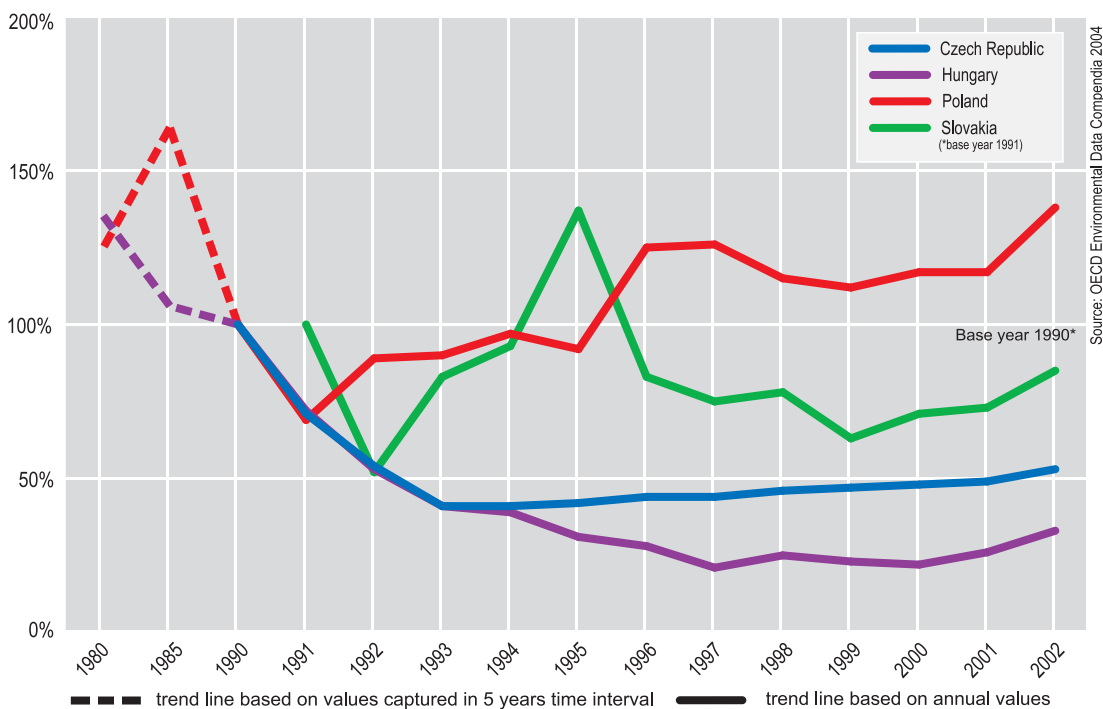
With the increase of agricultural production since 1994, fertiliser consumption resumed but pesticide use remained very low (see Figures 2.7 and 2.8). Today, many farmers cannot afford fertilisers or pesticides because prices for agricultural production (or “inputs”) have generally

Figure 2.7 Use of fertilisers per hectare of agricultural land, in active ingredients, 1985–1999



Source: Hungarian Central Statistical Office

Figure 2.8 Consumption of pesticides, 1980-2002



Source: OECD Environmental Data Compendia 2004

risen while those for farmers' produce (or "outputs") have declined – known more popularly as the "agrarian gap" or "scissors effect".

In the early 2000s, Poland accounted for about 45 per cent of the region's total fertiliser consumption, Romania 12 per cent, Hungary 12 per cent and the Czech Republic 10 per cent.

### Solutions

The size and diversity of the agriculture sector continue to be substantially influenced by changing consumer demands and rural patterns, technological advances and globalisation of the economy. These trends have positive and negative effects on the sector's performance with regard to environmental quality and nature conservation. For example, support for conventional production through increased fertiliser and pesticide use is forcing the introduction of GMO technologies into agriculture.

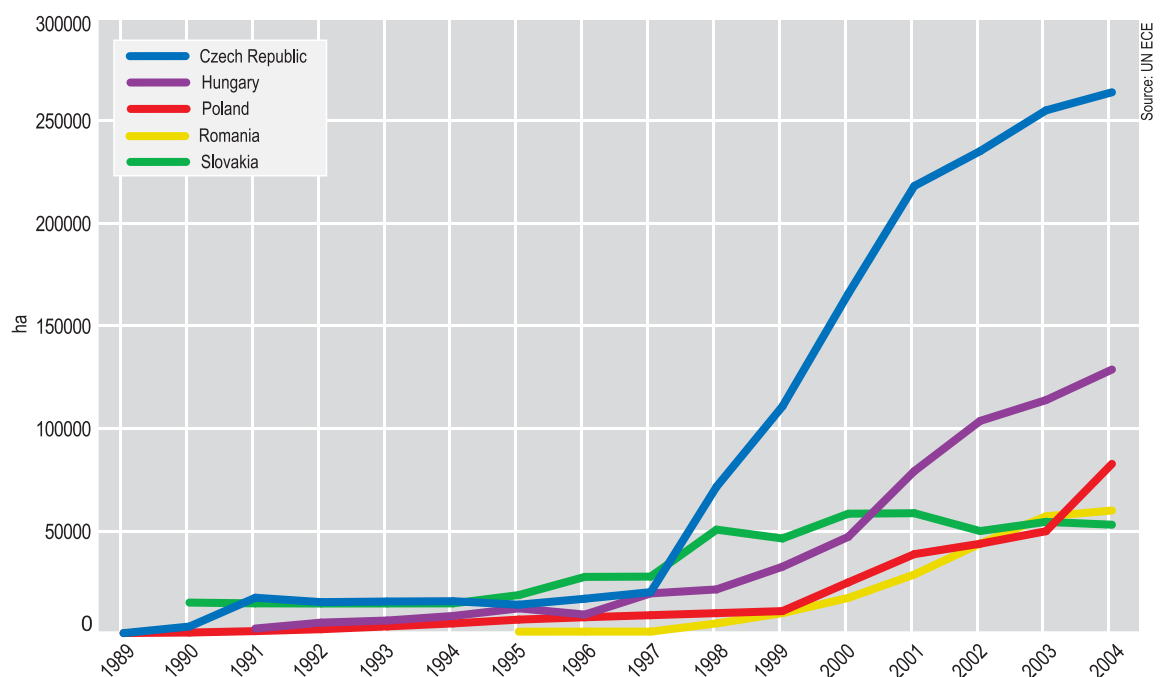
Threats to biodiversity continue, especially from intensive agriculture. Other threats to biodiversity include the continued perception of large predators as being incompatible with cattle breeding and herding by many local people. In

addition, more valuable meadows could continue to revert to shrubland if livestock grazing levels are not properly managed.

Agricultural landuse in the Carpathian Mountains can contribute to maintaining the area's biodiversity, as long as agricultural management is small-scale, diverse and respects the carrying capacity and suitability of local conditions. A positive sign is that the foothill arable lands, valley haylands and meadows and higher mountain meadows are generally managed sustainably by local communities.

Organic farming activities in the Carpathian countries date back to the mid-1980s although a marked expansion only started in the mid-1990s, with an exceptional growth rate in the Czech Republic. By 2004, the share of biologically cultivated area in the Czech Republic accounted for 7.3 per cent of total agricultural area, followed by Hungary with three per cent. In the region, Poland and Romania had the lowest rates with 0.57 and 0.48 per cent, respectively (Organic Centre Wales 2006). Today in the Carpathian countries, organic farming is still limited to a few per cent of the total agricultural area (see Figure 2.9). However, the low-intensity prac-

Figure 2.9 Organic farming in Carpathian countries, 1989–2004



tics of many private and co-operative farms are compatible with particular forms of integrated and ecological farming.

The European Union (EU) is a major factor, both positive and negative, for sustainable agriculture and rural development in the Carpathian Mountains. A number of EU laws and policies that are being prepared and implemented by the new EU member states are potentially powerful tools. These include the Special Assistance Program for Agriculture and Rural Development (SAPARD), Leader, Natura 2000 in agricultural areas and the mountainous less-favoured areas (LFA) approach.

The future challenge is to ensure that such opportunities are used to their full extent, to minimize potential negative impacts and maximize potential benefits (UNEP-ISCC 2006). For example, SAPARD pre-accession funding will make a difference when agri-environment measures have become a key policy instrument requiring capacity-building and training for farmers in the entire region. The agriculture sector is also clearly subject to structural changes under the Common Agricultural Policy (CAP) and its subsequent reforms.

Lessons can also be learned from the concept of the multi-functionality of agriculture as underlined by Agenda 2000, an action programme geared to strengthening EU policies and providing a new financial framework for the period 2000-06. Launched in 1999 in the form of twenty legislative texts, it attempts to address the various challenges for the agriculture sector. These include: producing food, fibres and energy sources; preserving the rural environment and landscape; and contributing to the viability of rural areas and balanced regional development. From an environmental point of view, balancing these various aims is equal to improving eco-efficiency, or in other words, reducing the burden on the environment while maintaining a certain level of output (EEA 2000).

A positive example can be found in the Polish Tatra Mountains. Here, shepherds are being encouraged to maintain traditional shepherding for tourism purposes, to maintain meadows and pastures using traditional agricultural activities in the Tatra National Park and to produce local products based on sheep herding.

### Traditional Agriculture in the Ukrainian Carpathians

Agriculture has traditionally played a significant role in the economy of Ukraine's Lemko, Hutsul and Boiko regions. In the 19th century, animal husbandry specialized in non-dairy cattle-raising in the Lemko and Boiko regions. In the Hutsul region, dairy cattle were bred along with sheep and horses (home of the famous 'Hutsul horse'). After the mid-1800s, differences between the various regions began to diminish. With the impoverishment of the peasantry, horse-raising replaced ox-raising, since the horse was useful in lumbering, and sheep-raising declined in western areas. By the 1950s, the structure of animal husbandry in Ukraine's Carpathian region was (nation-wide proportions in parentheses): cattle 80 per cent (75.5 per cent); hogs 9 per cent (18.8 per cent); and sheep and goats 11 per cent (6.7 per cent).

Today in the Boiko region, elevated fields are fertilized through sheep-grazing. Traces of the tree-clearing system of farming can still be found. The main crops are potato and oat, oat having been the main bread-baking grain until the beginning of the 20th century, and much animal feed is produced. The trend is to grow more potatoes and feed and less oats. In lower areas, rye and wheat are grown, while corn is the main crop on southern slopes. Soil fertility is low. The per capita supply of domestic animals is somewhat higher here than in other parts of Ukraine. Overall, production is now insufficient to feed the population while much of the arable land is left fallow.

(Source: CIUS 2006)



## Forestry

### Pre-transition

For centuries, the forest supplied highlanders with food such as berries, mushrooms and animals, pasture and materials and energy for small-scale industries. By the second half of the 19th century, they had become the main source of exports and a key economic resource. Exploitation of Carpathian forests intensified at the end of the 19th century when a network of narrow-gauge railroads was built to transport lumber from remote mountain areas.

Because of inadequate protective measures, the forests were at times excessively exploited, particularly under the Soviet regime. For example, in the 1950s, although the Carpathians possessed only 22 per cent of Ukraine's forests, they yielded over 60 per cent of total lumber produced in Soviet Ukraine. Legacies inherited from this past include younger and thinner forests as well as clear cuts.

### Carpathian Forests Today

Today, forestry remains an important economic sector in the Carpathian countries, particularly in Slovakia, Romania and Ukraine, although there are significant national and regional differences. The most forested country is Slovakia with more than 40 per cent of the total area. Ukraine has the smallest share with 16.5 per cent. Regionally, the highest shares of forested areas are located in Poland's Podkarpackie region (over 60 per cent), Slovakia's Stredne Slovensko, Ukraine's Zakarpats'ka and northeast, southeast and southwest Romania (between 50 to 60 per cent) (see Map 2.4). The average European forest cover is about 44 per cent (MFPFE 2003) (see Chapter 3, section 3.2).

Young forests and deforested areas constitute over 50 percent of forested lands, while mature forests account for scarcely 11 percent instead of the desirable 25 percent.

The primary processing of wood is declining due in part to decreases in some traditional

markets and the continued use of obsolete technology. In the Ukrainian part of the Tisza River Basin, about 500 thousand cu m of timber are logged annually, mainly by small and middle-sized companies, representing a local source of employment.

Forests provide a variety of products other than wood, many of which often have an important economic value. Examples include Christmas trees, mushrooms, berries, medicinal plants, decorative foliage, game meat, pelts, honey, nuts, bark for tannin extraction, birch sap, seeds, resin and tar. However, the related revenues do not always necessarily go to forest owners.

Some forest managers are taking efforts to preserve forest areas in order to preserve their natural and valuable functions such as erosion control and water retention.

### Problems

The process of industrial decline in many Carpathian areas had many beneficial environmental effects such as declining pollution levels. However, forests remain vulnerable. The Carpathian forests are subject to continuous threats. In general, forestry practices vary from country to country.

In most cases, logging techniques do not meet environmental standards. In all countries, there are records of unsustainable felling methods, clear-cutting and plantation of alien species or no replanting at all. There are also examples of forest lands being converted to agricultural use, for example in Ukraine.

Forests continue to get younger and thinner. The usual method of forest exploitation is selective cutting. Clear-cutting is legally permitted only in some forest types and limited areas. Nonetheless, legally or illegally, many privately-owned forests continue to be the victim of clear-cuttings as a means of earning quick profits. Extensive

Map 2.4 Forested area in the Carpathians and its environs, 2003



clear-cutting also often results in accelerated run-off during heavy rainfall.

For example, in Ukraine's Gorgany Mountains alone, 1 470 ha of rocky slope have appeared. Floods have increased and the importance of the mountains as a source of moisture has declined (CIUS 2006).

In the Carpathian countries, state as well as private forest stands are damaged through stealing and the collection of firewood (UNEP-ISC 2006). Illegal logging is common and much higher than official forestry statistics show. Increasing poverty, for example in Romania, is a key driving force, where wood is used for domestic heating and fuel needs. Generally in Romania, poor management of the forestry

sector and economic hardship have led to unsustainable logging to maintain the growing production, export and construction industry (UNEP-ISC 2006).

In most of the Central and Eastern European countries, the restitution or privatisation process is still ongoing, including that related to forest ownership. Significant restructuring is taking place, including the fragmentation of ownership. One result was that many former large state complexes across the Carpathians were broken up into smaller branches which now lack sufficient capital or entrepreneurial and marketing skills (Turnock 2002).

Today, the highest share of privately-owned forest and other wooded land occurs in Romania

(70 per cent) and Slovakia (52.3 per cent). In Ukraine, all forests still belong to the state.

### Solutions

Most countries have a planning, management and control system in place, which at least protects forests as a type of landuse that cannot be easily converted to other landuses. For example, in Slovakia, forests are considered to be a stock of national significance and efforts are made to protect forested areas against development and other landuse forms.

However, even in those countries where the issue of ownership has been secured by an existing legal framework, forest management is often problematic. Throughout the Carpathians, the legal framework and the sector itself are still too focussed on wood production, while the responsibilities for managing forest ecosystems are only sparsely introduced in practice.

It may be assumed that forests will be maintained and somewhat enlarged, but it is more important to enhance qualitative forest management.

Forestry practices are not generally addressed in conjunction with water management issues, despite the very close linkages that they should have within an integrated land-use management framework.

There is a double challenge to achieve sustainable forest management, particularly in the face of the fragmentation of forest ownership. This will require not only setting limits to cutting but also administering forests in the interests of all forest users. One solution is community forest management which links wood production with

processing, and also better reflects the multifunctionality of forest resources such as pasture, food, fuel, building materials, recreation, carbon sequestration and biodiversity conservation (Turnock 2002).

In some countries, a low forest utilisation rate has been observed – in part because of ownership structures where small, private holdings are not intensively managed, or due to management objectives such as biodiversity conservation or improving recreational opportunities. The utilisation rate represents annual tree felling expressed as a percentage of the annual increment. The balance of annual increment and annual felling highlights the sustainability of timber production over time. It also indicates the current and future availability of timber. For long-term sustainability, annual felling must not exceed the annual increment.

Among the Carpathian countries, the utilisation rate is the lowest in Ukraine (about 33 per cent) and highest in the Czech Republic (71 per cent) (MCPFE 2003).

Marketed services have gained importance in recent years. Examples include hunting and fishing licences, managed outdoor recreation areas, and trails for mountain biking, horse riding, skiing and other recreational activities, especially in national parks and protected areas. Another is contracts made between local authorities and private landowners to promote conservation – for example, compensating shepherds for the loss of their sheep to wolves that are protected. Such services may contribute directly to the income of forest owners and thus also to the economic viability of sustainable forest management (MCPFE 2003).

Table 2.3 Removal of non-wood forest products, 2005

	Mushrooms and truffles (t)	Fruits and berries (t)	Raw material for medicine (t)	Game meat (t)	Bush meat* (t)	Hides, skins and trophies (units)
Czech Republic	23 900	22 700	2 800	6 790	9574	216 570
Poland	3 276	8 745	–	8 153	10 456	–
Slovakia	8 750	15 200	–	1 673	1 688	22 470

Source: UN ECE

Note: \* Poached and illegally traded

Data on the quantity and value of marketed non-wood forest products are limited in most countries (Table 2.3). Many do not collect and report data because they do not perceive non-wood forest products as economically important, and because of the difficulties and costs in collecting accurate

data. At best, some countries collect data on the most important products, commercial production or exports. Personal use often accounts for the largest share. At the same time, it can be seen that non-wood forest products can be an important source of income, especially in rural areas.

## Energy and Industry

### Energy

In general, power production in the Carpathian region relies mainly on fossil fuels, followed by nuclear, hydro and renewable energy sources.

Some Carpathian countries hold important fossil fuel reserves, although total proven oil and natural gas reserves are limited. Romania, the largest oil and natural gas producer in the region, is an exception although oil and gas production declined considerably in the last decade (by 50 and 60 per cent, respectively).

The Carpathian countries remain highly dependent on imported oil and natural gas, mainly from Russia. The geo-strategic importance of the Carpathian region lies largely in the oil and natural gas pipelines traversing most of these countries on their way to Western Europe. The ‘Friendship’ (Družba) pipeline transports Russian crude oil to Ukraine, Slovakia and Hungary and onward to Western Europe. The ‘Brotherhood’ natural gas pipelines pass through Ukraine to Slovakia and Hungary. And the ‘Soyuz’ natural gas pipelines pass through Ukraine to Slovakia and the Czech Republic. In

Figure 2.10 Share of renewables in electricity generation, 1990–2004

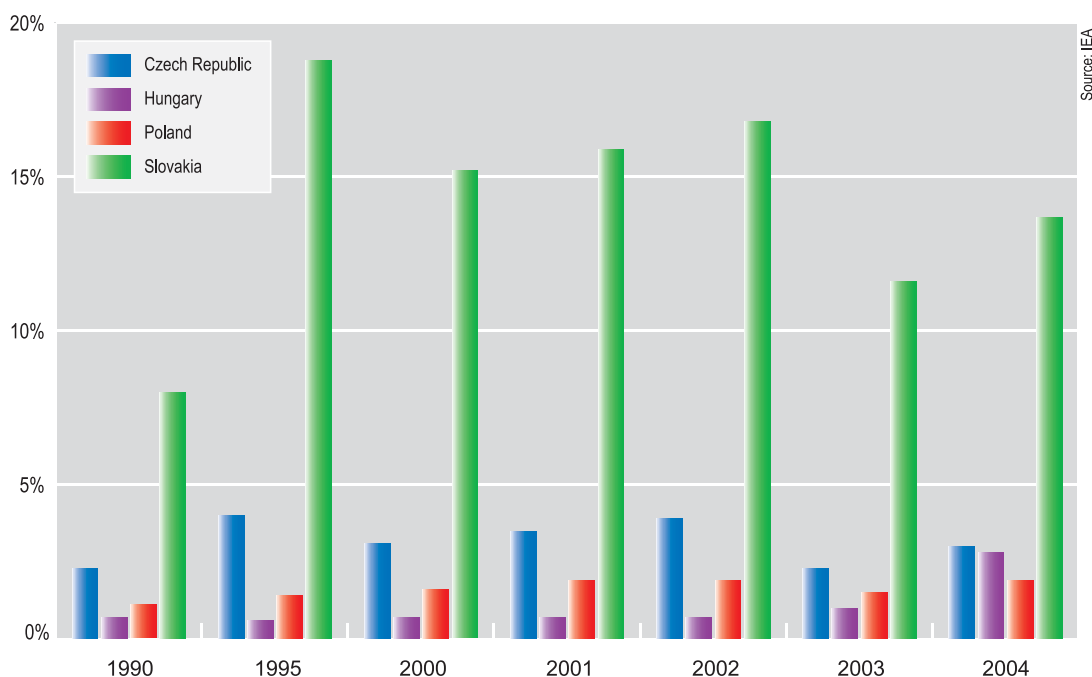
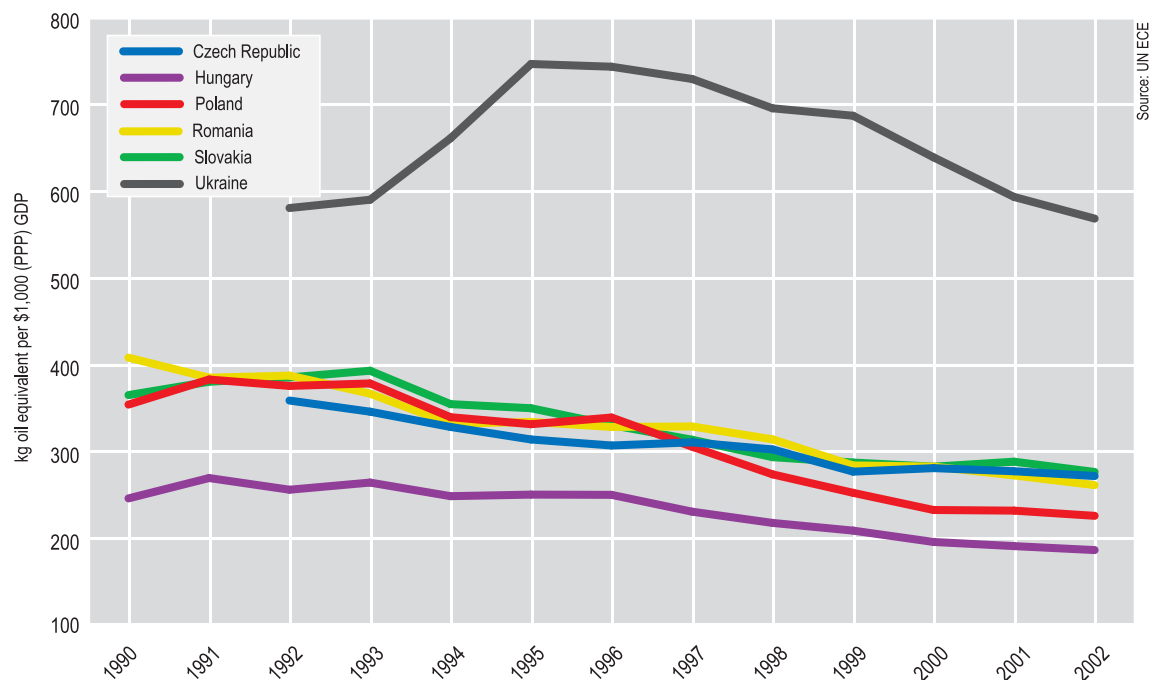


Figure 2.11 Energy use per \$1,000 (PPP) GDP, 1990–2002



Ukraine, serious oil and gas leakages from pipelines have been observed.

In all Carpathian countries except Romania and the former Serbia and Montenegro, between 1995 and 2002, natural gas consumption slightly increased. At the same time, the consumption of coal and coal products decreased considerably.

Over the past decade, Carpathian countries have restructured and downsized their coal industries by closing down inefficient (deep) mines and cutting down coal mining labour forces. The coal reserves of Romania and Ukraine remain significant, with most deposits located outside the Carpathian region.

In Ukraine, thermal power plants account for nearly 50 per cent of generation, while nuclear power generates 40 per cent and hydroelectric approximately ten per cent. Slovakia has become more reliant on nuclear reactors (Mochovce, Bohunice) producing around 55 per cent of the country's total electricity. In Poland, new natural gas reserves are being sought and geothermal energy is already exploited in the Zakopane area. Mining in the Hungarian Carpathians is no longer important since major deep coal mines were

closed. However, opencast mining of lignite still exists in Hungary's Mátra and Bükk Mountains.

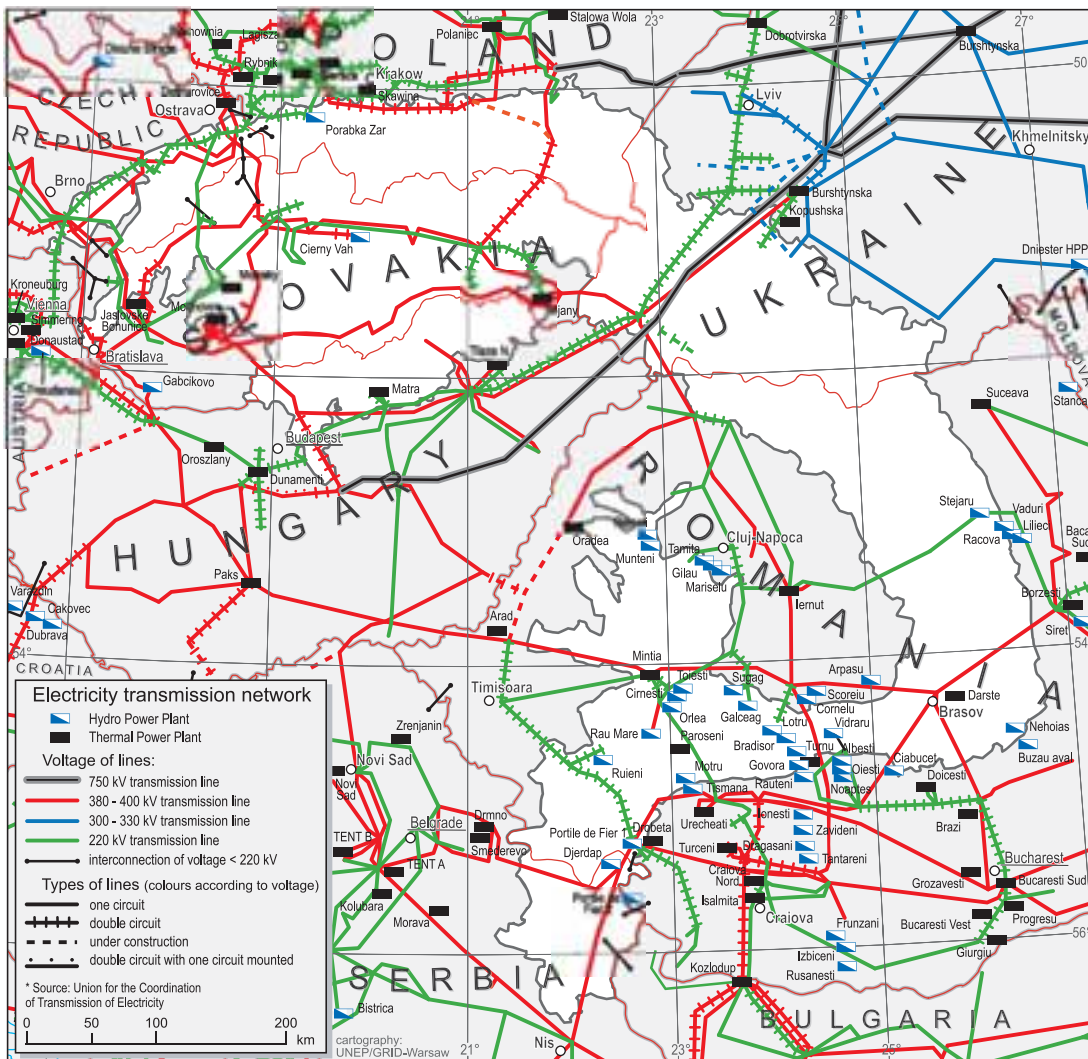
Over the years, the increasing demand for energy meant that Carpathian hydropower resources were almost fully exploited, leading to considerable losses of agricultural land, forest areas and some relocation of villages. Hydroelectric power plays a significant role in Romania, accounting for nearly 30 per cent of generation in 2001.

The Czech Republic, Hungary, Poland and Slovakia are well advanced in reaching the EU target of a 22 per cent share of renewable energy sources in total electricity generation by 2010 (European Communities 2006), with Slovakia now in the lead (see Figure 2.10).

Since 1990, energy intensity per unit of GDP has declined due to economic restructuring, technological modernisation and increased fuel prices (see Figure 2.11). However, it remains high in comparison with the EU-15 average. In Ukraine, energy intensity is now roughly double that of the other Carpathian countries.

The largest high-voltage electricity transmission line (750 kV) comes from Vinnitsa, Ukraine

Map 2.5 Electricity transmission network



through the Carpathians to Albertirsa, south of Budapest (see Map 2.5).

### Industry

As noted earlier, during communism the Carpathians were marginal to main development areas and remote from most leading markets. Nonetheless, the central planning system's heavy pressure on mineral resource exploitation led to the appearance of many production centres on the edge of the Carpathians with material inputs from the USSR. For example, Slovakia became the home for a new metallurgical complex built in Košice and an aluminium plant in Žiar nad Hronom. Farmlands were also converted to make way for new industry.

In the 1990s, industrial production in the Carpathian region dropped dramatically after the political changes. During this time, the main industrial centres were located in the Czech Republic, Hungary, Poland and Romania.

Today, mining and metallurgical industries have an important share in the regional economy, as do chemical, petrochemical, cement, engineering, pulp and paper, food, textile and furniture industries.

The mining industry is well-developed in Romania. Non-ferrous metals are intensively explored and exploited in the Romanian Carpathians, especially in areas such as Maramures, Gutii and the Apuseni Mountains. Non-ferrous metal mining generates much needed income within the Somes

Map 2.6 Potential accident risk spots in the Tisza river basin, with zoom in the Maramures mining region



**INDUSTRIAL HOT SPOTS AND TAILING PONDS**

- ▲ Mining with tailing ponds
- ▲ Mining industry
- ▲ Metallurgical industry
- ▲ Energy production and deposit
- ▲ Oil industry, pipeline
- ▲ Chemical industry
- ▲ Cellulose and paper industry
- ▲ Food, sugar factory
- ▲ Pig farm
- International boundary
- NUTS3 unit (in Ukraine NUTS2)
- KEO extent
- Tisza river basin
- Lake or reservoir
- River

- Settlements
- > 250 000 citizens
  - 100 000 - 250 000
  - < 100 000

\* Source: UNEP/DEWA/GRID-Europe

**HUNGARY**

1. Radioactive landfill at Puspokszlgy
2. Hunvsn Deposit, Ltrn
3. Htrotech Baryeszati, Gyngyosmez
4. Borsodchem Rt., Kazincbarcska
5. AES Borsod power plant & AES Summit Generation, Kazincbarcska
6. EMV Kft (North Hungarian Chemical Works Ltd.), Sajobabony
7. Columbian Chemical Co. & Columbian Tisza soot plant, Tiszaajvaros
8. AES Tisza I coal power plant, Tiszaajvaros
9. MOL oil refinery, Tiszaajvaros
10. AES Tisza II of power plant/AES Summit Generation
11. TVK Chemic Combine, Tiszaajvaros
12. Begin-say, Szolnok
13. TVM chemical works, Szolnok
14. Mol base depot, Szajol

**SLOVAKIA**

1. Zelba s.p. Siderit Nizna Slana/Rozvana
2. Bukocel Hencovce a.s. Vranov nad Toplou
3. Chemko Strazske a.s.

**UKRAINE**

1. Perechynski industrial complex
2. Prykarpattans oil product
3. Svalyava industrial complex
4. Druzhba
5. Prykarpattans naftoproduct
6. Velykobyckivsky industrial complex

**ROMANIA**

1. Nutriam Molin
2. West Construction Company
3. EM Turt
4. IMI Baia Mare-sector Iiba
5. IMI Baia Mare-sector Nistn
6. EM Baia Sprie-sector Hraj
7. Romplum Baia Mare
8. Transgold Baia Mare-Bocsete Aunl pond
9. EM Aurum Baia Mare-sector Sasar
10. Cuzrom Bucurui-sucurula Baia Mare
11. UP Flotatia Centrale Baia Mare
12. EM Baia Sprie-Tautii de Sus pond
13. EM Cavnice-Plopi Rachitele pond
14. EM Baiut-Bloaja pond
15. EM Baia Borsa-Novat pond
16. EM Baia Borsa-Colbu pond
17. Cominco Bucovina Frasin-Valea Bailor
18. EM Rodna-Valea Glodului pond
19. SC Somes SA Dej
20. SC Agroflip SA Bontida
21. SC Devamin SA Mine Baita (Fanate)
22. SC Devamin SA Mine Brad (Rabita)
23. EM Coranda Cerlej
24. EM Abrud
25. EM Rosia Montana
26. EM Baia de Aries
27. SC Bicapa SA Tamaveni

and Mures river basins. The industry offers employment for many thousands of local inhabitants but is also a serious source of soil and water pollution. A key problem in this sector is the use of obsolete technology. To improve the sustainable use of mineral resources and the efficiency of the mining industry, some mines were selected for closure which has (and will) reduce employment in some areas (see Chapter 3, section 3.4).

The ferrous metal industry in the region is present in Hunedoara, Rožnava, Košice and Miskolc. Small-scale mining occurs in Ukraine with the extraction of salt, kaolin, mercury, gold, zeolite and construction materials. The chemical industry operates mostly in northern Hungary, Romania and southern Slovakia. The petrochemical industry, including oil refineries, storage and transportation (pipelines), is an important sector in Hungary and Ukraine.

The pulp and paper industry is present in Slovakia, Romania and Ukraine. Here, the furniture industry is one of the few economic sectors that maintained a positive trade balance in the last decade and continues to share an important part of total industrial output.

### Cyanide Spill in Baia Mare

In 2000, Baia Mare and Baia Borsa, Romania became the site of the largest accidental spill of chemicals in the Carpathians ever. Here, the walls of the tailing dams of two gold mining companies collapsed. As a result, significant amounts of cyanide and heavy metals spilled into and contaminated the rivers Somes, Tisza and Danube, mostly in Romania and Hungary, and to a lesser extent in Serbia, before reaching the Black Sea. Ongoing debates continue between Hungary and Romania over compensation from the 2000 spill as well as over the opening of a new gold mine in nearby Rosia Montana, Romania.

The damages arising from mining operations are now being more fully acknowledged, including pollution generated by non-ferrous metallurgical smelters in Serbia, Slovakia and Romania. Some parts of the Eastern Carpathians with heavy mining legacies exhibiting lunar-like landscapes have created problems for exploiting the area's high tourist potential. Fortunately, in many parts of the Carpathians, threats from mining operations are now greatly reduced as uneconomical mines are closed down (see Map 2.6).

## Transport Infrastructure

Overall, there is a general lack of highway systems, and existing national road networks require improvements. Important road routes that cross the Carpathian region are the European E60, E671, E673, E68, E70, E71, E79 and E81 roads. The region is also crossed by Pan-European Corridor IV which follows the route Berlin-Nürnberg-Prague-Budapest-Arad-Bucharest-Constanta-Istanbul-Salonika, approved by the European Council during its Helsinki Summit in 1999.

New road building includes the Northern Transylvanian Highway from Brasov-Cluj-Napoca-Bors to the Hungarian border; currently under construction, it will have a total length of 415 km. Through its trans-European transport network (TEN-T) plans, the EU has also proposed a new

major transport corridor from Madrid to Kyiv. At the same time, new proposed road networks could lead to habitat fragmentation and potentially block biodiversity and migration corridors (WWF 2001), as might high-voltage electric power cables and badly designed and inadequately located developments such as transformer stations.

According to statistical data, road network density is the highest in some areas of the Czech, Slovak and Polish Carpathians. These are about four times higher than in the Hungarian, Romanian and Ukrainian parts (see map 2.7).

The stock of passenger cars in the Carpathian countries rose significantly from 16 million in 1995 to over 22 million in 2003 (see Map 2.8).



Map 2.7 Road network density in the Carpathians, 2003



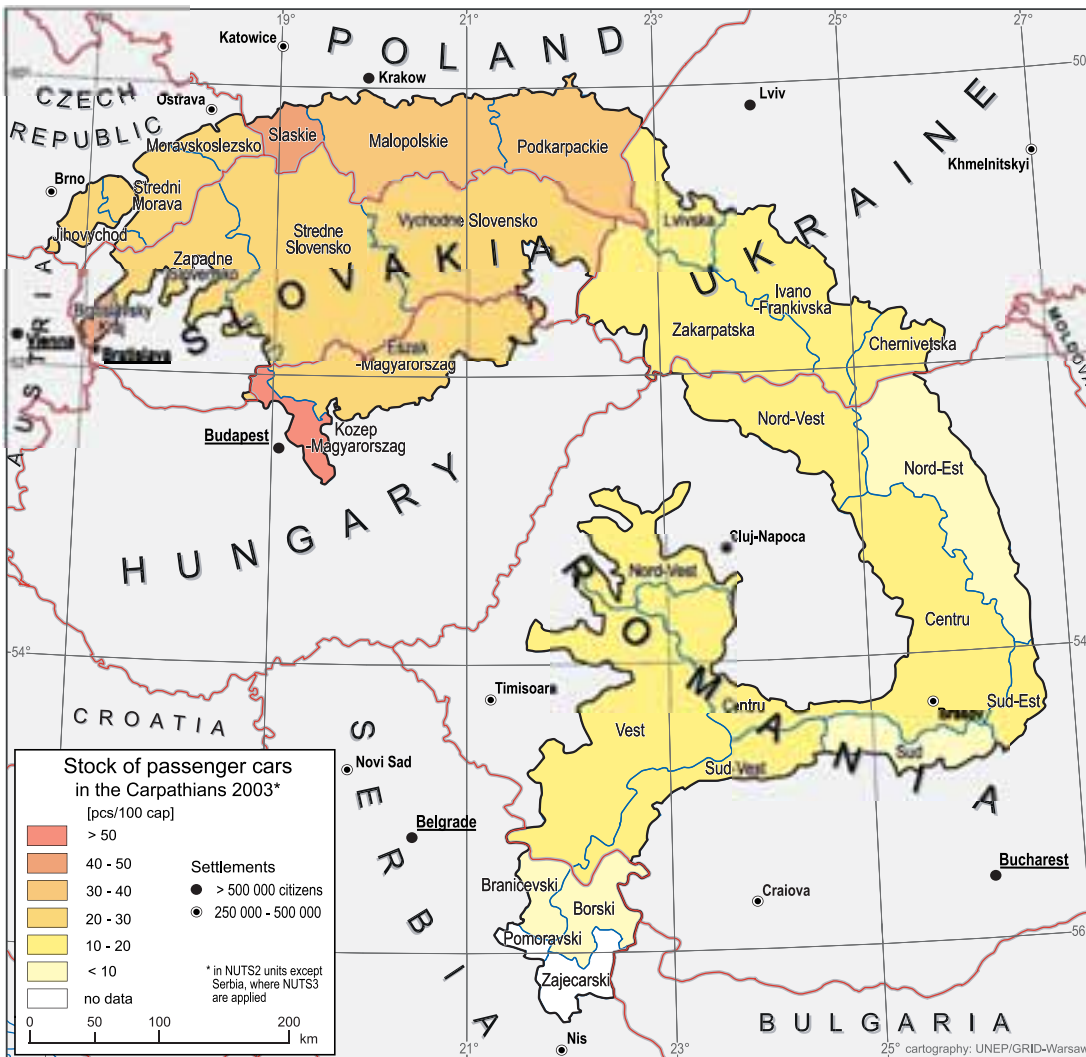
In 2003, the Czech Republic had the highest number of cars per capita at 36 per cent, while Romania showed the lowest figure at 13 per cent. The two counties around Bratislava and Budapest showed the highest peaks because of the influence of the two capital cities, while the northeastern and southern regions of Romania had the lowest figures.

Large disparities can be observed in the development of the rail transport network between the northwestern and southeastern parts of the Carpathians (see Map 2.9). The densest networks are found in the counties of Bratislavsky Kraj, Slovakia and Slaskie woivodship, Poland, with over 15 km of rail per 100 sq km, while the lowest densities are in Romania and Ukraine,

below five km per 100 sq km, largely because of the area's geomorphological features. In general, the regional rail network shows continuous degradation due to a lack of financial sources and maintenance. There is also a tendency to close down inefficient railway branch lines, replacing them with road passenger and freight transport (UNEP 2004a).

The region's air transportation is developing well with some international and regional airports such as: Ostrava in the Czech Republic; Poprad, Sliač, Košice, and Žilina in Slovakia; Krakow and Rzeszów in Poland; Baie Mare, Cluj-Napoca, Sibiu, Suceava and Tirgu Mures in Romania; and Chernivtsi, Ivano-Frankivsk, Lviv, and Uzhgorod in Ukraine.

Map 2.8 Stock of passenger cars in the Carpathians, 2003



Most of the region does not have watercourses suitable for navigation. However, the Danube River has been identified as Pan-European Cor-

ridor VII under TEN-T, linking the Black Sea with Germany and the Rhine River to the Baltic Sea.

## Tourism

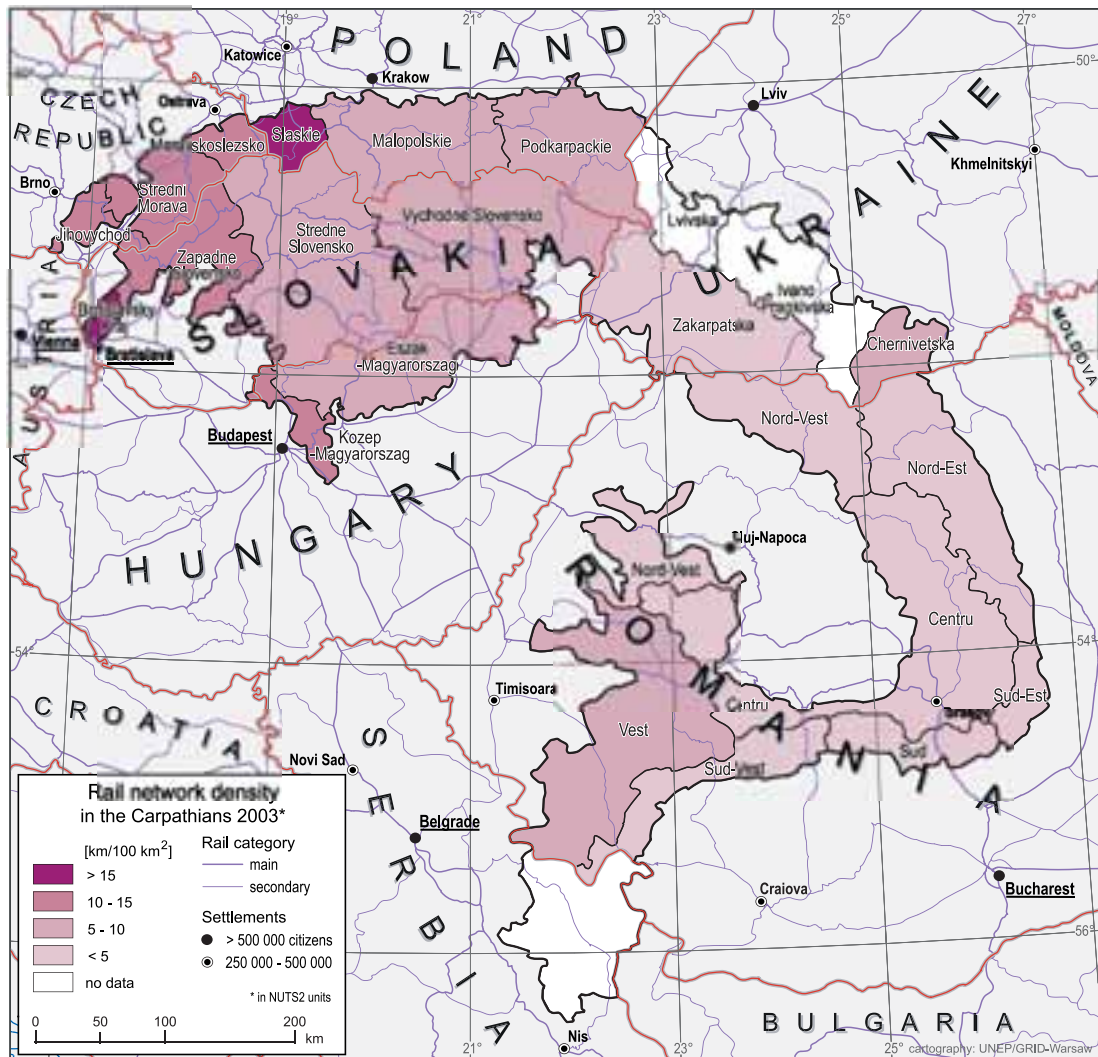
### Overview

Up to 1990, Central and Eastern Europe experienced a considerable expansion in international tourism, largely based on arrivals from other socialist countries. When the communist regime collapsed, this market disappeared along with a sharp

decline in tourism. In the early 1990s, only a few of the most important areas, such as Beskydy in the Czech Republic and the Tatra Mountains in Slovakia and Poland, continued to attract tourists.

Today, tourism is an important economic sector in the Carpathian countries with considerable

Map 2.9 Rail network density in the Carpathians, 2003



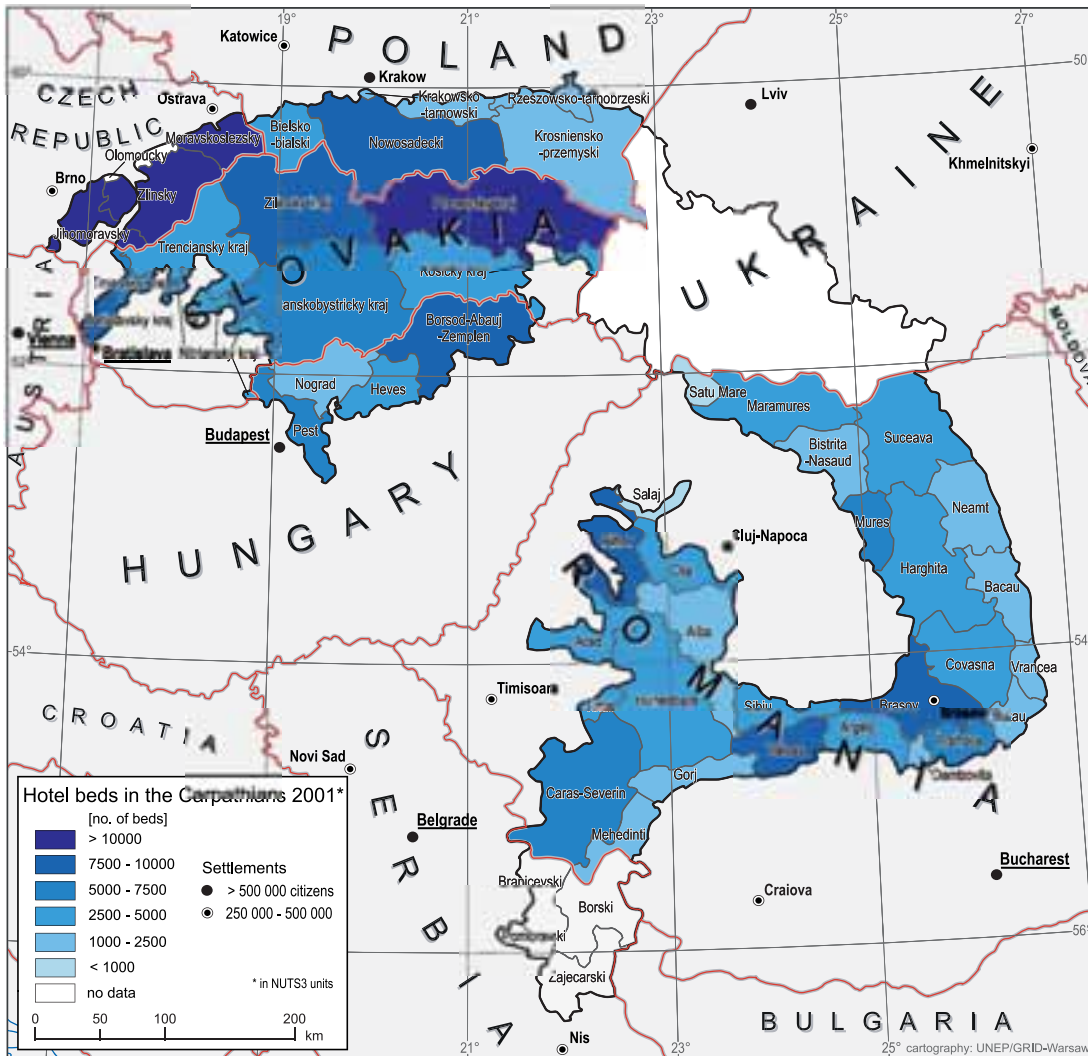
potential. The distribution of hotel beds, with the Czech, Polish and Slovak regions having the most hotel beds, correlates with the overall development of tourism infrastructure in the Carpathians (see Map 2.10).

Differences related to the economic importance of tourism between countries and even within the same country can be observed. For example, the natural resources of the northwestern part of the region (e.g. Slovak and Polish Tatras) face heavy pressures from tourist activities. In contrast, tourism activities in the southeastern and northeastern Carpathians (e.g. Romania and Ukraine), calculated in number of tourists, are very low and thus exert little pressure on the environment.

The region is rich in natural and cultural heritage. It includes four biosphere reserves and 33 national parks with an overall territory of nearly 10 500 sq km, representing about five per cent of the total Carpathian area. In 2006, the UNESCO World Heritage list contained 26 cultural and natural sites in the Carpathian region (see Chapter 1 and section 3.9 in Chapter 3).

The first protected areas, established in 1895, were the National Nature Reservation Ponická Dúbrava and National Nature Reservation Priboj in Slovakia. In the Western Carpathians, a system of protected areas was established after World War I and in 1932, Europe's first ever transboundary national park was established in Pieniny on the Polish and then Czechoslovak border.

Map 2.10 Hotel beds in the Carpathians, 2001



Overall, the protected area network is denser and better-managed in the northwestern part of the Carpathians than in the southeast.

The region's cultural diversity is almost as great as its biodiversity. People of different religions, languages, customs and traditions live together. The Second World War considerably destroyed this ethnographical variety, especially in the Eastern Carpathians, but many attractive historical monuments survive (Chapter 3, section 3.9).

It includes a wide variety of destinations, tourist facilities and products. Because of the region's healthy climate and natural beauty, the Carpathians provide excellent opportunities for health and wellness development, including an abundance of

thermal mineral springs – carbonic acid, salt, iodine salt, bitter and petroleum. The most famous springs are in Hungary's Miskolc-Tapolca, Slovakia's Bardejov, Pieštany in Poland Krynica, and Băile Tușnad and Băile Herculane in Romania.

Eco- and adventure tourism revolve around the numerous mountains and forests across Romania. Many mountainous areas are virgin lands, untouched by pollution where fresh air and beautiful sites abound. The Carpathian mountain range offers good quality ski resorts and a full range of winter sports. The most important Transylvanian city in the Carpathian Mountains in Romania is Brasov. Here in winter, nearby ski resorts such as Poiana Brasov, Sinaia and Predeal are filled with tourists.

During the spring, summer and autumn months, tourists come to the Carpathian Mountains to enjoy hundreds of kilometres of pristine alpine meadows, forest, lakes and valleys. The main leisure activities are hiking, hunting and fishing. Tourists either stay in hotels, motels, hostels, pensions or campsites. In Romania, rural tourism was developed only after the 1989 collapse of communism. Already, it can provide accommodations for some 10 000 tourists. Many domestic tourists are interested in rural tourism because it is generally less costly than other forms.

In Serbia's Carpathian region, 'farm tourism' is the most developed rural tourism product, especially in areas with undeveloped economies. And Serbia's National Park Djerdap has attractions and facilities proving it to be a tourist resort unique for the whole of Europe and the world.

The Ukrainian Carpathians, frequently referred to as the 'Ukrainian Alps' for their beautiful landscapes, microclimate and comfortable geographical location, are famous for their walking, cycling, water, spa, horse riding (especially the special hutsul or 'Hutsulyk' breed) and well-developed rural and cultural tourism possibili-

ties, including 'green village tourism' (Omelyan 2005, WWF 2001).

Excessive pressure in some areas rendered more accessible by cable cars and through the promotion of winter sports has caused some degradation of rich flora.

### Solutions

The main limitation for the tourism sector's development is poor infrastructure, difficult accessibility and low levels of standards, skills and management. Transportation and accommodation facilities need to be developed to make proper use of the rich natural potential of the region. Local job opportunities and incomes could then increase.

The economic attraction of tourism is persuading many communities, particularly in the northern Carpathians, to develop new tourist facilities with new and improved road networks.

Efforts should be made to boost sustainable tourism that goes beyond simply supplying beds and restaurants to protecting more landscapes, wildlife and cultural heritage and providing local organic products.

## Transboundary National Parks and Tourism

In 1992-93, a large area in the Tatra Mountains was designated a UNESCO Trans-boundary Biosphere Reserve. It now extends beyond the two original National Parks on each side of the boundary between Poland and Slovakia – Tatrzański National Park in Poland and Tatra National Park in Slovakia. Tourism is its most important economic activity. The Polish side receives some three million tourists annually. In Slovakia, the total is roughly five million. Walking and winter skiing are important activities. Over 600 km of hiking trails can be found on the Slovak side alone. Tourist resorts and hotels abound on both sides of the border.

Another outstanding example of sustainable tourism was the first trilateral reserve in the world and largest European reserve – the Polish-Slovak-Ukrainian International East Carpathian Biosphere Reserve (ECBR) completed

in 1998. The reserve area encompasses Europe's largest natural beech forest complex and its most important refuges for large animals living in primeval habitats. Endemic and threatened plant species and communities, unique fauna, including all native big predators, as well as large native mammals, constitute its natural value of global importance. Cultural heritage is preserved, such as remnants of Lemko and Boyko rural and sacral wooden architecture, as well as traditional land-use patterns and pastoral practises. The ECBR encompasses an area of 2 132 sq km and the following protected areas: Poland's Bieszczady Mountains National Park and Cisna-Wetlina and San River Valley; Poloniny National Park and its buffer zone in Slovakia; and Uzhans'ky National Park and Nadsans'ky Regional Landscape Park in Ukraine.

(Source: Omelyan, S. 2005)

## Traditional Economic Activities

The Carpathian Mountains represent an important refuge for biodiversity. This includes the development of a wide variety of animals and plants that were traditionally bred for agricultural purposes. However, the rapid economic transformation in agriculture resulting from privatisation and modern farming techniques pose a number of threats.

Among unique animals living in the region, the Hucul (Hutsul) horse population, known as the “pony of the Carpathian Mountains”, includes about 500 individuals, while world-wide only some 800 can be found. Buffalo cows number about 70 000 in the Romanian Carpathians and only 160 in Hungary. Conservation programmes are underway to protect the traditionally domesticated Red mangalica (mangalitsa) pig in Romania’s Apuseni Mountains and Saddleback and Blond mangalica pigs in Hungary.

In addition, Truskova (Wallachian) sheep account for 45 per cent of the Romanian sheep population. In Romania’s Brasov and Covasna counties, Trigai (Cigaja) transhumance sheep (with shepherds practicing vertical seasonal livestock movement) are found. Other traditional sheep varieties include the Carpathian sheep in Ukraine’s Chernivtsi oblast, the Polish mountain sheep (Valaska) and Racka sheep in the Hungarian Carpathians. Some 60 per cent to 70 per cent of all sheepdog breeds live in Bukovina, a region shared by Romania and Ukraine. Romania has the largest goat population (700 000 individuals) living together with the transhumant donkey.

In the context of subsistence agriculture and rural industry, particular importance was traditionally attached to fruit growing and viticulture. Interestingly, even domestic architecture was affected, with two-story houses often accommodating drying kilns and fermentation areas below living spaces.

Traditional varieties of fruit trees in the Carpathians represent a genetic treasure to be conserved. Old fruit varieties, selected to withstand harsh

environments, became adapted to local soil and climatic conditions, possess good quality and taste and are resistant to diseases and parasites. Rural people use about 20 species of fruit trees such as apple, pear and cherry.

Unfortunately, the last 50 years witnessed dramatic decreases in the diversity of wild fruit plants. Many local valuable genotypes were lost because of the collectivisation of agricultural land and development of pasture farming. Fruit plant populations now consist mainly of very old trees, at times over 100 years old (Monitoring Institute for Rare Breeds and Seeds in Europe 1999).

Brandy distillation in the Romanian Carpathians remains one of the few activities that have retained a significant role. Under socialism, peasants were allowed to make a “borhot” which they delivered to central distilleries and for which they received payment in distilled products. Many farmers now make their own brandy in small home stills. Throughout the Carpathians, wild cherries found in the hills are often used for brandy-making, as are plums, apples and pears.

Plant species have also provided resources for textile crops such as wool, flax and hemp from which a wide range of goods were regularly produced including winter clothing, blankets and covers.

Woodworking has been an important type of local production in Carpathian villages, especially for building homes and cattle shelters and wood carving. In most parts of the Carpathians, every village had generations of timber specialists and a variety of related trades such as joiners, wheelwrights, shuttle-makers and coopers. The collection of non-wood forest products such as mushrooms and berries has also provided revenues for mountain people.

The existence of skilled stone masons goes back to prehistoric times, later apparent in the production of domestic items such as stone fireplaces

and bread ovens in peasant houses. Practices such as the production of lime in kilns and furnaces, as well as charcoal, are referred to in the

Middle Ages throughout the Carpathians. Pottery making is another important craft central to Carpathian rural life (Turnock 2002, Muica et al. 2000).

### Traditional Knowledge and Activities: Czech White Carpathians

Stretched along the Czech-Slovak border at the western edge of the Carpathian Mountains, the White Carpathians are characterised by deciduous forest and species-rich grassland which harbour over 30 rare orchids and 250 varieties of fruit trees. In Hostetin, a small village of 250 inhabitants, the Veronica Ecological Institute and other civic organisations initiated a range of local sustainable development projects. Their main objective was to preserve the gene pool of different species of fruit trees and to promote organic farming and landscape stewardship. Another important aim was to strengthen the rural economy by creating new jobs and income opportunities for villagers, facilitate the marketing of traditional local products, and raise public awareness of local heritage and its close connection with preserving the environment. Hostetin is gradually becoming a model for sustainable development. Its organic juicing plant, the first in the Czech Republic, is only one of several small-scale projects.

In 1998, an association of NGOs together with local fruit producers launched a programme called 'Traditions of the White Carpathians', aimed at promoting and preserving the area's cultural and natural heritage. A regional brand name was launched to market local high-quality traditional products, promote the region and accelerate its development. Branding helped to create demand for local products among tourists and residents, and was

key to the development of small enterprises and the survival of traditional handicrafts and food production (Ruzicka, 2006).

Examples of products labelled with the 'Traditions of the White Carpathians' brand are dried fruits, mutton produced in Moravian Wallachia, traditional crafts, and the award-winning apple juice produced in Hostetin, a flagship product now sold in major supermarkets throughout the country. In addition to providing seasonal jobs for many residents and supplementing the incomes of local orchard owners, the organic juice processing plant is an important feature of a larger strategy to preserve the rich diversity of some 250 varieties of fruit that are native to the White Carpathians. In 2003, this product was awarded the Organic Product of the Year distinction by the Czech Environmental Partnership Foundation.

Another popular activity in the region is the St. Nicolas Fair. Today, it is the most popular local fair featuring crafts, foods and traditions of the region. Visitors can enjoy the popular local plum brandy 'slivovica', taste 'frgále' pear cakes, and play cymbal music. Other sustainable development projects in the region include a biomass heating plant, ecological reed-bed sewage treatment facility and traditional fruit drying kiln.

(Source: [www.tradicebk.cz](http://www.tradicebk.cz), <http://hostetin.veronica.cz/>)



## 2.3 Societal Driving Forces and Pressures

### Population Trends

Over the last 15 years, population trends in the Carpathian countries have generally been characterized by features such as high rates of population loss in Romania and Ukraine and slight decreases or stagnation in Hungary and Slovakia. This is seen as a negative pressure, as healthy populations are needed to preserve cultural and economic traditions, especially in mountain areas.

Since 1991, Ukraine has lost roughly ten per cent of its population, or some 4.5 million people, leading to a serious demographic crisis. During the same time period, the Romanian population decreased by seven per cent (see Figure 2.12). In both countries, international migration was a key contributing factor. For example, between 1975 and 1999, nearly 700 000 people emigrated from Romania, most of them Romanians, Germans and Hungarians (Ethnic Mobility in Romania 2004). Migration has increased in recent years due to the scarcity of work opportunities in the poorest areas of the

basin, and the proliferation of job offers in more economically developed areas, for example Romanians and Ukrainians crossing into Hungary or outside of the basin.

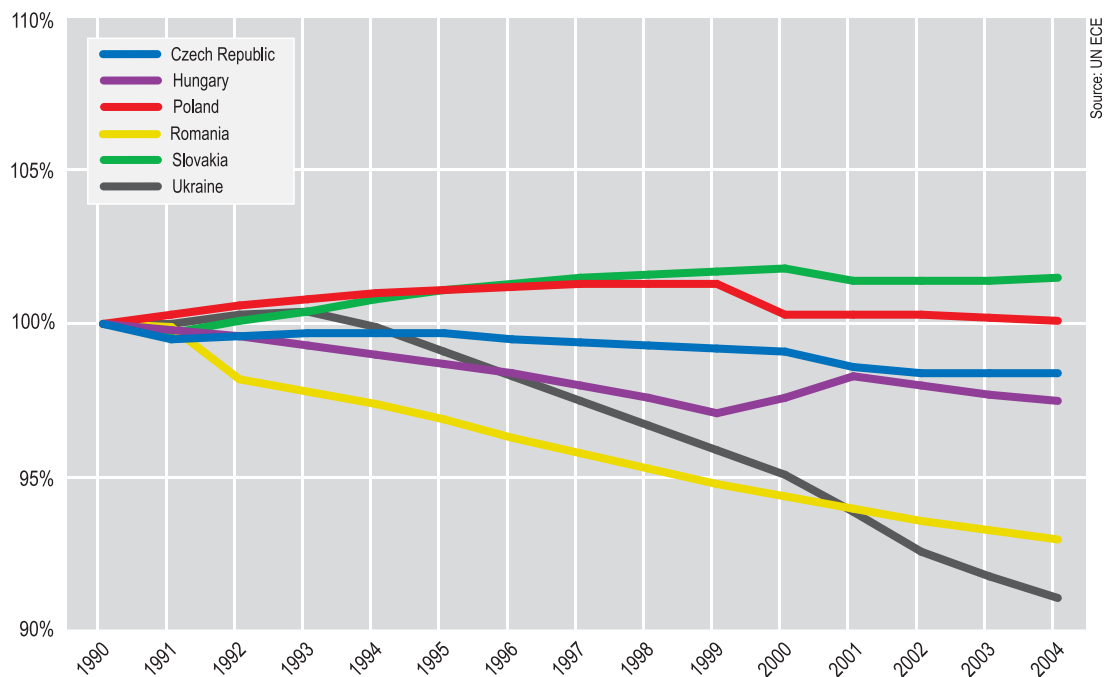
Population density varies significantly from region to region. Those with the highest population density are located in the Czech and Polish Carpathians, with over 175 inhabitants per sq km. The lowest densities occur mainly in the Romanian Carpathian, with less than 100 inhabitants per sq km (see Map 2.11).

In all Carpathian countries, males on average have shorter lives compared to female populations. At the same time, there are wide variations, for example, between male life expectancy in the Czech Republic at 72 years compared to only 60 years in Ukraine.

In the early 2000s, the highest infant and child mortality rates were observed in Romania, the former Serbia and Montenegro, and Ukraine.



Figure 2.12 Total population growth rate, 1990–2004



Ukraine had nearly double the rates of the other Carpathian countries (see Figure 2.13).

A general tendency in the Carpathians is the ageing of the population, with some regional discrepancies. For example, at the national level, the proportion of the young population under 25

in Serbia is the highest among the Carpathian countries (see Figure 2.14).

There is a large Roma (otherwise known as “Gypsy”) population in the Carpathians, particularly in eastern Slovakia, northeastern Hungary, western Ukraine and northern Romania. These

### Linking Poverty and Environment

The poverty and environment inter-linkage is an important theme concerning how human well-being and the natural environment influence each other. Ecosystems, besides providing just goods for humans, also provide critical life-supporting services – the conditions and processes through which natural ecosystems sustain and fulfil human life. They maintain biodiversity and the production of goods such as forage, timber, biomass fuels, natural fibres, pharmaceuticals and industrial products. They provide life-supporting functions such as cleansing, recycling and renewal, and confer many intangible aesthetic, spiritual and cultural benefits and values.

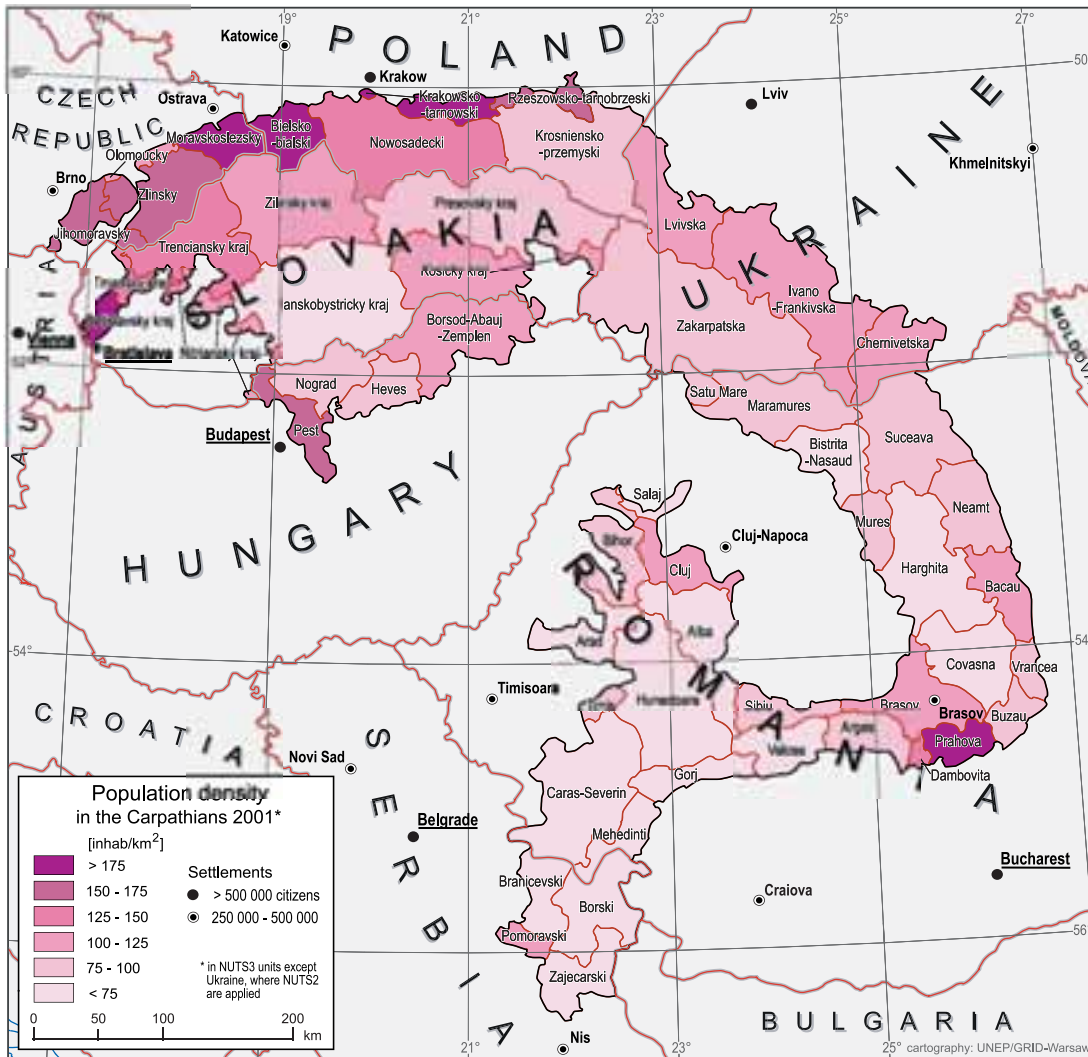
All people – rich and poor, living in developing or developed countries – depend on ecosystem services. However, this is only true in the long run. In the short run, the poor are more heavily dependent on these services. For example, the rich can buy clean water or the technology to filter and purify water if it is contaminated. The poor, on the other hand, have limited resources to pursue these options and must usually depend on natural wa-

ter systems and/or public water supply systems, many of which do not meet the minimum standards for human consumption, especially in developing countries.

The same can be said for extreme natural events like floods, storms, heat waves and extremely cold winters. These tend to have a bigger impact on the poor because they do not have the resources to build appropriate shelters or because their homes are built on land where the natural barriers to landslides and floods have been destroyed. In the last decade, an increasing number of flood events adversely affected poor as well as old people. One of the most vulnerable groups is the Roma.

Furthermore, poor women and children suffer disproportionately in acquiring dwindling natural energy supplies for cooking and heating. The suffering is amplified by the greater amount of time they spend in badly ventilated shelters when using highly polluting fuels like coal and firewood. (Source: Duraipapp 2002)

Map 2.11 Population density in the Carpathians, 2001



are some of the poorest regions of their respective countries and suffer from high unemployment and economic underdevelopment (Pomázi et al 2006). Communities are vulnerable, as residents are victims of poverty, social exclusion and discrimination. Addressing these concerns is becoming an increasingly important socio-political issue for national and sub-regional governments. Effectively integrated land and water management applied in a sustainable manner would be one of the tools that could be used to alleviate poverty in the region.

Roma are far fewer in number and less controversial in Poland. Estimates of their population in Poland range from 15 000 to 50 000. In contrast, Roma in the former Czechoslovakia numbered 500 000 in the 1980s when Poland became a transit point on the illegal migration route from Romania to Germany. The emigration of Polish Roma to Germany in the late 1980s reduced Poland's Roma population by as much as 75 percent.

Figure 2.13 Life expectancy, infant and child mortality, early 2000s

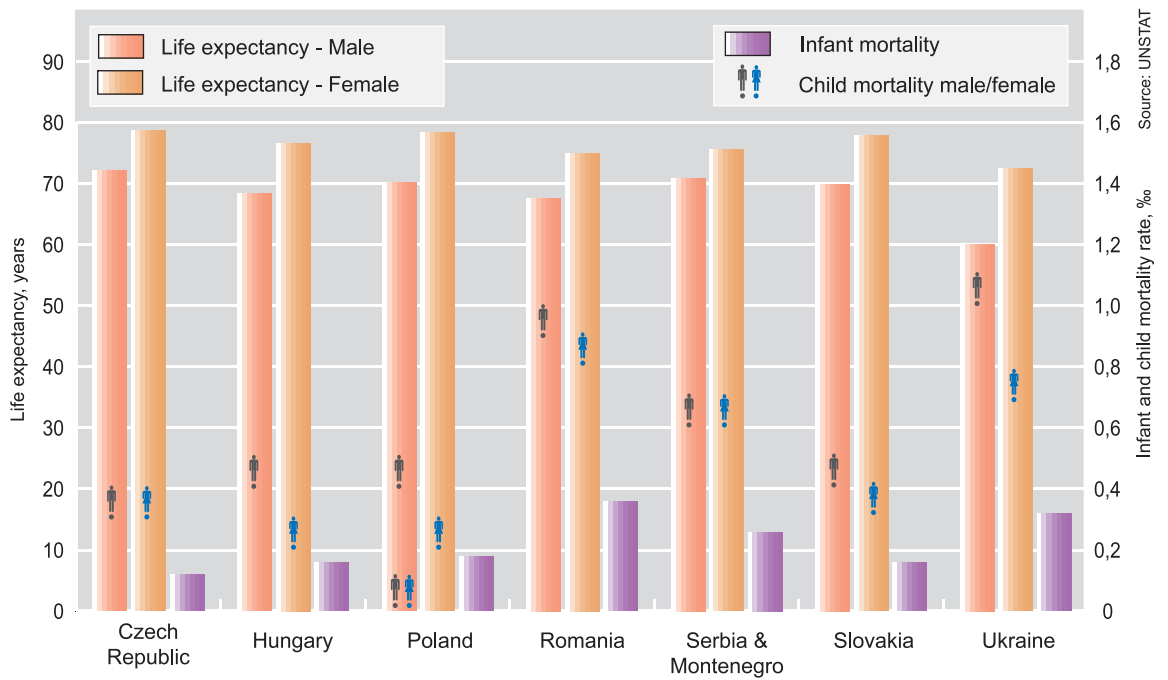
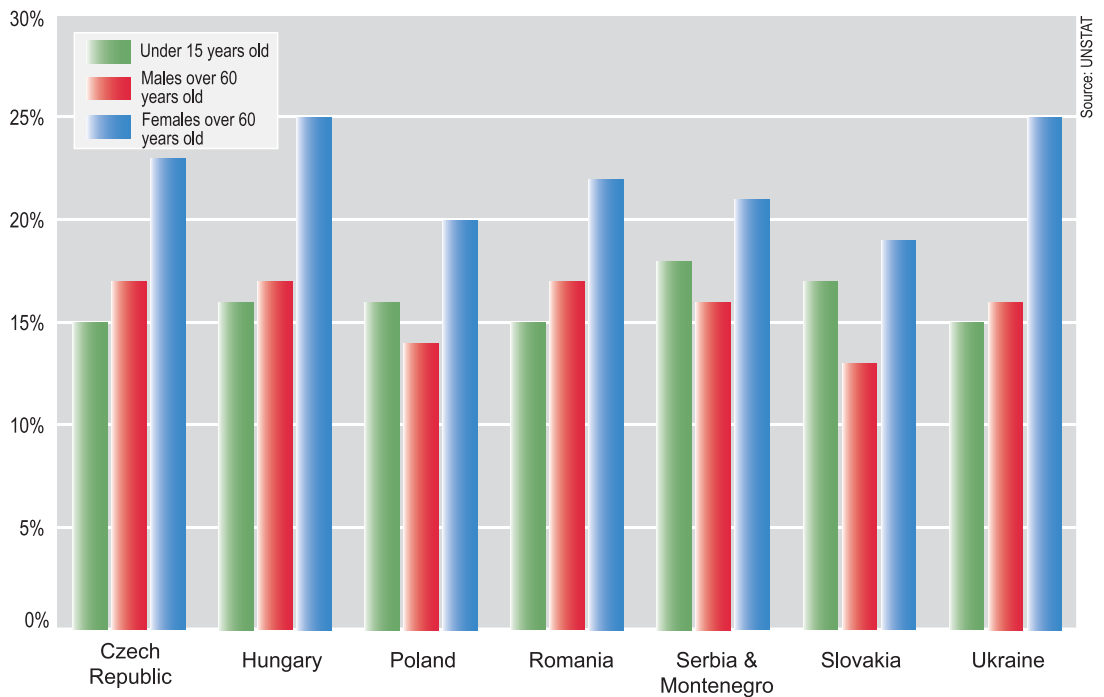


Figure 2.14 Age structure of population, 2005



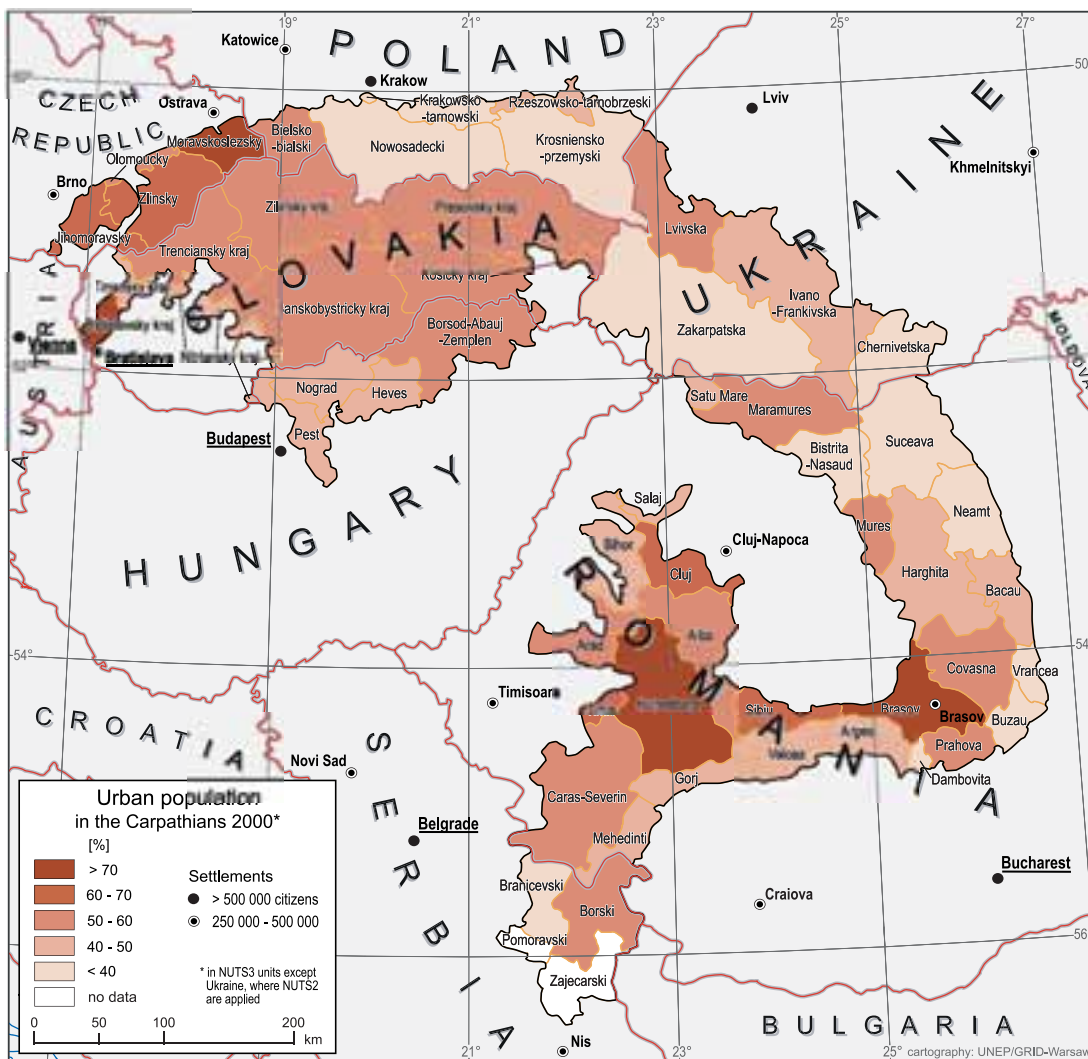
## Rural De-population and Land Abandonment

‘Rural areas’ in the Carpathians are sparsely settled places, distinct from the urban influences of large cities and towns and distinct from unsettled lands such as outback or wilderness. People live in villages, on farms and in other isolated houses, as in pre-industrial societies. Today, many rural areas focus on agriculture, although their economies may also be based on logging, mining, petroleum and natural gas exploration or tourism.

Relative to urban areas, rural areas are characterised by higher levels of poverty and lower prices and levels of power. Inequality is growing

between rural and urban areas for many reasons. During the transition period, rural conditions throughout the region deteriorated. Most of the Carpathian region’s poor now live in rural areas. Rural populations are generally in decline, largely because of migration to urban areas and other countries in the search for employment. Migration has been a predominantly male phenomenon. Impacts include women now making up a large percentage of the rural poor and rural populations increasingly represented by women and the elderly. Furthermore, households are increasingly headed by seniors and pensioners,

Map 2.12 Urban population in the Carpathians, 2000



while rural household members are much older than those in urban areas.

High unemployment is a common feature of rural areas. In most Carpathian countries, the agriculture sector accounted for the greatest decline in employment. Rural villages suffered, particularly those where agricultural concerns and heavy industries, many now obsolete, were the main employers.

Lifestyles in Carpathian rural areas differ from those in urban areas, mainly because of limited services. Rural infrastructure has often experienced considerable deterioration. Many rural roads, irrigation systems and erosion control measures remain in poor condition. Originally designed to suit the cultivation of large tracts of land, they have not undergone the reconstruction required to suit the newer and smaller family farms on the rise in rural areas.

Public services such as police, schools, fire stations, community centres and libraries may be distant, limited, suffering from lack of attention in scope or simply unavailable. The same holds true for water and sewerage facilities, street lighting and public waste management, as well as public transport, as many people use their own vehicles, walk, cycle or even ride animals such as horses and donkeys. Power and water systems are prone to frequent breakdowns.

Furthermore, much of the environmental damage that occurred in rural areas during the socialist period has not been repaired. Large-scale cultivation destroyed field roads, watercourses, vegetation belts and other landscape features suitable for individual farming. Production centres were often placed in the heart of villages with adverse ecological impacts. Environmental degradation at times increased during the transition period, for example through the deforestation of valuable species, inappropriate tillage of soils and a failure to maintain a balance of nutrients in the topsoil (FAO 2003).

One of the main threats – maybe even the most crucial one – that mountain territories now face is the abandonment of agricultural lands and traditional farming practices. This phenomenon reflects a post-war trend of rural depopulation and the marginalisation of wide agricultural regions. ‘Marginalisation’ is a process in the sense that it affects areas which were not marginal in the past. In other words, it means ‘becoming marginal’ as opposed to ‘being marginal’. This is of fundamental importance when analysing land abandonment and its economic and environmental consequences. For example, if previously cultivated or otherwise semi-managed lands are neglected, then the unique biodiversity that has become adapted to those lands could be lost; basically, the ecosystem could become almost completely restructured.

### From Farming to Tourism in Poland

In 1990, the Polish Carpathians as a region had one of the best rural demographic and economic situations in Poland, as indicated by population growth, the advantageous gender and age structure, low unemployment rate and good housing standards. Today, population growth in Poland, especially in the Carpathian area, is practically zero. Village residents regularly migrate as more youngsters flee to cities looking for work.

A major concern has been the worsening agricultural situation complicated by the unfavourable natural conditions of the mountainous terrain, fragmentation of holdings and low level of efficiency. As food production on the more fertile soils of other areas in Poland is sufficient, the likelihood of the further abandonment of mountainous lands by farmers is high, as numerous examples from Western Europe prove.

On the other hand, tourism is a positive factor in the socio-economic transformation of the Carpathian country-

side. It was a significant activity even before the Second World War when lodgings were sought in private houses in many villages of the Sub-Tatra, Podhale Basin and the Silesian and Sacz Beskides. The villages currently active as tourist centres show the most dynamic development and the highest level of socio-economic infrastructure (Kurek 1996).

The same holds true for Poland's Bieszczady Mountains where lands have become less valuable for agriculture. Focusing the area's high aesthetical values on tourism is now probably the best way to use the potential of its landscape. Tourism infrastructure should be developed with the aim to attract more visitors for numerous recreational and sporting activities in the summer and winter. Local residents have already realised the opportunities, reflected in the growing number of agro-tourist accommodations in the mountains and foothills. (Source: Janicki 2005)

The abandonment of traditional farming activities results in a number of impacts which can be summarized as follows: increasing natural hazards; loss of productive lands; diminishing terrain value; loss of natural capital and environmental quality; depletion of environmental services; loss of open or otherwise accessible spaces suitable for various purposes such as tourist, recreation and sporting activities; loss of local, typical products and traditional farming practices; diminishing habitat variety and biodi-

versity; decline of traditional lifestyles and knowledge; permanent loss of cultural landscape; loss of cultural and social heritage and identity; and a decline of human presence and its consequent territorial care in the mountains (Conti, Fagarazzi 2004).

Overall, efforts to enhance the quality of rural life in the Carpathians must include improvements to agricultural production, employment, infrastructure, environment and housing.

## Environmental Democracy

### Information Access

Since the 1990s, there has been increased interest in the Carpathian countries devoted to understandable and usable environmental information. Much can be attributed to the entry into force of the Aarhus Convention in 2001 which obliges signatory governments to provide citizens with access to environmental information (see Table 2.4). All EU Member States are also now obliged to meet the requirements of the Convention.

In all of the Carpathian countries, state of the environment (SoE) reports are available in printed and electronic form. The Czech Republic annually publishes SoE reports at the national, regional and urban (large municipalities) level, as well as a statistical yearbook on the environment. Underlying data are updated periodically while the form of the reports is modified annually and the sets of indicators are further developed. In Hungary, environmental statistical yearbooks and reports using environmental indicators (i.e. key, main and headline environmental indicators) are regularly published at the national level.

In Poland, SoE reports include a national report every four years and voivodship reports yearly or biannually. Slovakia publishes yearly SoE reports at the national level. In Ukraine, annual SoE reports are published at the national and oblast level. In Romania, annual SoE reports are

published. Serbia does not publish regular SoE reports.

Table 2.4 Status of Aarhus Convention in the Carpathian countries

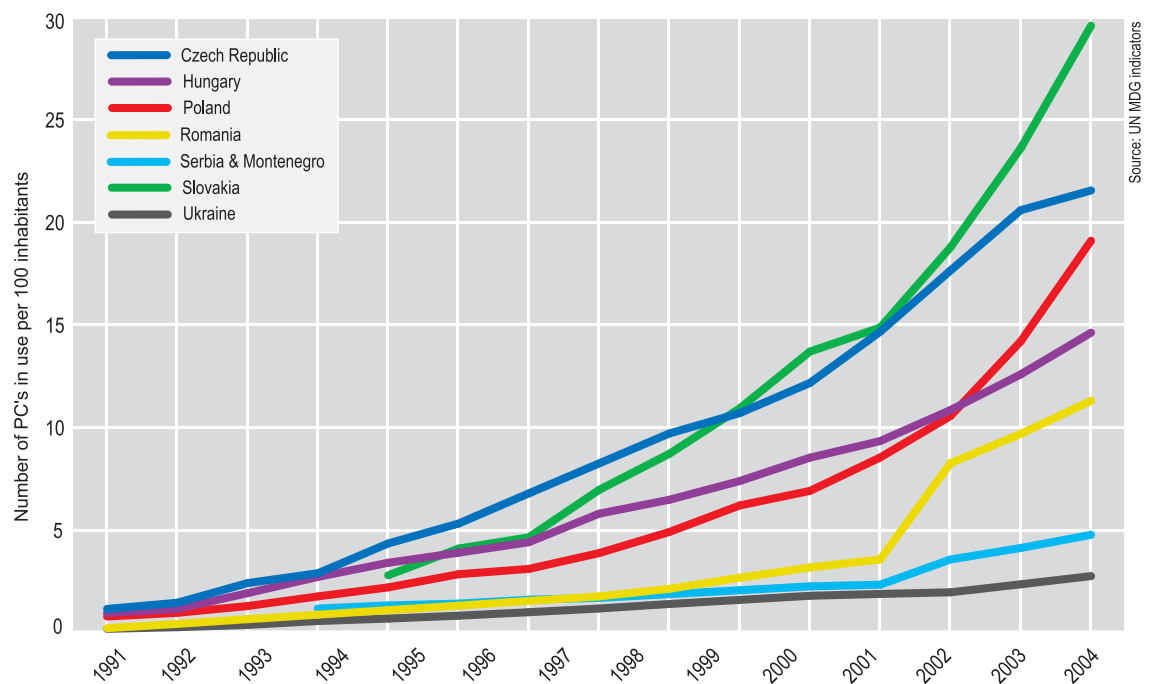
	Ratification	Accession
Czech Republic	2004	—
Hungary	2001	—
Poland	2002	—
Romania	2000	—
Serbia and Montenegro	—	—
Slovakia	—	2005
Ukraine	1999	—

Source: Aarhus Secretariat 2007

### New Technologies

New information and communication technologies play an increasing role in accessing information about the environment in the Carpathians, including the internet, personal computers and cellular phones. However, large differences are visible. Most of the Carpathian countries lag behind the EU average in terms of personal computer and internet use (see Figures 2.15 to 2.17). As another example, Slovakia's number of personal computer users per 100 inhabitants is ten times higher than that in Ukraine (Aarhus Secretariat 2006).

Figure 2.15 Personal computers in use per 100 inhabitants, 1990–2004



## NGOs

In the last 15-20 years, civic initiatives, movements and non-governmental organizations (NGOs) have been strengthening in the Carpathian region. Environmental NGOs are particularly important at the local level where they are often represented on local councils and are able to influence environmental decision-making. Many NGOs have also established good working relationships with governmental institutions and international organizations, for example in Serbia. Environmental NGOs have significantly raised the level of public awareness about the environment and have contributed to the development of local environmental action plans. Many, such as the Serbian Ecological Society and the Danube Environmental Forum, have contributed to an improved dissemination of environmental information through their websites and publishing activities (REC/EURAC 2005).

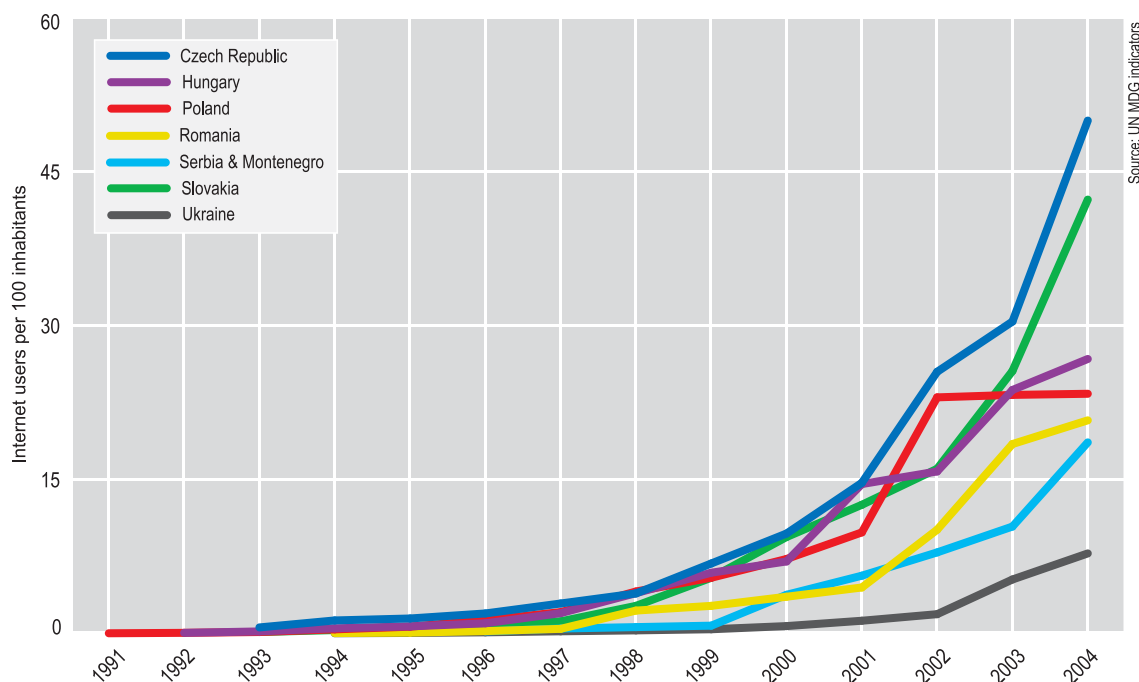
The 'Carpathian Foundation' is a unique, cross-border regional organization that provides grants and technical assistance to projects which result in tangible benefits to communities on both sides of national borders in the Carpathian Mountains in Hungary, Poland, Romania, Slovakia and

Ukraine. Support goes to NGOs and local governments. The Foundation strives to improve the quality of life of people in cities and small towns, focusing primarily on inter-regional, economic development and transboundary activities. It encourages the development of public-private-NGO partnerships, including cross-border and inter-ethnic approaches to promote regional and community development and to help prevent conflicts. It also promotes good relations, social stability and economic progress in the bordering regions.

In Romania, the Carpathian Foundation from Brasov developed ecological education projects for the Carpathian region in the framework of the Carpathian Large Carnivores Project. NGOs have also developed ecological education projects through the framework of the Regional Centre for Ecological Surveillance (CRSE), a network of NGOs working on nature conservation in Romania's Apuseni Mountains (REC/EURAC 2005).

Much has been done in the Hungarian Carpathians by civil society, especially in the framework of a large carnivore project concentrating on lynx and wolf, run by the University of Gödöllő.

Figure 2.16 Internet users per 100 inhabitants, 1991–2004



Source: UN MDG indicators

This EU LIFE project, ‘Funding the base of long-term large carnivore conservation in Hungary’, focuses on the monitoring and reintroduction of these large carnivore species in northern Hungary. Bird Life International (Hungary), with its regional affiliated society, is also active in the region, as are the member organisations of the Central and East European Working Group for the Enhancement of Biodiversity (CEEWEB).

Also in Hungary, the Ecological Institute for Sustainable Development has a number of projects involving protected area management, habitat restoration and networking between NGOs. The Friends of Nature NGO has a volunteer-based nature protection programme that helps maintain access to protected areas for hikers by managing paths and route signs. The National Society for Conservationists, a network of organisations including NGOs such as Marcel Loubens Barlangkutató Egyesület, Miskolci Öko-kör and Green Action Hungary, is also active (REC/EURAC 2005).

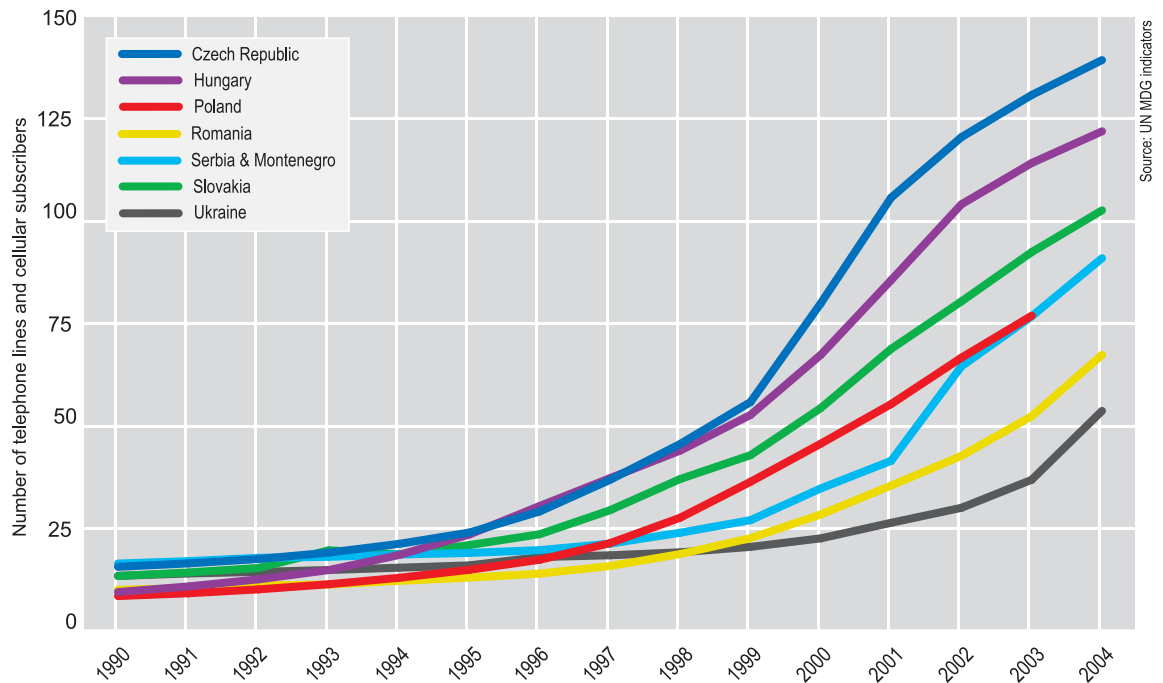
In Ukraine, a number of NGOs are carrying out educational activities geared to fulfilling the goals of the Carpathian Convention. These include the Bukovynian affiliate of the National

Ecocentre “Krona” (Chernivtsi region), Sokolyata, Eco-play, Edelveys, Nash Dim, Nadvirna District Society of Live Ethics, Eco-Gal-Ostwind (Ivano-Frankivsk oblast), Zeleniy Svit, WETI, Ecopravo-Lviv, Mama-86, Society of Nature Protection, Children’s Ecological-Naturalistic Centre (Lviv region), Ecosphera, a branch of the Eco-Center in Khust and many others. Environmental awareness-raising, particularly related to Carpathian Convention implementation, is being carried out by the charitable information-publishing centre Zelene Dosie (Green Dossier) (REC/EURAC 2005). The Charitable Foundation Ecopravo-Lviv consults citizens and NGOs on their environmental rights and how to protect them, organizes seminars and trainings and produces publications for related issues.

The environmental NGO “Eco-Ex” in Zakarpatska oblast was established in 1994 by the teachers of ZOENC (Eco-Eks Teachers’ Educational and Tourist Association). Its mission is to assist in the renaissance of school groups of young naturalists involving teachers and students in practical nature protection events and actions, promote the environmentally rational use of nature, and increase environmental awareness and culture.



Figure 2.17 Telephone lines and cellular phone subscribers per 100 capita, 1990–2004



Some Ukrainian NGOs have become active in local decision-making. For example, Ecosphera, Nash Dim, Western Centre of World Laboratory, Ecopravo-Lviv and regional organizations of the Ukrainian Company of Protection of Nature have participated in decision-making at the regional, national and international levels. This includes involvement in the Public Boards of Regional Environmental Administrations, communicating positions, comments and proposals, protesting undesirable plans and projects, and participating in public hearings and international workshops.

In recent years, environmental NGOs have developed a number of initiatives and networks in the region. One of them is the South Eastern European Environmental NGOs Network (SEEENN) which endeavours to coordinate environmental NGOs on a regional level. Another is the SEE NGO Electronic Network whose goal is a stronger, better organized and more coordinated environmental NGO community.

Besides environmental and cultural civic organisations, a wide range of other institutions (e.g. universities, academic institutions) have also dealt with scientific research activities in the Carpathians.

## Conclusions

Current development patterns in the Carpathian region are leading to a loss of traditional knowledge, livelihoods, practices and values. It is therefore critically important that culturally sustainable and coherent policies be formulated and implemented for the Carpathians, in order to halt and reverse this trend before it is too late. Rural de-population threatens the preservation of the traditional character of the Carpathian countryside.

Emerging issues include the illegal cross-border transport of natural resources such as timber from Ukraine, species under CITES, second-hand technology (e.g. personal computers, mobile phones, old refrigerators) and waste. Land fragmentation is also a major threat, as new land ownership patterns result in owners prioritizing economic over environmental concerns. New infrastructure development is another further cause of habitat loss and fragmentation and species loss in the Carpathians.

## References

- Aarhus Secretariat (2006). National implementation reports of the Czech Republic, Hungary, Poland, Romania, Ukraine
- Buza, M., Turnock, D. (2004). A research note: planning for the Carpathians. *GeoJournal* 60, 135–142
- Canadian Institute of Ukrainian Studies (CIUS). (2006). *Internet Encyclopaedia of Ukraine*. <http://www.encyclopediaofukraine.com>
- Conti, G., Fagarazzi, L. (2004). Sustainable Mountain Development and the key-issue of Abandonment of Marginal Rural Areas. *The European Journal of Planning online*
- Duraiappah, A.K. (2002). *Poverty and Ecosystems: A Conceptual Framework*. UNEP Division of Policy and Law Paper, United Nations Environment Programme, Nairobi, 49 pp.
- EEA (2000). *Environmental signals 2000*. Environmental assessment report No 6, European Environment Agency, Copenhagen
- Ethnobarometer (2004). *Ethnic Mobility in Romania 2004*. <http://www.ethnobarometer.org/romania.pdf>
- European Commission (2006). *EU environment-related indicators 2006*. European Communities, Brussels
- FAO (2003). *The design of land consolidation pilot projects in Central and Eastern Europe*. FAO Land Tenure Studies 6, Rome
- IFA (2006). [http://www.fertilizer.org/ifa/statistics/indicators/ind\\_cn\\_ceur.asp](http://www.fertilizer.org/ifa/statistics/indicators/ind_cn_ceur.asp)
- Janicki, R. (2005). Effects of Land Abandonment on Landscape Changes in SE Polish Carpathians. In *Human Impact on Sensitive Geosystems* (eds: J. Rejman, W. Zglobicki) p. 39–46, UMCS Press, Lublin
- Kocsis, K. (1999). Society and economy in the Carpathian basin of the present. In: *A Kárpát-medence földrajza* (eds. B. Bull, T. Mendöl), reprint by Lucidus, Budapest
- Kurek, W. (1996). Agriculture versus tourism in rural areas of the Polish Carpathians. *GeoJournal* 18, 191–196
- Ministerial Conference on the Protection of Forests in Europe (MCPFE) (2003). *State of Europe's Forests 2003: The MCPFE Report on Sustainable Forest Management in Europe*, Vienna
- Monitoring Institute for Rare Breeds and Seeds in Europe (1999). *Rare Breeds and Plant Varieties in the Carpathian Mountains*. Workshop Report, Suceava, Romania
- Muica, N., Nancu, D., Turnock, D. (2000). Historical and contemporary aspects of pluriactivity in the Curvature Sub Carpathians of Romania. *GeoJournal* 50, 199–212
- Omelyan, S. (2005). *Sustainable Tourism Development in the Carpathians: Market and Stakeholder Analysis*. Interim Secretariat of the Carpathian Convention, Vienna
- Organic Centre Wales (2006). <http://www.organic.aber.ac.uk>
- Pomázi, I., Szabó, E., Tiner, T., Zentai, L. (2006). *A Kárpátok magyarországi területe*. KvVM–UNEP/GRID-Budapest, Budapest
- REC/EURAC (2005). *Questionnaire for the assess-*

- ment of the national policy, legal and institutional frameworks related to the Carpathian convention*
- Ruzicka, T. (2006). A Regional Brand from the White Carpathians. *CERI Newsletter* No. 1.
- Turnock, D. (2002). Ecoregion-based conservation in the Carpathians and land-use implications. *Land Use Policy* 19, 47–63.
- UNECE (2005). *The Economic Situation in the ECE region in mid-2005*. Economic Survey of Europe No. 2, Geneva
- UNEP (2004a). *Environmental Assessment of the Tisza River Basin*, UNEP/ROE and UNEP/DEWA/GRID-Europe, Geneva
- UNEP (2004b). *From Conflict to Sustainable Development Assessment and Clean-up in Serbia and Montenegro*, Switzerland
- UNEP/GRID-Budapest (2004). *Scoping paper for KEO*, Budapest
- UNEP-ISCN (2006). *Policy Consultation on Sustainable Agriculture and Rural Development In the Carpathians*, prepared by Kanianska, R., Maryshkevych, O., Burdusel, E., Vienna
- Williams, A. M., Baláž, V. (2001). From collective provision to commodification of tourism? *Annals of Tourism Research* 28(1), 27–49
- Williams, A. M., Baláž, V. (2001). Tourism in Transition: Economic Change in Central Europe. *Enterprise Soc.* 2, 827–830
- WWF (2001). *The Status of the Carpathians*. Bratislava  
[www.carpathians.org/carp\\_people.htm](http://www.carpathians.org/carp_people.htm) (2006)

#### Internet sites used:

- [enrin.grida.no/biodiv/biodiv/national/ukraine/prt/res.htm](http://enrin.grida.no/biodiv/biodiv/national/ukraine/prt/res.htm)
- [epp.eurostat.ec.europa.eu](http://epp.eurostat.ec.europa.eu)
- [hostetin.veronica.cz/](http://hostetin.veronica.cz/)
- [unstats.un.org/unsd/databases.htm](http://unstats.un.org/unsd/databases.htm)
- [whc.unesco.org/en/list](http://whc.unesco.org/en/list)
- [www.carpathians.org.ua](http://www.carpathians.org.ua)
- [www.cia.gov/cia/publications/factbook/geos/sr.html#Issues](http://www.cia.gov/cia/publications/factbook/geos/sr.html#Issues)
- [www.energy-community.org](http://www.energy-community.org)
- [www.fertilizer.org](http://www.fertilizer.org)
- [www.monitoring-inst.de](http://www.monitoring-inst.de)
- [www.save-foundation.net](http://www.save-foundation.net)
- [www.slovenska-republika.com/data/oldsites/uzemia.htm](http://www.slovenska-republika.com/data/oldsites/uzemia.htm)
- [www.tradicebk.cz](http://www.tradicebk.cz)
- [www.zb.eco.pl/GH/6/tkarp\\_e.htm](http://www.zb.eco.pl/GH/6/tkarp_e.htm)

Chapter Three

# State of the Carpathians' Environment and Policy Measures





© František Sulgan

## 3.1 Species, Habitat and Landscape Diversity

**A**round the world, mountain regions are well known as centres of species diversity. Mountains' high levels of species richness and endemism were among the main reasons for their designation as biologically outstanding ecosystems in the Global 200 Initiative (Dinestein et al. 2000). The Carpathians were subsequently identified as one of the Global 200 terrestrial ecoregions that are critically endangered by the direct impacts of human activities.

The biodiversity of the Carpathians is difficult to estimate, due to imperfect and often fragmented knowledge on the exact number of species and each one's abundance, along with their precise distribution and range. As the Carpathian region encompasses broad foothill areas and river valleys, one needs to include in the list many species that represent lowland ecosystems, only marginally inhabiting montane areas. In addition, one should consider migratory and invasive

species. It is estimated that the entire Carpathian region is home to more than 60,000 native species, excluding microorganisms.

Research on plant and animal diversity continues throughout Europe, with international groups investigating focal taxa and nominating areas where biodiversity is particularly high. One of the first study groups, BirdLife International, focused on European birds and produced a list of areas (Important Bird Areas, IBAs), considered significant for this taxon and later used as an important component of the EU list of Natura 2000 sites (Heat and Evans 2000, Sidło et al. 2004). Other groups, such as PlantLife International, are studying vascular plants and preparing a European list of Important Plant Areas (IPAs). Carpathian IPAs were identified and selected for the Czech Republic, Poland, Romania, Serbia and Slovakia (Anderson et al. 2005).

## Carpathian Landscapes

### Vertical Bio-climatic Zonation

Mountains are characterized by the vertical zonation of their flora and fauna, changing with elevation according to climatic conditions. Normally, for every 100-meter rise in elevation, the temperature drops 0.6 degree Celsius. The altitudinal variation of the climate and vegetation can be compared with longitudinal zonation between the poles and the Equator. In this regard, the Carpathians can be divided into five fairly distinct vertical zones of climate and vegetation types. In general, (1) the foothills correspond to a “mixed deciduous” zone; (2) the lower mountain (beech) forests correspond to a “temperate forest” zone; (3) the upper mountain (spruce) forests correspond to the “taiga” zone; (4) dwarf pine forests and alpine meadows correspond to the “tundra” zone; and (5) the sub-nival level to the “arctic” zone.

The **foothill zone (1)** extends up to 500-650 m above sea level in the northern Carpathians, and approximately 200-300m higher in the southern part of the range. In terms of forest types, foothills are dominated by mixed deciduous forests with pedunculate oak (*Quercus robur*), the small-leaf lime (*Tilia cordata*) and the hornbeam (*Carpinus betulus*), with an admixture of birch (*Betula pendula*) and Scots pine (*Pinus sylvestris*) in the north, and various oak species (*Quercus petraea*, *Q. cerris*, *Q. pubescens* and *Q. frainetto*) in the south. In the foothills of the Southern Carpathians in Romania, there is a forest steppe zone with oaks (*Quercus petraea* and *Q. pubescens*). However at present the foothill zone overall is dominated by agriculture, human settlements and artificial lakes.

**The mountain forest zones** – between 600 and 1450 m in the north, and 650 and 1750 m in the south – are dominated by European beech (*Fagus sylvatica*), Norway spruce (*Picea abies*) and silver fir (*Abies alba*). Pure beech forests dominate the mountain zone in some ranges of the Western Carpathians (Bile Karpaty, Male

Karpaty, Tribeč), Eastern Carpathians (the Vihorlat, Bukovské, Bieszczady, Polonina Rowna, Polonina Krasna and the southern slopes of Swidowiec) and in some parts of the Southern Carpathians. Areas dominated by beech forests are slightly warmer and drier than other Carpathian areas. Beech species grow better in such conditions than do coniferous species.

The **lower mountain forest zone (2)** typically consists of almost pure beech forest stands and mixed forest ecosystems. Dominant species include beech (*Fagus sylvatica*) and fir (*Abies alba*), with scarce occurrence of Norway spruce (*Picea abies*). On the southern slopes, one finds a mixture of oaks, maples and ash within beech forests.

However, in most of the Carpathians, beech is mixed with coniferous trees, namely with silver fir and Norway spruce (plantations of the latter have replaced many natural forests). In some places, the mountain zone is totally dominated by conifers, usually a mixture of silver fir and Norway spruce (Tatry, Moravske Beskydy and Oravska Magura in the Western Carpathians; Gorgany, Czarnohora and the Bistra Mountains in the Eastern Carpathians).

The **upper mountain forest zone (3)** is mainly constituted by spruce forests *Picea abies*, situated at 1,100-1,450 m in the Northwestern and Eastern Carpathians and at 1,300-1,750 m in the Southern Carpathians. Other main species are *Sorbus aucuparia* and stone pine *Pinus cembra*, silver fir *Abies alba* and *Alnus incana*. Grass cover is represented by *Oxalis acetosella*, *Soldanella Montana* and *Luzula sylvatica*.

On the highest Carpathian massifs, **alpine meadows and dwarf pine (*Pinus mugo*) forests (4)** are characteristic, but cover very limited areas. The alpine pastures consist of plant communities with grasses and sedges, including grass species such as *Carex curvula*, *Juncus trifidus*, *Agrostis rupestris* and *Festuca ovina*, *Vaccinium gault-*

*heroides Ericaceae* shrubs and dwarf willow *Salix herbaces*. In areas of intensive cattle and sheep grazing (e.g. in some parts of the Southern and Eastern Carpathians), there are grassy *Nardus stricta* pastures which may also be found at lower altitudes.

The stone pine (*Pinus cembra*) occurs on the alpine timberline in the highest mountain ranges of the Carpathians (Tatra, Gorgany, Czarnohora, Maramureş, Făgăraş, Retezat). In the timberline belt of the Tatra, one can find small areas of mixed *Pinus cembra-Larix decidua* forests similar to those growing in the central Alps.

Above the timberline, which extends from 1400 m in the Northwestern Carpathians, about 1600 m in the Eastern Carpathians, and about 1900 m in the south, a distinct krummholz sub-zone is found. It consists of dense thickets of dwarf pine (*Pinus mugo*), at times with an admixture of dwarf juniper (*Juniperus communis subsp. nana*) and small groups of Norway spruce thickets.

Finally, the **subnival zone (5)** only occurs in the highest parts of the Tatra Mountains (above 2350 m). It is characterized by patches of permanent snow and a lack of glaciers (Mirek and Piękoś-Mirkowa 1992).

## Flora and Vegetation

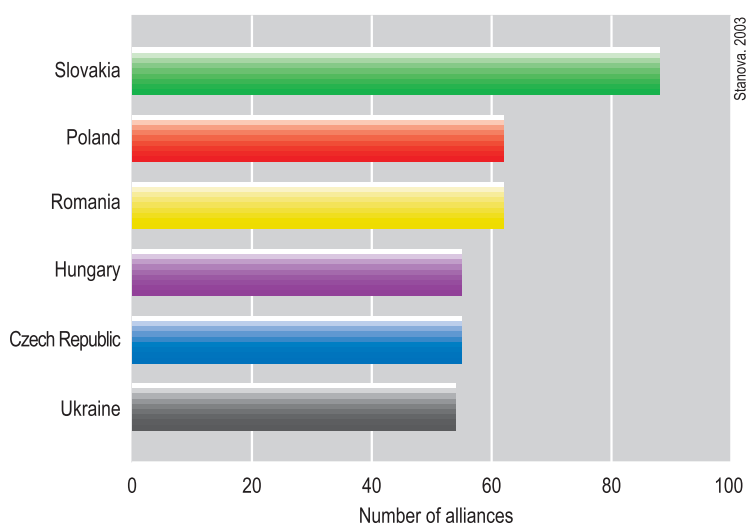
The richness of Carpathian vascular plants is well known. According to Tassenkevych (1998, 2003), the Carpathians are home to 3,988 native vascular plant species and archaeophytes (i.e. non-native plant species which were introduced in "ancient" times). Taking into account natural immigrants and invasive species introduced by humans, the total number of species in the Carpathians exceeds 4,000. This figure comprises approximately 30% of Europe's flora, while the

proportion of the Carpathians' area to that of Europe is only 1:46 (Tassenkevych 2003).

The flora of the Carpathians is relatively rich in endemic species. The current list of endemic plants includes 387 species and sub-species, and 99 'micro-species'<sup>1</sup> from the genera *Alchemilla*, *Rubus*, *Sorbus* and *Hieracium* (Stanova 2003). A similar number of endemic plant species has been reported in the Alps (Mirek, Piękoś-Mirkowa 1992), while in the Caucasus, more than 1,600 endemic species have been described (UNEP 2002).

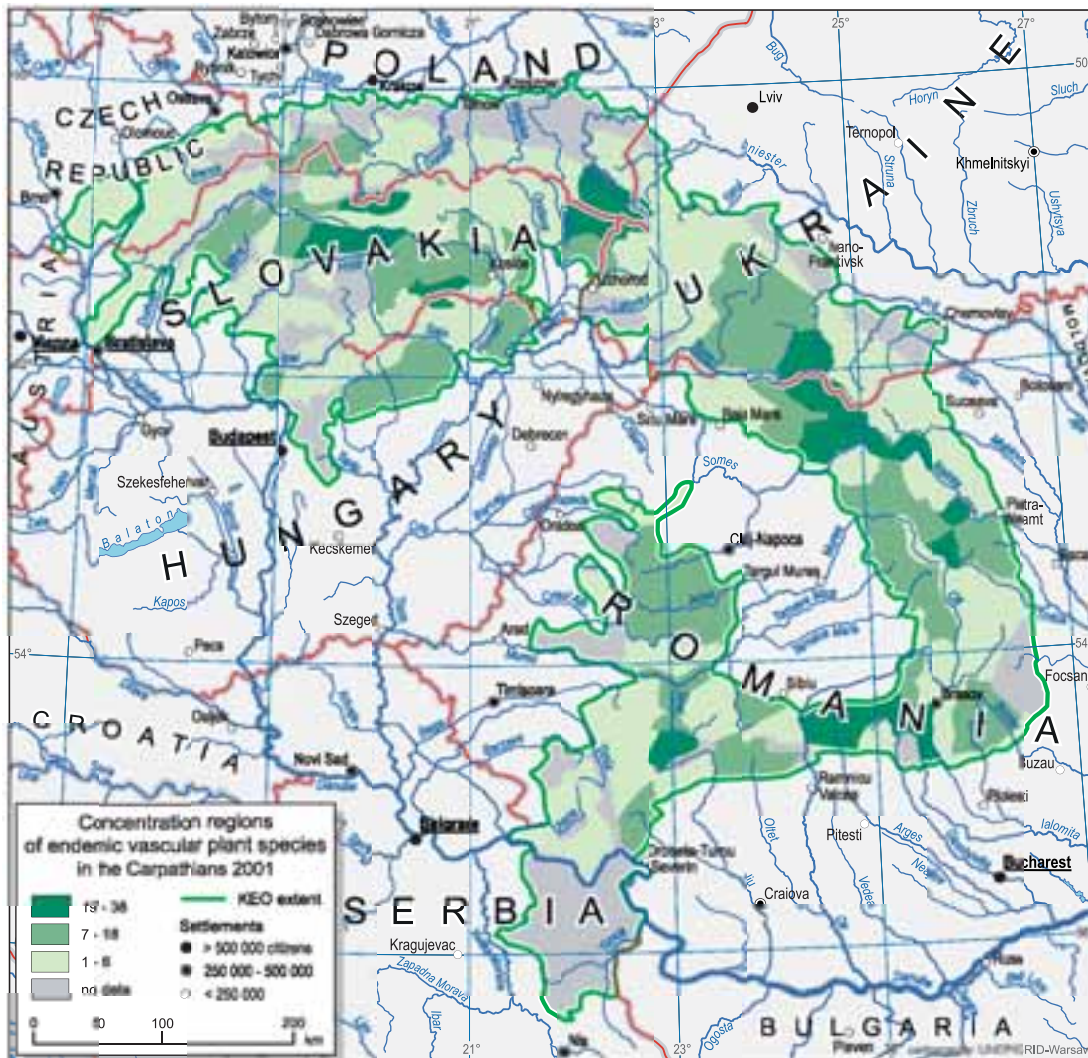
In most cases, the distribution of Carpathian endemics is of 'island' type, with isolated centres in areas such as: the Tatra, Lower Tatra and Slovensky Kras in the North; the Bieszczady, Czarnohora, Maramuresului, Rodnei, Giumalau-Rarau, Ceahlau and Hasma Mountains in the East; and Retezat, Fagaras, Bucegi and Piatra Craiului Mountains in the South (see Map 3.1). Some endemic species are broadly distributed in the Carpathians' area, such as the heart-leaf comfrey (*Symphytum cordatum*) and laserwort (*Laserpitium archangelica*) (Meusel et al. 1965, Parusel 2001).

Figure 3.1 The number and occurrence of plant alliances in the Carpathian countries (according to Stanova 2003)



<sup>1</sup> Species which reproduce asexually, with genetically identical specimens from one generation to the next.

Map 3.1 Concentration regions of endemic vascular plant species in the Carpathians (according to CERI 2001)



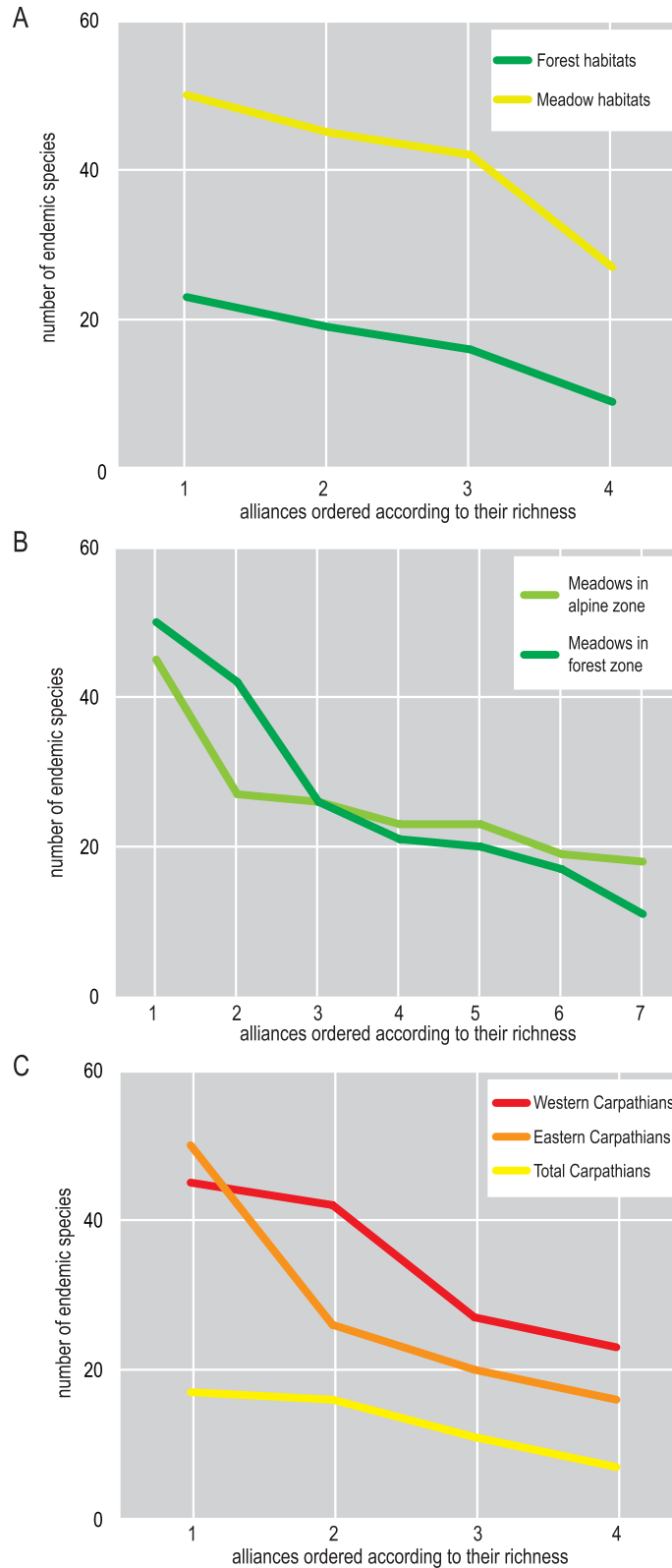
The most common and interesting endemics in the Carpathians are glacial relicts, species with an alpine-arctic distribution pattern. These include the alpine clubmoss (*Diphasium alpinum*) and Norway spruce (*Picea abies*). Other interesting groups include species living near the limit of their geographical range, such as the ox-eye daisy (*Dendranthema zawadzki*), a post-glacial relict largely found in Asia, living in only three European sites – the Pieniny Mountains in the West Carpathians, and two Russian localities. Among commonly distributed ‘archaeophytes’, migrants that invaded the Carpathians following early human settlement and agriculture, are the wild oat (*Avena fatua*) and tiny vetch (*Vicia hirsute*).

The richness and diversity of plant species are not evenly distributed throughout the Carpathian Mountains range. In general, the Western Carpathians are less rich in flora species than the eastern and southern parts. Low mountains and areas which are marginal to the mountain range also have less diverse flora than higher areas with an extensive alpine zone.

Stanova (2003) assessed the biodiversity value of habitats and ecosystems within the Carpathians by evaluating the proportion of endemic species in plant alliances. Results show a substantial richness of plant alliances in each region of the Carpathians (see Figure 3.1). The largest number of plant alliances exists in the Slovak Carpathians,



Figure 3.2 Comparison of top alliances ranked according to their proportion of endemic species (recalculated according to Stanova 2003)



A – open habitats vs. forest and shrub, B – alpine meadows vs. meadows and open habitats in the forest zone, C – the richest alliances in the Carpathians vs. Eastern and Western Carpathians. Axis X – alliances ordered according to their richness, axis Y – number of endemic species

due to their extremely diverse geological background, exceptional mineral richness and their position between the Pannonian plane to the South and the Carpathian range to the North. The Eastern and Southern Carpathians remain less intensively surveyed, and thus the number of alliances and their floristic richness may actually be much greater than currently known.

Also according to Stanova (2003), endemic species are mainly concentrated in meadow-type alliances/habitats (see Figure 3.2a). Natural (alpine) meadows and meadows of human origin

located in the forest zone show similar proportions of endemic species (Figure 3.2b). The highest proportion of plant endemism occurs in the most broadly distributed plant alliances known in the entire region. Lower proportions of endemism were identified within alliances located solely in the Eastern Carpathians, and the lowest endemism level was found in alliances located in the Western Carpathians (Figure 3.2c). According to Stanova's results, the most vulnerable and endangered plant alliances in the Carpathians are located in natural and semi-natural meadows and pastures.

## Fauna

The Carpathian vertebrate fauna includes 90 species of mammals, 300 nesting birds, 17 amphibians, 12 reptiles and 82 species of fish and lampreys, including some alien, introduced species. Among small mammals, the distribution and geographical range of bats is perhaps best known. A total of 26 species of bats are described, the majority of them found in the entire Carpathian range (Wołoszyn and Bashta 2001).

Similarly to vascular plants, there are many endemic animal species in the Carpathians, most of them among invertebrate taxa. Only several vertebrate endemics can be found, such as the Tatra pine vole (*Microtus tatricus*), and the Carpathian newt (*Triturus montadoni*). Endemic fauna species may be found throughout the Carpathian range, or be restricted to only one of the numerous massifs of the Carpathians.

The number of endemic caddis flies (*Trichoptera*), a well-investigated water insect taxon, is extremely high in the Carpathians: at least 43 endemics have been described, nearly as many as in the Alps (47), where endemic invertebrate fauna in general is more numerous. Some of these can only be found locally, such as *Allogamus starmachi*, which occurs solely in small, high-altitude springs in the Tatra Mountains. Others, such as *Melampophylax polonicus* have a much broader distribution. Watercourses are

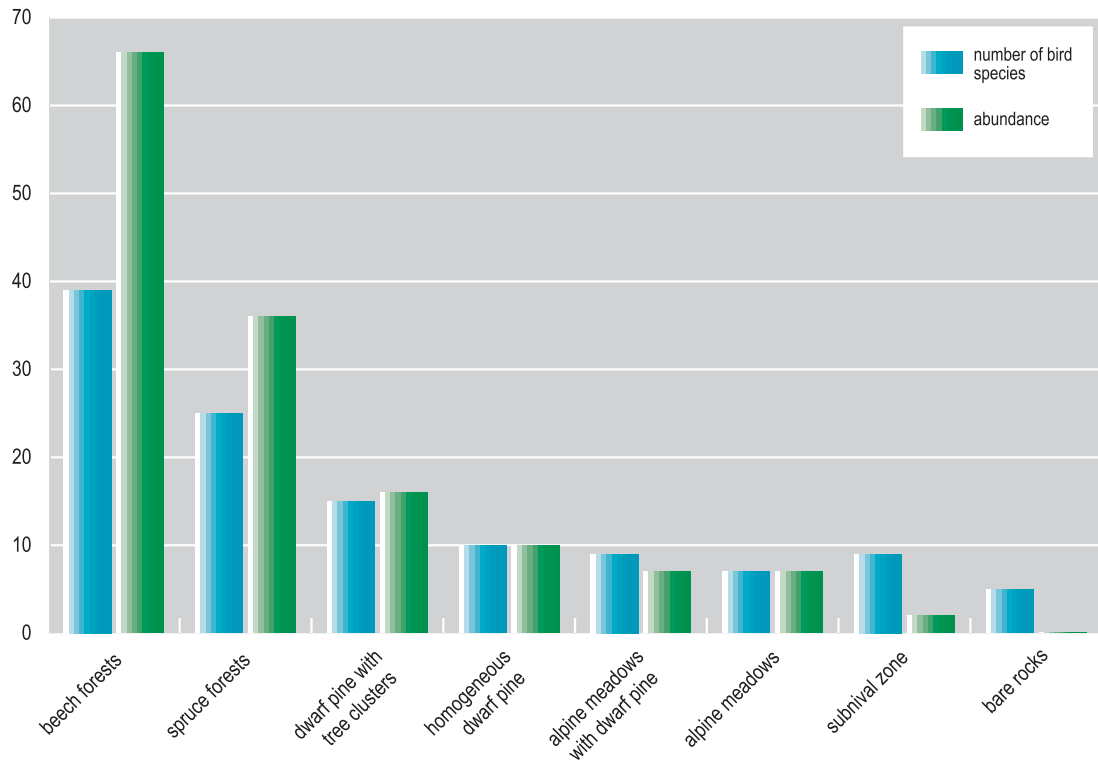
also inhabited by endemic stonefly and mayfly species, which often occur throughout the region. While *Baetis beskidensis* is a good example of the latter, *Isoperla carpathica* is limited to the Eastern Carpathians. Beetles (*Coleoptera*) are also an important Carpathian endemic taxon, with *Carabus transsylvanicus*, for example, inhabiting alpine meadows.

Generally, the number of species and their population density decrease as altitude increases, such as observed in the bird fauna in the Tatra (Figure 3.3) (Głowaciński 1996). There are, however, exceptions to this rule, one of which is the *Tardigrada* group, invertebrates living in mosses and litter, whose number of species is highest between 1,700 to 1,800 m above sea level.

An enormous contribution to mountain diversity is made by 35,000 invertebrate species, mainly insects, soil mites and spiders. Except for some small, well-investigated areas such as national parks where invertebrate monitoring has been carefully done, current knowledge about the distribution, abundance and species composition of Carpathian invertebrates remains limited.

The Carpathians have the richest community of large carnivores in Europe, including all the large European predators. Their populations are

Figure 3.3 Number of species and abundance (no of specimen/10 ha) of birds in main habitats of the Tatra National Park (after Głowaciński 1996)



a – bare rocks (2100-2500 asl), b – subnival zone (1900-2200 asl), c – alpine meadows (1700-2000 asl), d – alpine meadows with dwarf pine (1600-1800 asl), e – homogeneous dwarf pine (1500-1700 asl), f – dwarf pine with tree clusters (1400-1600 asl), g – spruce forests (1300-1450 asl), h – beech forests (1000-1100 asl)

still vital and numerous. Official statistics indicate a population of more than 8,100 brown bears (*Ursus arctos*). Two main refuges with more than 1,000 individuals can be found in Romania and Slovakia. The density of bears in the Romanian part of the Carpathians slightly exceeds four individuals per 10 sq. km. Similar densities are observed in Slovakia, Ukraine and in the southeastern Polish Carpathians, where human population density is low.

Bear populations have shown a slightly upward trend, despite being a hunted species in Romania, Slovakia and Ukraine. According to official data, hunters annually kill approximately 350 bears in Romania and over 60 in Slovakia.

Wolf populations (*Canis lupus*) include approximately 4,500-5,500 individuals. The species is strictly protected only in those Carpathians countries where small or medium-size populations occur (the Czech Republic, Hungary and Poland). In other Carpathian countries, the

wolf is a partially protected species or protected game species with hunting quotas established yearly. Only in Ukraine is the wolf neither protected nor managed as a game species. Strict protection has at times led to tensions between conservationists and farmers. In Romania, the annual loss of livestock due to wolves can surpass 2% of the herd (Mertens and Anghel 2000).

The lynx (*Lynx lynx*) represents the third distinctive large carnivore species of the Carpathians. Its population is currently estimated at 2,400-2,500 individuals, and decreasing in most Carpathian countries (Natura 2000 Newsletter 2007). The decline of the lynx during the last 20-30 years resembles the earlier decline of the wildcat (*Felis silvestris*), which disappeared from the Northwestern Carpathians during the first half of the 20th century. Vital populations still occur in southern Romania, Slovakia and Ukraine, while new inventories show its decline in Hungary (Heltai et al. 2006).

## Species Richness in the Pieniny Park (Poland/Slovakia)

The Pieniny National Park in Poland (2,500 ha) and its counterpart in Slovakia have a great species richness compared to larger and better-investigated national parks in Poland (see table below). Extensive investiga-

tions carried out there covered vertebrate and invertebrate species, as well as plants and other taxa (Panigaj 2002, Razowski 2000, Voloscuk 1992, 1997, Zarzycki 1982).

Table 3.1 Numbers of known species in the best-surveyed Carpathian national parks in Poland by systematic group

Systematic group	Number of identified species			
	Babia Góra NP (3,392 ha)	Bieszczady NP (27,064 ha)	Pieniny Mts NP (2,500 ha)	Tatra NP (21,164 ha)
Vascular plants	626	780	~1100	~1000
<i>Bryophyta</i> and <i>Marchantiophyta</i>	380	361	327	650
<i>Cyanophyta</i> and <i>Algae</i>	118	Not known	184	1000
<i>Lichenes</i>	329	569	470	700
<i>Fungi</i> and <i>Myxomycetes</i>	1228	1030	1316	707
<i>Protozoa</i>	15	10	14	17
Molluscs	93	77	107	91
Arthropods	4116	6425	6770	5118
Other Invertebrates	51	118	144	385
Vertebrates	199	284	271	170
Total	7155	9654	10703	9838

One of the reasons for high biodiversity in the Pieninys is their location close to the biodiversity-rich Tatra Mountains. It has been shown that mountain species of flora and fauna in the Pieninys were supplemented from the Tatras by migrating species and accidentally by extraordinary events such as hurricane winds and floods. Secondly, the Pieniny Mountains have characteristic North-South perpendicular limestone structures. The majority of the mild slopes with a northern exposure maintain favourable habitats for mountain species, while much steeper slopes with a southern

exposure preserve habitats more favourable for species which prefer warmer temperatures.

Furthermore, recent studies show that the Pieninys are one of the oldest places of human settlement in the Polish Carpathians. As a result, they were largely deforested for thousands of years. Small-scale traditional agriculture still dominates here. Small farms with mixed uses support a large diversity of landscapes and habitats, considered as main contributors to the enormous species richness in the Pieniny National Park.

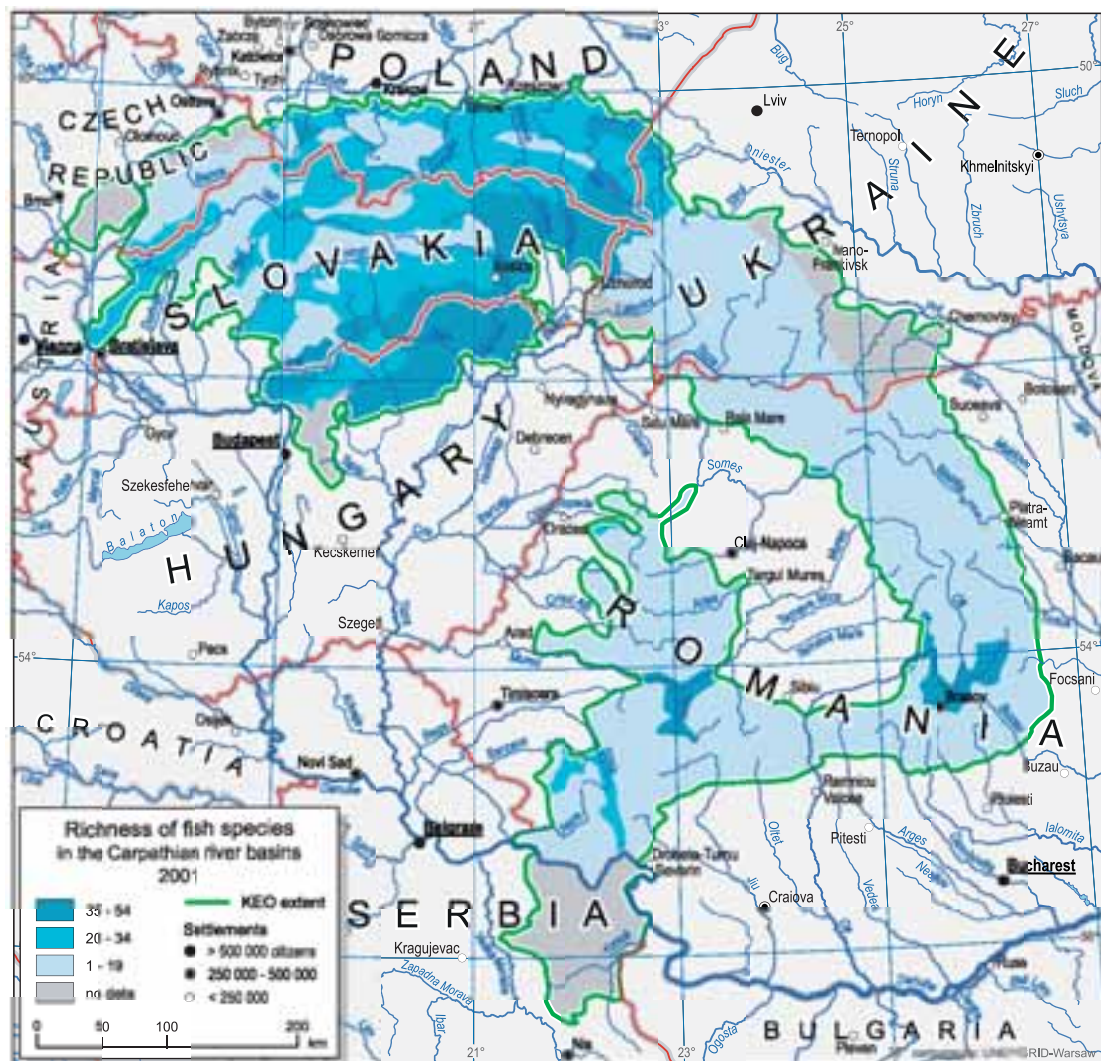
Carpathian game species include herbivores such as large populations of deer, roe deer and wild boar in the north, fallow deer in the south, and the European bison which was re-introduced in the Carpathians during the last century.

Among large bird species, the most characteristic are the imperial eagle (*Aquila heliaca*) and lesser-spotted eagle (*Aquila pomarina*), both with at least 20 to 40% of their European populations living in the Carpathians. The wood grouse (*Tetrao urogallus*) and many other forest mammals and birds also find a major European refuge in the Carpathians.

The migratory elk (*Alces alces*), a large herbivore which lives in the vicinity of moors and large rivers, is one of the major representatives of the vertebrate fauna of wetlands and rivers. Another species maintaining vital populations in the region is the European beaver *Castor fiber*, successfully re-introduced in the Carpathians during the last three-four decades. The density of otter (*Lutra lutra*) populations is probably also one of the highest in Europe.

Fish species also represent a diversified and rich fauna taxon in the Carpathians (see Map 3.2). Some migratory fish species, such as the Atlantic sturgeon (*Accipenser sturio*) and Atlantic salmon

Map 3.2 Richness of fish species in the Carpathian river basins (CERI 2001)



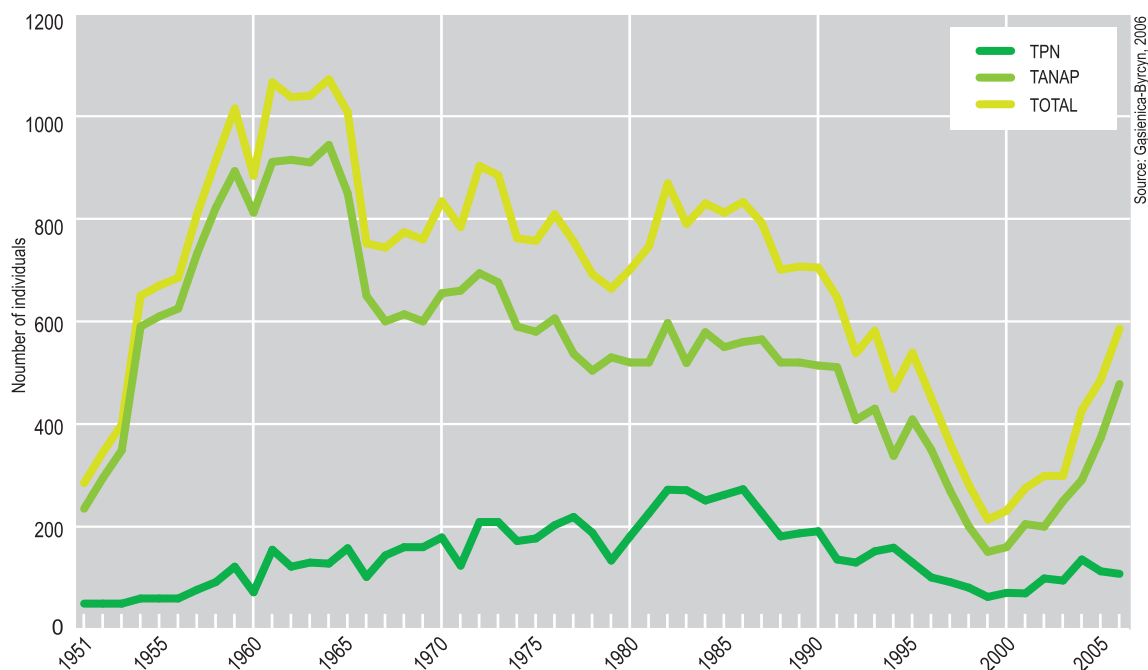
(*Salmo salar*), have become extinct in the Baltic-catchment rivers of the Carpathians due to dams and other waterworks.

The majority of fish species live in the Carpathian tributaries of the Danube. For example, the Kessler's gudgeon *Gobio kessleri* is a Ponto-Caspian element in the Danube and its Carpathian tributaries. During the last few decades, the species spread its geographical range to the alpine region, crossing the Vistula's tributaries and building abundant populations in the San River near the Polish-Ukrainian border. According to Hakai and Biroz (2007) both of these processes – broadening of the species' range and moving up to higher altitudes – are effects of climate change.

Alpine habitats and landscapes in the Carpathians are extremely limited in area, with less than 3% of the entire region having a high montane character. High montane vertebrate fauna in the Carpathians is not as rich as in the higher Alps or Caucasus. Two high mountain species can be found here, the chamois *Rupicapra rupicapra* and the marmot *Marmota marmota*.

Both of these species are liable to become extinct, as shown by a long-term monitoring study of Tatra chamois (Figure 3.4). The probability of extinction of high montane species in the Carpathians is likely to increase rapidly in the coming decades, since according to climate change predictions, mountain vegetation zones in the temperate climate zone would shift

**Figure 3.4 Number of chamois in the Polish (TPN) and Slovak (TANAP) Tatra Mountains National Parks (Gašienica-Byrcyn 2006)**



Source: Gašienica-Byrcyn, 2006

upwards by nearly 200-300 m, resulting in the loss of some species and ecosystems.

In mountain areas, many species have small isolated populations. Long-term isolation leads to the development of 'divergent sub-species' – local ecotypes which differ from initial populations through specific anatomic and behavioural characters. Examples in the Carpathians include the chamois, represented by two sub-species: *Rupicapra rupicapra tatrica* in the Tatra Mountains and *Rupicapra rupicapra carpathica* in the

Romanian Carpathians. Another strongly diversified species is the apollo butterfly *Parnassius Apollo*, comprising 20 sub-species in the Carpathians (Glassl 1993).

In addition two small rodents, the snow vole *Microtus nivalis* and Tatra pine vole *Microtus tatricus*, live in alpine habitats. High montane meadow bird species include the horned lark *Eremophila alpestris*, Alpine accentor *Prunella collaris* and water pipit *Anthus spinoletta*.

## General Threats to Species

Among species at high risk in the Carpathians ("critically endangered" species), invertebrates form the grand majority, followed by plants and vertebrate species groups. Invertebrate species are less well documented in the Carpathians than other taxonomic groups. Witkowski et al. (2003) evaluated threats to three groups of in-

vertebrates in the Carpathians; results are presented in Table 3.2.

In addition, 130 species of vertebrates are also listed as threatened in the Carpathians. Most of these are mammals, followed by fish and birds. About 25% of vertebrate fauna species are en-

Table 3.2 Threatened species of invertebrates in the Carpathians grouped according to their level of threat (Witkowski et al. 2003)

Category of threat	Number of species		
	Gastropods	Beetles	Butterflies and Moths
Extinct	0	0	0
Critically endangered	18	24	13
Endangered	13	25	34
Vulnerable	15	24	32
Total	46	73	79

Table 3.3 Endangered vertebrate species in the Carpathians grouped according to their level of threat (Witkowski et al. 2003).

Category of threat	Classes				
	Mammals	Birds	Reptiles	Amphibians	Fishes and Lampreys
Extinct	2	0	0	0	2
Critically endangered	2	7	1	0	3
Endangered	12	11	2	4	14

dangered. A comparison between taxonomic units shows that the most threatened categories are mammals and amphibians (60%). Nearly 40% of all reptilian species, 30% of fish species and lampreys and 10% of birds are also threatened (see Table 3.3).

Of 1500 vascular plant species listed in the national inventories of six Carpathian countries (i.e. other than Serbia), 307 species and 37 subspecies are classified as extinct or threatened (Tasenkevich 2003) (see Table 3.4).

Table 3.4 Threatened species of vascular plants in the Carpathians grouped according to their level of threat (Tasenkevich 2003)

Category of threat	Number of species and subspecies
Extinct	13
Critically Endangered	41
Endangered	135
Vulnerable	155
Total	344

## Anthropogenic Impacts on Species and Habitats

### Climate Change

Climate change is likely to result in changed habitats, a regression in the range of some species and expansion in the spatial distribution of others. Montane habitats are particularly vulnerable, as many endemic and relict plant and animal species have their only refuges in the mountains. Global warming is likely to result in the migration of vegetation zones towards higher

altitudes. During this process, small, isolated populations of alpine species will become extinct from many sites in the Carpathians. Others will fall into a bottleneck trap; their populations will become too small to maintain their genetic viability and adaptability to a changing environment. An example of such climate change impacts in the Carpathians is the overall decline of Norway spruce. Foresters have observed a gradual increase of pests and pathogens, and

a successive decline of the Norway spruce in the lower mountain forest zone.

Climate change is also likely to increase the spatial distribution of other species. For example, in the last two decades, newly established populations of the European mantis *Mantis religiosa* were discovered in the Beskid Niski and Bieszczady Mountains in Poland. Individuals crossed the crest of the Carpathians from south to north in places where the Carpathians' main ridge is relatively low.

### Mass Tourism

The last decades have shown a rapid increase in tourism activities, particularly in protected areas. Large tourist centres, and particularly ski resorts, are being established. The Polish Tatras are an excellent example of these recent developments. In 1870, the area attracted no more than one hundred visitors. In 1938, about 60,000 tourists visited the area, and 150,000 in 1948. The "avalanche" in tourism began in the 1960s. In 1962, over one million visitors were recorded, in 1964 over two millions, and in 1976, 3.6 million tourists came for recreation in the Polish Tatras. Since then, the annual number of visitors has fluctuated around three million people (Mirek 1996).

The recent proposal to organise the Winter Olympic Games in Poprad, Slovakia, and Zakopane, Poland, could pose a major threat to biodiversity, as development plans imply large-scale damage to nature and landscape on both sides of the Tatra National Park (Janiga et al. 1992, Witkowski et al. 1998).

Mass tourism also favours the introduction of invasive species into native habitats. Even at high altitudes, in the alpine zone, the invasive annual grass *Poa annua* occurs alongside tourist trails. The nettle *Urtica dioica* also spreads in the vicinity of tourist camps and huts. Many activities aim at counterbalancing negative aspects of mass tourism in the Carpathians, within a sustainable tourism framework. The Carpathian Large Carnivore Project, aiming to develop and implement a comprehensive conservation programme for large carnivores in Romania, is one example. As part of the project,

an eco-tourism programme "Wolves, Bears, and Lynx in Transylvania" was developed. Between 1997 and 2003, over 3,000 persons have visited the area through this programme.

### Air and water pollution

Air pollution, mainly comprised by SO<sub>2</sub> and nitrogen oxide emissions, has affected the Carpathians for decades. The main pollution sources were steel works, power and heat stations, and coal mines concentrated in the Western and Northwestern Carpathians, in the Czech and Polish parts of the Silesia region. The most drastic effects have been observed in the upper montane forest zone, in the northwestern part of the Beskidy Mountains, and in the Western Carpathians. Annual growth rings in Norway spruce reveal a 30-50% growth reduction in the period 1960 to 1990 compared with the first half of the century (Orzeł 1993). The process of forest decline is still ongoing, because the natural recovery of habitats from acidification and deposition of heavy metals lasts for decades.

### Hydro-electric investments: construction of large dams and reservoirs

Most of the large Carpathian tributaries of the Danube and Vistula River are now dammed. Additional constructions, such as the Czorsztyn-Sromowce artificial reservoirs on the Dunajec River threaten nature in the Pieniny National Park in Poland and Slovakia through changes of the natural river structure, water regime and microclimate (Rybacki 1995, Voloscuk 1997). The future impacts of hydroelectric constructions and artificial dams are likely to be even greater, as Carpathian tributaries of the Danube and Vistula contribute up to 30% to water resources in the countries surrounding the Carpathian region.

### Planning and construction of trans-Carpathian highways and motorways

Trans-Carpathian highways and motorways will increase the isolation of the Carpathians natural environment from other mountain ranges and northern Europe. The highway Bratislava-Katowice and its branch to Ostrava on the Czech-Polish-Slovakian border divides the Moravian



and Silesian Beskid into two separate parts, isolated from the other ranges of the Beskid Mountains (Witkowski 1998). The planned highway joining Estonia and Greece along the eastern borders of the EU would cross the Carpathian crest at least twice. Highway construction involves such negative effects as high levels of dust and nitrate concentrations, noise and physical barriers to the natural movement of many organisms.

### Changes in agriculture and forestry

Abandonment of traditional agriculture and forestry methods, such as pasturage or coppicing, is common in the Carpathians. As a consequence, many horse, sheep and cattle races are vanishing. The traditional fine-grained landscapes are disappearing and both species and landscape diversity are generally decreasing. The process is most advanced in the Western Carpathians where the high rate of forest fragmentation, changes to large-scale agriculture and urbanisation are now the main causes of species' extinctions (CERI 2001).

### Hunting and poaching

These pressures affect nearly all taxa of fauna. In national parks, illegal hunting, poaching and anthropogenic destruction of habitats occur regularly. These illegal activities focus on rare

and endangered species such as large carnivores, eagles, owls, chamois, marmots and many small invertebrates and plants. Small, isolated populations have become extinct or are unable to maintain long-term viability.

### Invasive alien species

During the last century, many species have been introduced by humans, often unintentionally, into new areas across the globe. Invasive alien species often pose threats to native flora and fauna or natural ecosystems. In the Carpathians, they have entered natural and semi-natural ecosystems and become established in the region during the last decades.

Among plants, examples of invasive alien species include the Caucasian hogweed *Heraclium sosnowskyi*, introduced due to agriculture in the 1980s and now dispersed in many Carpathian river valleys. Invasive alien carnivores arriving in the Carpathians a few decades ago include the American mink *Mustela vison*. This new immigrant pushed its European relative *Mustela erminea* towards extinction in a relatively short period. Another carnivore from Asia, the raccoon dog (*Nyctereutes procyonoides*) was introduced in Europe from the former Soviet Union and spread quickly throughout the Carpathians, but fortunately is still a rare species.

## Human impacts on Pilsko Mountain

As early as the 15th century, agricultural practices based on pastoral management of forest glades and clearings developed around Pilsko Mountain in Slovakia. These practices remained largely unchanged for 300 years, stabilizing the structure and composition of habitats. Forest areas fell to 46% of the total area of the massif, while ploughed areas covered 29% and mountain meadows and pastures 23%.

Several new plant associations emerged and became established on pasture glades, including *Gladiolo-Agrostietum*, *Hieracio-Nardetum*, *Rumicetum alpini*, as well as peat bogs. These were originally not found in the region, when the entire area was largely covered by forests. Meadows and pastures in the forest zone included many high-altitude plants such as the chive *Alium schoenoprasum* and felwort *Swertia perennis*, and animals such as the Tatra pine vole *Pitymys tatricus* and water pipit *Anthus spinoletta*. These species are now very dependent on the distribution of pastures and meadows (Kurzyński et al. 1996).

In the 1970s, a ski resort was developed at the top of Pilsko Mountain, essentially changing the structure of the local landscape. In earlier times, the landscape typically was 'coarsely grained', with extensive areas of forest dominating steep slopes, and pastures on flatter ones. The emerging ski industry led to a more 'finely-grained' structure, as forests were cut to facilitate access to steep slopes, whereas former pasture areas are now witnessing the initial phases of forest succession (Witkowski 1996). The remaining small patches of meadows and forests are now dominated by common species, as many specialized species were not able to survive.

The Pilsko Mountain case appears to be representative of many new ski resorts being developed in the Carpathians. Similar landscape effects were observed in newly-established ski resorts on Jaworzyna Krynicka Mountain and in the Tatras.

## Policy Measures and Responses

In the last decade of the 20<sup>th</sup> century, the Carpathian countries made significant efforts to maintain their diverse native flora and fauna. Some basic conservation standards and measures were harmonized, including the categories of protected areas and lists of protected species. Moreover, significant international agreements devoted to nature conservation, such as the Ramsar Convention on Wetlands, Bern Convention on the Conservation of European Wildlife and Natural Habitats, and the Convention on Biological Diversity (CBD) were accepted and signed by all Carpathian countries.

These efforts resulted in a well-developed network of national parks and their cooperation within the Association of the Carpathian National Parks and Protected Areas (ACANAP). These include bi- and trilateral cooperation agreements between national parks and other protected territories. The first bilateral national park in Europe was established in 1932 in the Pieniny Mountains by Poland and former Czechoslovakia. Europe's first trilateral agreement protected border areas in the Bieszczady Mountains, including parts of Poland, Slovakia and Ukraine.

All of the Carpathian countries participate in the Pan-European Biological and Landscape Diversity Strategy (PEBLDS) and make efforts to implement the Kyiv Resolution on Biodiversity, endorsed at the 5<sup>th</sup> Ministerial Conference *Environment for Europe* in 2003, which has as its main objective to halt the loss of biodiversity in the pan-European region by 2010. The Carpathian countries are also members of the Ministerial Conference for the Protection of Forests in Europe, a high level political initiative working towards the protection and sustainable management of forests in the pan-European region.

Despite such local and regional achievements in the nature conservation field, local communities, ecologists and politicians became increasingly aware that bi- and trilateral cooperation agreements were insufficient for effective conservation of the entire unique Carpathian ecosystem. Partly

to remedy this situation, a 'Carpathians Unite' parliamentary meeting was held in Warsaw in 1997 (Bloemhard et al. 1997), resulting in extensive cooperation between local and regional NGOs under the framework of the 'Carpathian Ecoregion Initiative' and WWF Danube-Carpathian Programme. This was followed by a political summit held in Bucharest in April 2001 (Webster et al. 2001). One final outcome of these political efforts was the Carpathian Framework Convention (CFC), signed in 2003 in Kiev, which UNEP played an essential role in brokering.

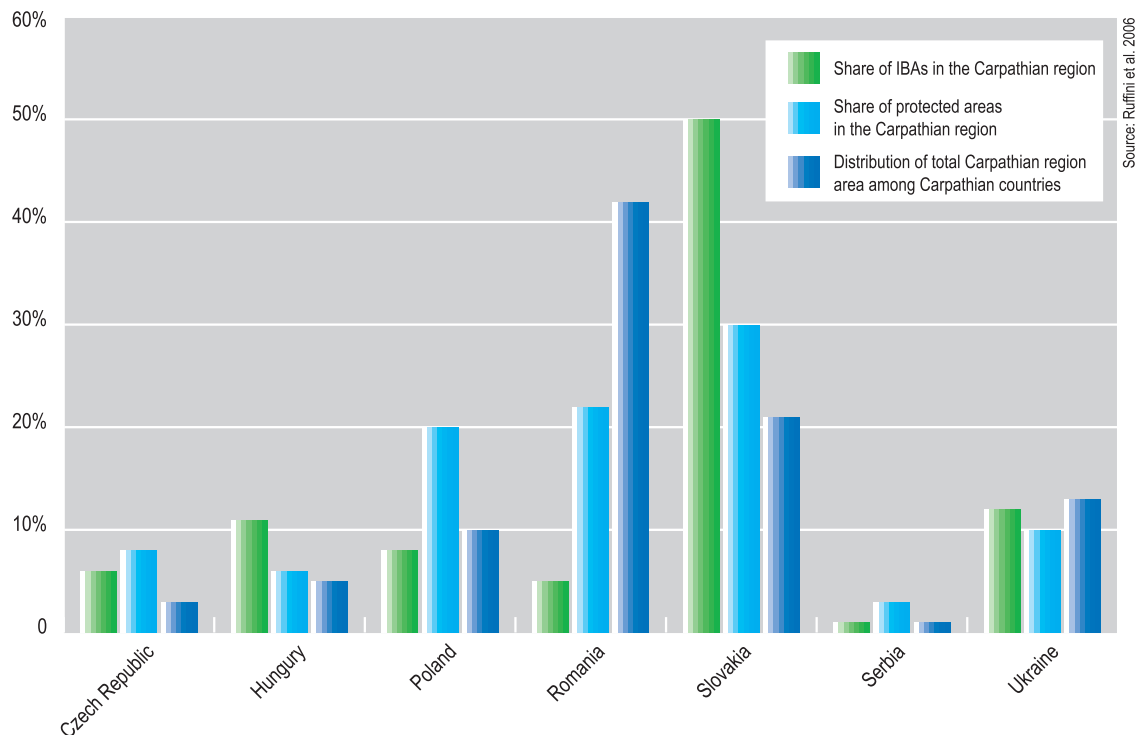
### The Carpathian Framework Convention (CFC)

One of the main forces in nature conservation management in the entire Carpathian region is the CFC, providing a framework for integrated multi-sectoral policy coordination. The coordination activity of the Convention should solve some important questions related to nature conservation, including harmonization of legislation, particularly on hunting and fishing, unification of species status, closing time of hunting seasons, hunting methods and methods to calculate the percentage of populations being hunted. Another major issue for the Carpathians concerns landscape planning regulations and their consequences for nature conservation efforts. The development and harmonization of tourism should be pursued, with particular promotion of eco- and sustainable tourism activities. The most difficult and problematic issue is the maintenance of all regional aspects of culture, including traditional forest and agriculture practices, and their connection to sustainable use of natural resources. These also are among the most ambitious fields of local NGOs' activities. In general, the CFC seeks to assure an integrated and holistic vision of mountain development.

### EU Directives

The majority of the Carpathian territory (approximately 90%) falls within EU member states since 1 January 2007. As a consequence, the

Fig. 3.5 The share of protected areas and Important Bird Areas (IBAs) in the Carpathian region



Source: Ruffini et al. 2006

implementation of nature conservation measures and policies in the Carpathians is for the most part guided by the EU Bird and Habitat Directives and the Natura 2000 programme.

The implementation of Natura 2000 will result in at least 15% of the Carpathian territory being protected. Furthermore, the lists of protected habitats and species in the Carpathian countries will be better harmonized through the incorporation of lists of species and habitats for which special protection measures must be taken according to appendices of the Bird and Habitat Directives. Finally, the Directives require permanent monitoring of habitats and species, which will provide reliable and comparable data on the effectiveness of nature conservation measures in the Carpathians.

The EU Common Agricultural Policy (CAP) also influences biodiversity preservation measures in the Carpathians, with some financial resources dedicated to viable agro-environmental schemes. The introduction of GMO products may also constitute a threat to native species and ecosystems (Burdusel et al. 2006).

### Protected Areas

The high value of the Carpathians natural environment is mainly preserved through two types of large-scale protected areas (greater than 1000 hectares): national parks and national nature parks (33 areas), as well as protected landscape areas or landscape parks (42 areas). These two categories of protected lands cover as much as 13% of the Carpathian area.

The EU legislation obliged new members and accession countries to prepare a new unified network of protected areas under the Natura 2000 program. To date, all seven Carpathian countries have finalised their proposals for Special Protection Areas (SPAs), which constitute the Natura 2000 component covering the needs for bird fauna conservation (Ruffini et al. 2006). Nevertheless, available data show that unequal efforts are being made in the nature conservation field in the Carpathian countries (see Figure 3.5).

The non-EU Carpathian countries preserve their natural landscapes through their national eco-

Table 3.5 Natura 2000 efforts in four EU countries sharing the Carpathian territory (IUCN 2005)

Country	Natura 2000 sites	Number	Area (ha)	% of country	Carpathians as % of country
Czech Republic	SPAs	41	~ 623 000	7,9	9
	pSCIs	864	~ 718 000	9,1	
	<b>Total</b>	<b>905</b>	<b>~ 1 065 000</b>	<b>13,5</b>	
Hungary	SPAs	45	1 191 784	12,8	8
	pSCIs	457	1 237 785	13,3	
	SPAs & pSCIs	10	159 572	1,7	
	<b>Total</b>	<b>512</b>	<b>1 975 159</b>	<b>21,2</b>	
Poland	SPAs	72	3 312 800	7,8	6
	pSCIs	184	1 171 600	3,6	
	<b>Total</b>	<b>248</b>	<b>?</b>	<b>~ 10,3</b>	
Slovakia	SPAs	38	1 220 563	25,2	72
	pSCIs	382	571 191	11,72	
	<b>Total</b>	<b>?</b>	<b>~ 1 426 102</b>	<b>28,9</b>	

logical networks, by implementing international agreements such as the Bern Convention (which includes participation in the Emerald Network), and by contributing to the Pan-European Ecological Network (PEEN). For example, Ukraine has established more protected areas in forms of national parks and strengthened incentive measures in recent years under its National EcoNetwork Formation Programme (CBD 2007).

IUCN (2005) has also shown that there are differences in implementing Natura 2000 guidelines in four (of five) EU Carpathian countries (see Table 3.5). In Slovakia, where the Carpathians cover as much as 72% of its territory, nearly 29% of the country's area is included in Natura 2000. As for Romania, the country's proposal for the Natura 2000 network is now in the final phase of preparation.

Table 3.6 Establishment of protected areas in non-EU Carpathian countries (CBD 2007)

Country	Number	Area (ha)	% of country	Carpathians in % of country
Ukraine	7243	~2 916 158	4,8	~5
Serbia	178	N/A	N/A	N/A

## Conclusions

Many landscapes, habitats, and flora and fauna species show characteristic and unique features occurring solely or mainly in the Carpathian region, as results of long-term evolution, migration and adaptation processes that existed well before humans settled in the Carpathians.

Human penetration in the Carpathians was a slow process. In the beginning, human influ-

ence was relatively beneficial to the landscape, habitat and species diversity. Traditional methods of woodland management, such as the coppicing of forests and establishment of meadows and pastures created new ecosystems that enriched Carpathian landscapes and biodiversity. This situation changed with industrialization and increased human settlement. These processes caused major changes to forests, simplified the

local diversity of agro-ecosystems and resulted in a decline of native flora and fauna. Later in the 20th century, new biodiversity threats emerged in the region, including air and water pollution, climate change, large-scale investments such as highways and artificial lakes, illegal collection and poaching and a major increase in tourism and recreation activities.

To counterbalance these activities, some countries began to introduce their own protective

mechanisms and measures such as establishing protected area networks, species protection decrees and inventories for monitoring the decline of habitats and species. Carpathian countries have also signed bilateral/multilateral cooperation agreements, culminating in the adoption of the Carpathian Convention, a regional framework within which new sustainable development and biodiversity conservation measures and policies will be implemented.



## 3.2 Forest Resources

The existence of virgin primeval forests throughout the Carpathian region lasted until one to two millennia ago in the lower mountains. Human influence in the region dates back to ancient times in the foothills of the Southern Carpathians, while in the North, human settlement began in late medieval times.

At the end of the 16th century, the Wallachian people, many of them shepherds, began their in-migration from the Balkans to settle in the Carpathian region's higher altitudes. They were the first people to inhabit more remote areas within the mountains. By cutting and burning forests along the mountain ridges, they created numerous glades and meadows, which have since become a distinguishing feature of the Carpathian landscape.

From the 18th to 20th centuries, Carpathian forests were in many places much reduced through the rapid development of industry, including sawmills, glass and smelting works and metal ore mines. Forest cover decreased and changed rapidly. The majority of native beech and fir forests were replaced, often through clear-cuts, by monocultural Norway spruce plantations. The impact of industrial activity was much

stronger in the Western Carpathians than in the Romanian and Ukrainian parts of the range.

Until the second half of the 19th century, the main function of forests was wood production and its economic values and benefits, measured as the quantity and quality of wood produced. Other functions, including areas for hunting and recreation and environmental and social values, were of secondary importance. In the late 19th century, tourism and recreation became increasingly important services provided by forests. In the second half of the 20th century, during the period of communism, timber production was one of the most important sources of foreign currency, and large-scale and wasteful clear-cut areas were commonly found on the mountain slopes.

However, by the 1990s, the attitude of scientists, foresters and communities towards forests had changed, with the ecological and social functions of forests matching their economic function nearly everywhere in the Western Carpathians. While in Ukraine forest practices continued to focus on economic uses, timber exploitation in the other Carpathian countries became only one amongst many forest functions. Today, forests continue to be a major economic resource.

The logging and wood-processing industry still represents the main source of income in many areas. Nonetheless, the importance of other forest functions has grown, as they are no longer perceived from a purely economic perspective and as a source of timber. Their recognized ecological services now include stabilization of soils, regulation of water output from mountain watersheds, carbon sequestration and air purification. Social functions include providing jobs for local people and enhancing recreation and tourism. Their provision of non-wood products, such as wild animals, mushrooms, berries, flowers and honey, is also important to inhabitants.

Carpathian forests are increasingly valued for both nature conservation and biodiversity main-

tenance, given the high utility assigned to their diversity of plant and animal species. The forests are a reservoir and prime habitat for one of the richest continental stocks of large animals, and icons of the primeval forest. They are a crucial sanctuary for large carnivores, where bears, wolves and lynxes are estimated in the thousands, as well as for many large bird species in Europe (see section 3.1). For vital populations to survive, these species need extensive areas of forest and large patches of pastures and meadows.

A key positive result of this recognition of forests' multiple roles has been new forest policies and laws, improved forest management and an increase in protected forest areas.

## Current Forest Cover and Composition

Much of the Carpathian range is covered by vast areas of forests. On average, forest cover is nearly 60% but the percentage varies significantly among countries and areas. The largest forest complexes are in the Eastern Carpathians. In the Western and Southern Carpathians, substantial areas were deforested and converted to other landuses. Past deforestation and fragmentation increases from the region's main ridge to its peripheries. In the foothill areas, forests are

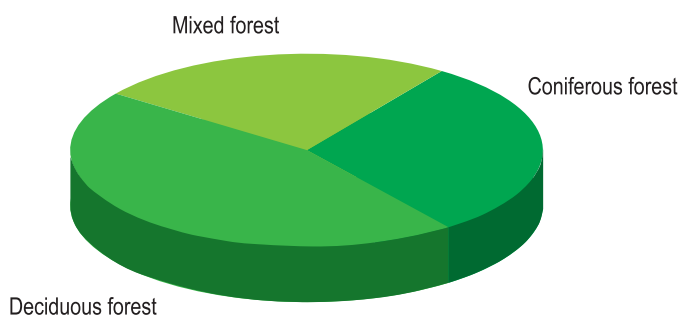
small and scattered and the landscape is dominated by other land uses (see Map 3.5).

The Carpathians are famous for their relatively large share of natural and semi-natural forests, occurring either at high elevations or in areas of rugged topography with limited access. While their total area is not precisely determined, an estimate is 3,000 sq km (see Map 3.3). Lower plants, lichens and fungi associated with these old-growth forests and their ecosystems, especially dead wood, are still poorly known. However, it is expected that these ecosystems provide shelter to a rich variety of rare species, now extinct elsewhere due to intense forms of forest management.

The forests of the Carpathians are a patchwork of coniferous, deciduous and mixed stands (see Figure 3.6). Like other vegetation types, forests display a distinct vertical zonation. The four main levels are the foothill zone, lower mountain forest zone, upper mountain forest zone and dwarf pine zone (see section 3.1).

In most areas of the Carpathians, beech is mixed with coniferous trees, namely silver fir and

Figure 3.6 Main types of forest formation in the Carpathians (according to Ruffini et al. 2006)



According to Ruffini et al. 2006

Norway spruce. In the lower parts of the montane zone, especially on south-facing slopes, a mixture of oaks, maples and ash may be found in beech forests. In some places, the montane zone is totally dominated by conifers, usually a mix-

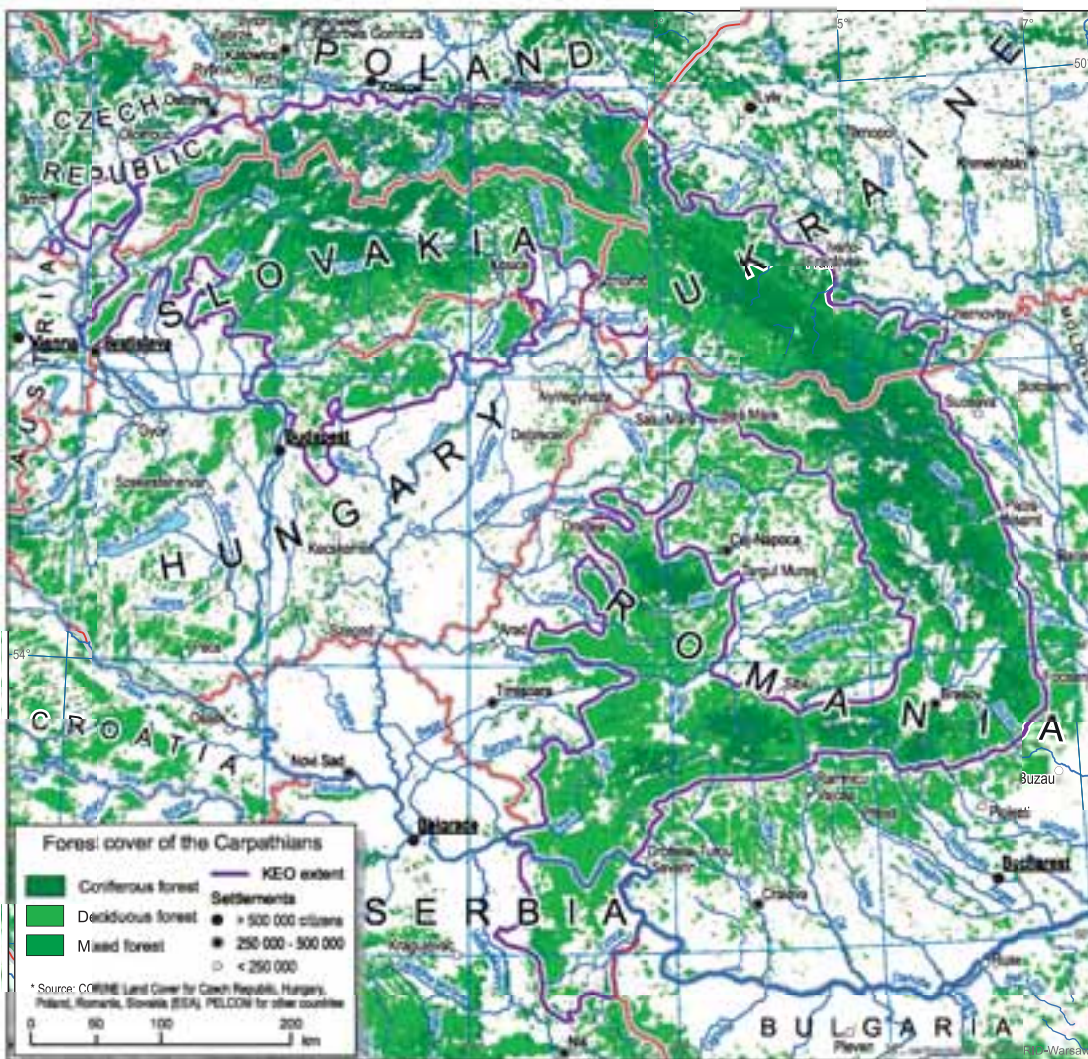
ture of silver fir and Norway spruce (e.g. the Tatra, Moravske Beskydy, Oravska Magura in the Western Carpathians, and the Gorgany, Czar-nohora, and Muntii Bistrei in the Eastern Car-pathians).

## Natural Virgin Forests

Characteristic features of natural Carpathian forests include their age, the existence of large carnivores and raptors and the volume of dead wood. Natural forest floors maintain over 100 cubic meters of dead wood per hectare, while in

managed forests dead wood occupies less than 10 cubic meters over the same area. A lack of dead wood implies a significant lack of biodiversity (e.g. plants, fungi and invertebrates that depend on this particular substrate for their survival). For

Map 3.3 Forest cover of the Carpathians (CORINE Land Cover/PELCOM)





example, in the Carpathians, two rare beetle species – *Osmoderma eremita* and the Longhorn beetle *Rosalia alpina* – are of European importance for the EU's Natura 2000 network. Many rare species of fungal symbionts<sup>2</sup>, lichens and lower plants also depend on dead wood. Furthermore, dead wood has many environmental values, the most important being carbon sequestration, particularly in higher altitudes where the process of tree decay can be as long as one century, much longer than in the lowlands. Recently, the EU proposed a new agro-environmental scheme of financial support during the period of 2007 to 2013 that would provide opportunities for increasing the area of old wood refuges and protected primeval forests which are in private ownership.

<sup>2</sup> Organisms that live in association with individuals of different species.

Nearly all the remnants of natural and semi-natural forests in the Western Carpathians are now protected in nature reserves and national parks in the Czech Republic, Hungary, Poland and Slovakia, including their valuable, rare and threatened forest ecosystems. Much larger areas of natural and primeval Carpathian forest still exist in the Eastern, Southeastern and Southern Carpathians in Ukraine and Romania. Not all of these areas are protected by law, but large-scale clear-cuts have nevertheless been abolished and forest management is mainly conducted by establishing protected areas of various kinds, employing selective cutting systems and limiting forest exploitation. Forest regeneration is mostly natural, while the planting of tree seedlings is widely used as a way to convert secondary Norway spruce stands (plantations) into more diverse forest stands.

## Current Threats

### Deforestation

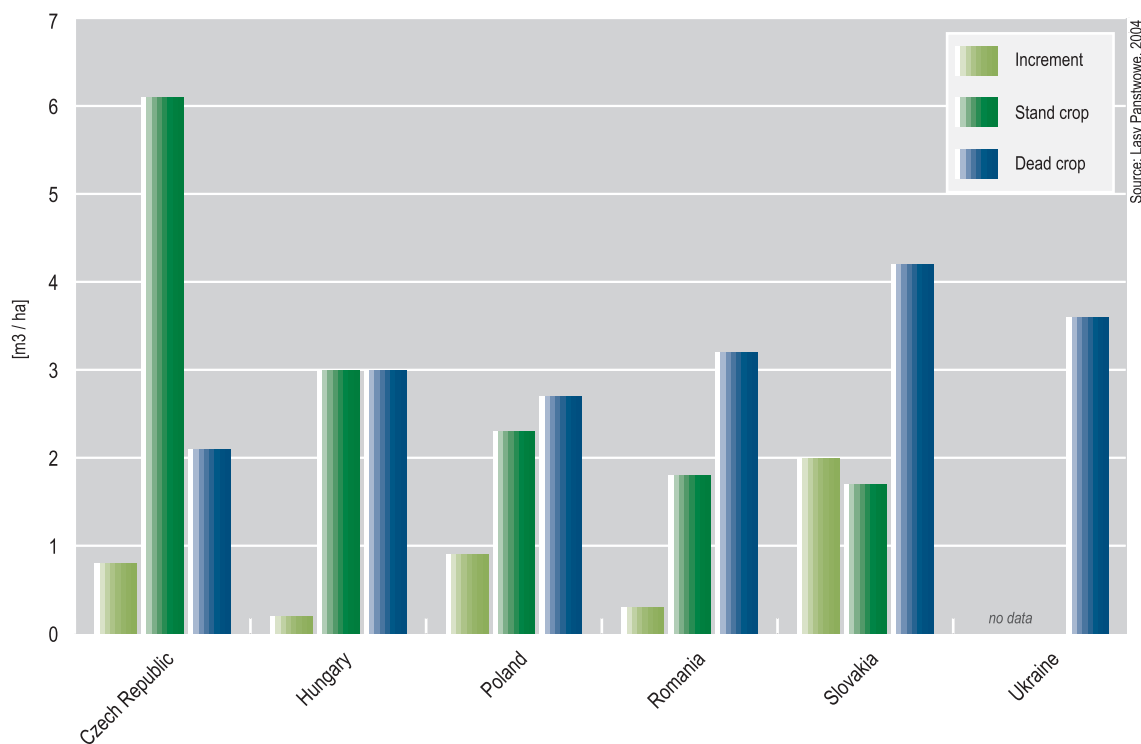
The current status of Carpathian forestry is complex, and a lack of precise data renders a detailed assessment even more difficult. On the one hand there are processes of reforestation. On the other, timber production in some countries equals or exceeds the annual increment of tree stands, resulting not only in deforestation, but also a thinning of the stands.

Data presented by the Temperate and Boreal Forest Resource Assessment (Lasy Państwowe 2004) suggest that forest timber yield (calculated as the stand crop plus the dead crop) may sometimes exceed the annual increment of forests in some Carpathian countries (see Figure 3.7). However, this figure is calculated for entire countries and not according to particular country areas in the Carpathians. According to the same source, Carpathian forests are healthier and less exploited than those in lowland areas (many of which are plantations), since access to many mountain forest stands remains limited due to topography.

In general, as in most European countries, overall annual timber cutting in the Carpathians is lower than the gross annual increment of wood volume (Figure 3.7). Nevertheless, deforestation processes are still occurring in the region, and can be observed in Ukraine and to a lesser extent in Romania (see Figure 3.10). Local, small-scale deforestation was monitored and documented in the western part of the Beskidy Mountains in the Czech Republic, Poland and Slovakia (Fabijanowski and Jaworski 1996). These processes resulted from synergetic effects of several factors, such as increases in soil pollution and acidification due to the long-term effects of acid rain. Similar effects were also reported near ski trails where the opening of forest margins altered the microclimate and gave rise to bark-beetle outbreaks.

Pure Norway spruce stands, planted using varieties outside of their natural range and habitat in the Carpathian foothills and lower montane forests zone, are prone to diseases and bark-beetle outbreaks. Furthermore, illegal clear-cutting, poaching and the over-exploitation of other forest products such as mushrooms, berries

Figure 3.7 Forest yearly increment and standing crop divided into stand and dead crop (in cubic meter/ha) (Lasy Państwowe 2004)



and rare plants and animals are alarming phenomena that are on the upswing.

### Afforestation

After centuries of deforestation, the forest area expanded substantially over the last few decades, especially in the Western Carpathians. Forest recovery is crucial for the conservation of rich habitats in the Carpathians and maintenance of its biodiversity, especially for large carnivores. The afforestation process predominates in the Czech Republic, Hungary, Poland and Slovakia (see Figure 3.10). This was mainly a result of tree planting in former arable fields and natural processes of secondary forest succession in areas abandoned by agriculture. The Millennium Ecosystem Assessment (Hassan et al. 2005) shows that the process of deforestation is being reversed in Europe, and some of the first signs of this turn-around are observable in the Carpathians.

### Forest ownership changes

The structure of forest ownership in the Carpathians has changed rapidly over the last decade. In the 1990s, the majority of forests

were state-owned, nearly 100% in Ukraine, over 90% in Romania, and more than 80% in Hungary and Poland. The subsequent re-privatisation and restitution of forest properties to private owners (those who owned forests prior to 1945) were most advanced in the Czech Republic and Slovakia, with nearly 40% of forests returned to private hands after 1999.

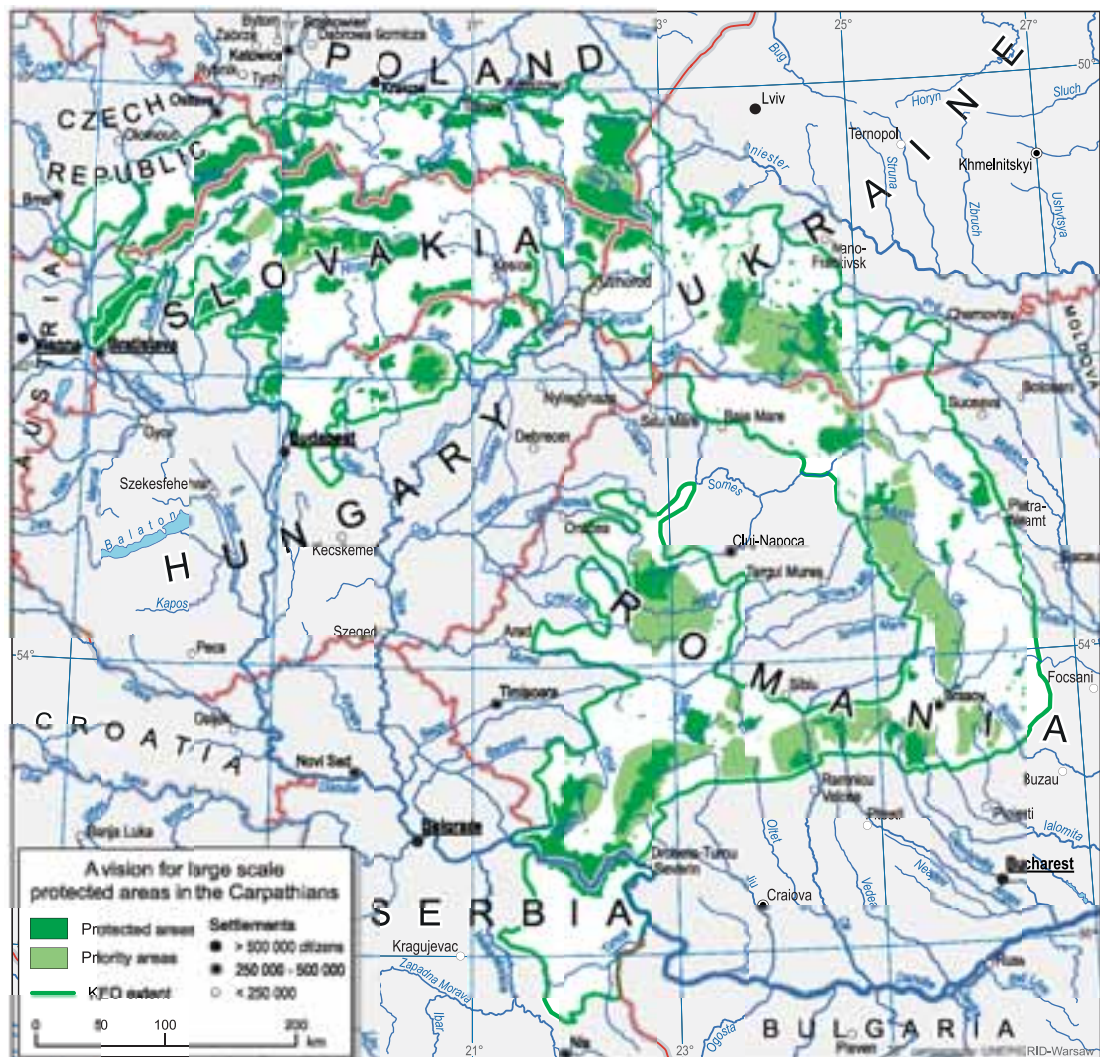
Private ownership often results in a disintegration of forest management and fragmentation of stands. A good example may be found in Poland, where the number of private forest owners is estimated at 900,000. Regular censuses of forest resources show that private forests are now younger and thinner than state-owned forests, and often inappropriately managed. Forest privatisation also tends to place more value on economic benefits rather than on ecological and/or social values of forest ecosystems, as new forest owners often do not recognize their social and environmental responsibilities (Lasy Państwowe 2004). A recent positive sign is EU support for the development of cooperative owner groups, which are economically stronger and better suited to improved cooperation and management.

## Protected Areas

The efforts to protect Carpathian forests have been growing from decade to decade. The increase in the protected area in the Polish Carpathians serves as an example of this positive trend. In 1980, less than 10% of forests were protected. By 2003, protected areas of various types (biodiversity and landscape protection) covered nearly 40% of all forests. The same process can be seen in other regions of the Carpathians, especially in those countries which became new members of the EU.

Large-scale protection of Carpathian habitats is still far from optimal. The Carpathian Ecoregion Initiative (CERI 2001) developed the first large-scale analysis of the Carpathians with an assessment of the conservation needs of key species and habitats (see Map 3.4). It was found that in the Western Carpathians the CERI conservation proposal mostly coincides with the existing protected areas. However, in the Eastern and Southern Carpathians, data show that much work is still needed to build and implement a conservation network.

Map 3.4 A vision for large scale protected areas in the Carpathians (CERI 2001)



## Conclusions

Centuries of evolution and human impact changed the initial natural species composition, forest stand structure, size scale and character of the Carpathian forests. However forests are still vital. Many virgin stands rich in species remain of high social, environmental and economic value for the local people and visitors to the region.

Timber production remains a major source of income in the Carpathian region. However, in some areas, small sawmills and other wood processing industries have a more social than economic character (e.g. preventing local unemployment). A growing source of income from forests is tourism and recreation. Forest tourism trails, hunting areas and guest rooms in mountain villages are all successful economic activities competing with simple wood processing in the Carpathians.

Three key changes have recently been observed as having positive effects on the situation: the attitude of local people towards forest use, pri-

vatization, and conservation status of forests. The attitudes of local people towards forests have become increasingly "sustainable". Even if the majority of forests remain in public hands, private owners are now an important segment of the market for timber production and other economic forest uses. The new EU proposal of financial support for forest protection through an agro-environmental scheme for the period 2007 to 2013 gives an opportunity to private owners to increase the area of old wood refuges and protected primeval forests.

Forest conservation in the Carpathians is primarily supported by a wealthier segment of the population. Economically disadvantaged communities throughout the Carpathians currently have little interest in conservation issues as such. Along with increased environmental education, the most important goal for decision-makers should be to give local communities a chance for a better quality of life, including improved incomes from sustainable forest usage.



## 3.3 Land Resources

**M**ost of the area of the Carpathian Mountains is covered by forests (59.2%). The second largest form of land cover is agriculture (27.5%). Other land uses, mainly urbanized and industrial areas, cover 13.4%. Much of the land-use pattern in the Carpathians has been modified by the human presence over centuries of time. A characteristic feature of the Carpathians' landscape is the

typically small scale of land use patches. Except for large patches of forests, areas used for other purposes such as grasslands, pastures, agricultural lands and urban settlements are small, with the latter distributed throughout the region except in forest areas. Together, these patches form a unique landscape 'grain pattern' with 'coarse' forest areas and 'fine' areas for other uses (see Map 3.5).

### State and Trends: Soils

#### Origin of soils in the Carpathians

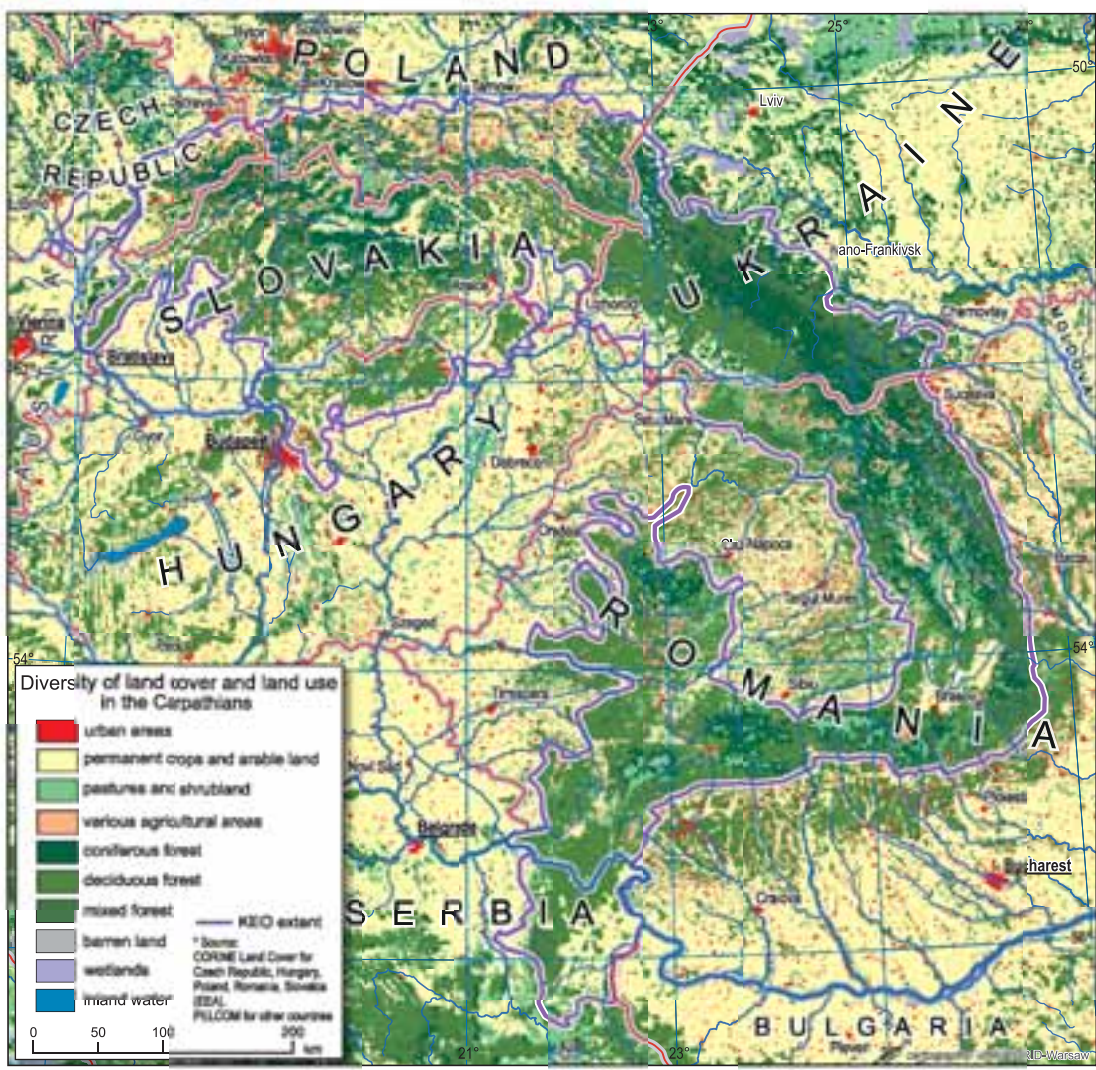
Several characteristic features differentiate Carpathian soils from lowland soils. Their origin is directly connected to slow weathering processes that produced regolith (the layer of weathering bedrock), and intense morpho-genetic processes (e.g. rock falls, rock slides, debris and grain flows, solifluction) that determined the fragmentary character of the soil cover. As a result, the shallow soil profile and large amount of rock pebbles in the soil mass are characteristic features Carpathian soils.

Different variants of soil occur at high altitudes (Skiba 2006). Examples include those of the Tatra Mountains, rock walls in the Bucegi Mountains, Western and Eastern Beskid Mountain ridge, rock outcrops and rock rubbles in the Gorgany Mountains.

The mountain relief and regolith<sup>3</sup> are also connected with specific hydrological conditions. The lateral movement of soil solutions (liquid

<sup>3</sup> Material covering solid rocks, comprising the soil, alluvium and bedrock.

Map 3.5 Diversity of land cover and land use in the Carpathians (according to CORINE Land Cover)



component of the soil) produces exudations which occur in the form of slow and steady water discharges, as well as moist areas and in-slope water sources. These waters are characteristic of mountain soils, and also influence the formation of specific soil variants. Examples include patches of eutric regosols enriched with alkaline elements, as well as Carpathian mollic gleysols occurring in the Outer Carpathians.

An interesting characteristic of Carpathian mountain soils is the large amount of weakly decomposed and peat-like organic matter, as well as the increase in organic layer depth with increased altitude. The mountains' cool and humid conditions, as well as the adjacent plant communities (together with soil organisms), lead to low rates of decomposition of plant mate-

rial (Skiba et al. 1997, Drewmik 2006). Soils with organic horizons of more than 10-20 cm occur at high altitudes, under blueberry (*Vaccinietum*) and dwarf pine communities, forming tangel rankers or tangel rendzinas soil types. This shows the important role of both the local climate and vegetation in the genesis of the mountain soils.

The acid reaction of the surface soil in the mountain regions derives from soil genesis processes that are characteristic for the humid climatic conditions of the Carpathian Mountains. Low pH levels are not always affected by acid rains (Skiba 2006); however, some extremely acidic soils in the Western Carpathians can be further overloaded by acid deposition.

### Soil division in the Carpathians

The Carpathian region includes the Carpathian foothills, Outer Carpathians and Inner or Central Carpathians (see Chapter 1). Nearly 90% of the foothills area is covered by silt formations deposited on flysch formations, known as Carpathian loess, up to 25-30 meters deep. Concomitant soil formations (e.g. gley and fluvi-eutric soils) cover significantly smaller areas. Similar soils are found in the Transylvanian Plateau in Romania.

The Outer Carpathians include the Beskidy Mountains, whose ridges are situated within nappe-fold flysch formations that belong to different structural units (nappes), built of complexes of sedimentary rock beds. The mantle rock of these formations is usually loamy and remodelled by morpho-genetic processes that form the slope cover. In the Outer Carpathians, mainly dystric cambisols developed on decalcified clay slopes. Shallow cambic rankers and eutric cam-

bisols cover smaller areas, usually on carbonate flysch weathering formations. They are also found in areas enriched in alkaline elements.

The Inner Carpathians have a very differentiated geological substratum, similar to that of the Southern Carpathians. The geological base is formed of crystalline, volcanic and metamorphic rocks and Mesozoic limestone and dolomites. The soil cover corresponds to the varied geological and orographic conditions. On non-carbonate rocks (e.g. granites, shales), acidic soils (mainly haplic podzols) were formed. On steep slopes, podzolic rankers and raw-humus forms of alpine rankers developed. Within the sub-alpine and alpine belts, initial soils and regosols prevail.

On carbonate rocks, various sub-types of rendzinas (such as rendzic leptosols) prevail, including specific alpine variants of raw-humus rendzinas. On volcanic rocks, andi-lithic leptosols may be found.

## Erosion

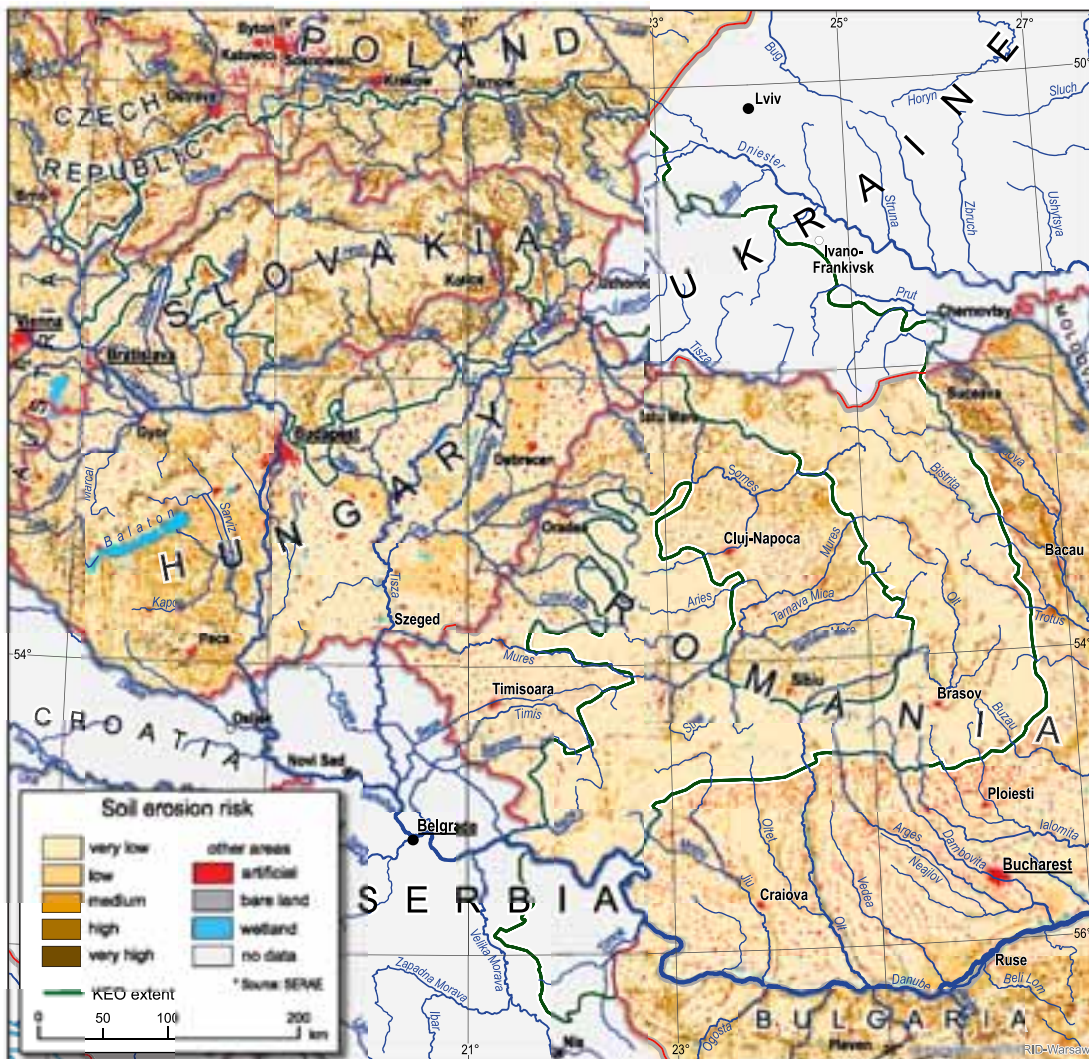
Threats to soil cover in the Carpathians include natural processes, such as soil erosion and landslides, and processes stemming from human activities and land uses, such as forest management, pasturing, tourism and recreation. Natural threats mainly affect areas above the forest zone, where geomorphologic processes are most intense (e.g. debris flows, rockfalls, gravitational movement of detached material) (Kotarba et al 2002).

One of the most important consequences of inappropriate agriculture and forest management (e.g. large clear-cuts) in mountain areas is soil erosion (see Map 3.6). Examples include the maintenance of ploughed fields on steep slopes and excessive concentrations of cattle or sheep in mountain pastures. Deforestation is the main anthropogenic activity increasing the instability of slopes, and also triggering gully erosion. Afforested sectors have very stable slopes, being

affected by mass movements only to a small degree (10-15%). Deforestation is accompanied by rapid expansion of degraded lands. Low-stability slopes are entirely deforested in some sectors and more than 70% are susceptible to landslides. The vulnerability of mountainous systems to landslide and erosion also increases when agricultural uses are intensified or reduced. Traditional land use composition and structure as organised by Wallachian shepherds were strongly dependent on the slope exposure and topography. Their main pastures and hay meadows were located on low-angle slopes near the mountain ridges.

The degree of erosion depends on several factors such as the steepness of the slope, soil character and land management scheme. The soil outflow is calculated as less than 0.00001 mm/year from forested slopes, 0.0002 mm/year from pastures and grasslands with similar slopes and soils,

Map 3.6 Soil erosion risk in the Carpathians



while in potato fields it reaches more than 1 mm per year (Starkel 1972).

In addition, soil water retention decreases as soil cover is degraded through timber extraction, forest thinning and chemical changes in pasture glades. The catastrophic floods in the Ukrainian Carpathians (Tisza Valley) in the last decade are an example of this impact.

The occurrence of extreme phenomena affects the evolution of valley floors and slopes. The intensification of vertical erosion is also connected with the increased frequency of heavy rainfalls and higher river energy. The tendency of valleys to deepen, correlated with higher water movement on slopes, brings about greater instability on colluvial slopes and the expansion of landslide-prone areas.

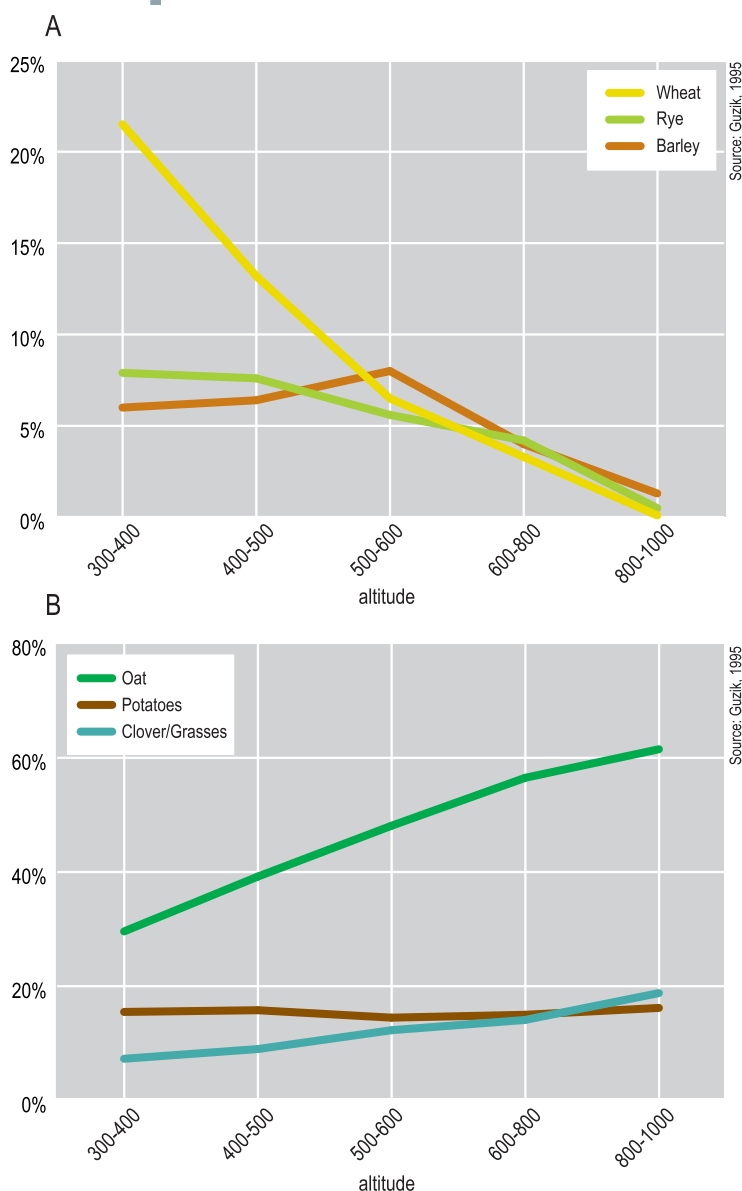


## State and Trends: Agriculture

Historically, the main factor of land and habitat stabilization in the Carpathians and surrounding hilly areas was agriculture. Carpathian countries have mainly produced grain crops, corn, vegetables and potatoes, as well as fruits (Hungary, Romania and Ukraine), grapes (Romania) and hops (Slovakia).

Traditionally, the main agricultural crops in the Carpathians were strongly dependent on altitude. At higher elevations, on steeper slopes and poor soils, productive crops such as wheat, rye and barley were replaced by cold-resistant crops such as oats and potatoes, as well as grasslands, clover fields and pastures (see Figure 3.8). Such a traditional crop division is still maintained in some marginal agricultural areas of Poland, Romania and Ukraine (Guzik 1995).

Figure 3.8 Percentage presence of wheat, rye and barley (A) and oat, potatoes and grasses/clover (B) in relation to altitude (Guzik 1995).



Animal breeding density was also dependent on altitude (Guzik 1995). Livestock species were found in higher numbers in the Carpathian foothills. In mountain farmlands, the density of sheep reached their local peak, with the montane race of sheep predominating in the higher regions of Polish, Romanian and Slovakian Carpathians (see Figure 3.9).

Traditional small farming was particularly difficult and unprofitable in mountain locations, due to severe climate, shallow soils and infertile habitats. Mountain farmers needed additional land for food production, and thus any suitable land was converted to farmland, meadows or pastures. Forests areas were subsequently reduced and large carnivore species and raptors became gradually extinct. Nevertheless, the regionalisation of crop varieties and animal breeding led to an increase of habitat, landscape and species diversity. Changes in landscape and habitat structures were beneficial for open habitat species, such as pollinating insects and butterflies, warm climate snakes and other land reptiles, as well as many bird species such as the corncrake *Crex crex*, partridge *Perdix perdix*, quail *Coturnix coturnix* and skylark *Alauda arvensis*.

After World War II, traditional agricultural practices including the ownership structure changed rapidly, as forced collectivisation was introduced. As a result, state-farm agriculture replaced small-scale private farms. In some Carpathian countries such as Poland and Romania,

### Wallachians and the mosaic of land cover in the Carpathians

Wallachian shepherding, agriculture and forestry were nature-friendly. Traditional agricultural and forestry practices changed the landscape, habitats and species composition. The effects of these human activities are still visible, including large patches of meadows and pastures, as well as ploughed lands at high altitudes, that have been preserved for centuries. Beautiful landscapes abound, with a balanced composition of forest areas covering slopes, meadows and pastures around mountain ridges, and sparse settlements and intensive agriculture areas in the valleys.

Mountain biodiversity was influenced in a positive manner by this mosaic structure. For example, new meadow plant communities have developed on mountain glades, including *Gladiolo-Agrostietum*, *Rumicetum alpine*, *Hieracio-Nardetum* and various mountain peat bogs. At higher elevations, new communities of alpine plant species, such as the alpine

lovage *Ligusticum mutellina*, gul potentil *Potentilla aurea* and alpine bog swertia *Swertia perennis alpestris*, spread and have remained. High montane meadows and pastures were also successfully colonized by montane endemic fauna such as the rodent *Pitymys tatricus*, newt *Triturus montadoni* and high alpine species such as the water pipit *Anthus spinoletta* and bumblebee *Bombus pyrenaicus*. Meadows and pastures in the mountains include nearly as many endemic plants as alpine meadows above the tree line, including over 60% of the Carpathians' total biodiversity (Burdusel et al. 2005).

This rich biodiversity and characteristic pattern of the mountain landscape are currently disappearing throughout the Carpathians. Mountain meadows and pastures have lost their economic importance, and many highland dwellers are now more interested in revenues from tourism and recreation, or leaving the land altogether.

forced collectivisation in mountain regions was less extensive than in the hills and plains. The fine-grained mosaic of small-scale fields, grasslands and wetlands was transformed into vast uniform fields covering hundreds of hectares. By simplifying the landscape structure, species and habitat diversity were substantially reduced. Many common mountain species became rare, including the corncrake, quail and numerous hay meadow plant and insect species.

This trend was reversed in the 1990s with the recovery of private property. Between 1992 and 1994 in Hungary, privatisation created some 350,000 new landowners, who regained 1.5 million hectares of land (Csorba 1996). As a result, private producers now own 47% of the arable land. The process altered and diversified the land use structure, as small parcels now adjoin large traditional farms, pastures and abandoned lands.

Poland was the only Carpathian country where the collectivisation of agriculture was limited and land remained in private hands. The land ownership structure in the 1990s had hardly changed from the beginning of the 20th century. In the Polish Carpathians, the mean size of farms (including forests) is now approximately three to five hectares, and the land ownership and land use patterns are quite complex. In other Car-

pathian countries the mean size of farms and private forest units is still much larger.

In the Eastern, and to some extent in the Southern Carpathians, industrial unemployment and slow economic growth have added new pressures by increasing the share of agriculture lands at the expense of forest cover (see Figure 3.10). The process is dynamic and difficult to analyse

Figure 3.9 Percentage presence of livestock, hogs and sheep according to altitude (Guzik 1995). Altitude classes: 1: 300-400 m, 2: 400-500 m, 3: 500-600 m, 4: 600-800 m and 5: 800-1000 m.

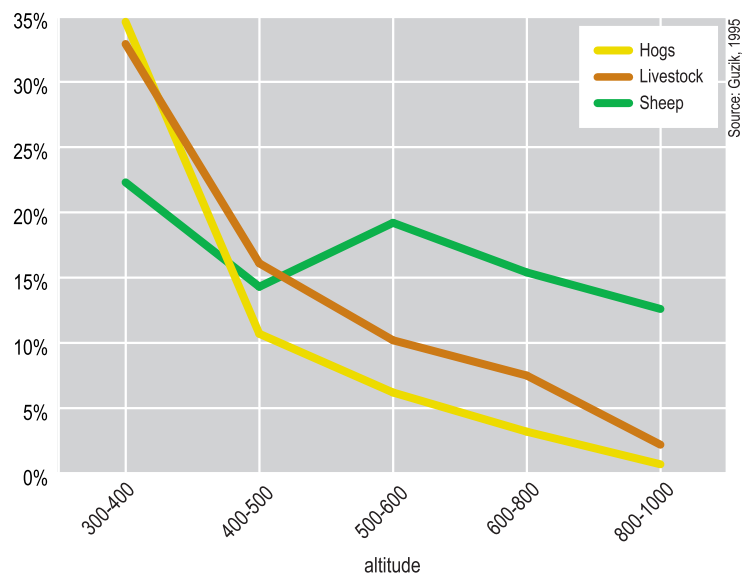
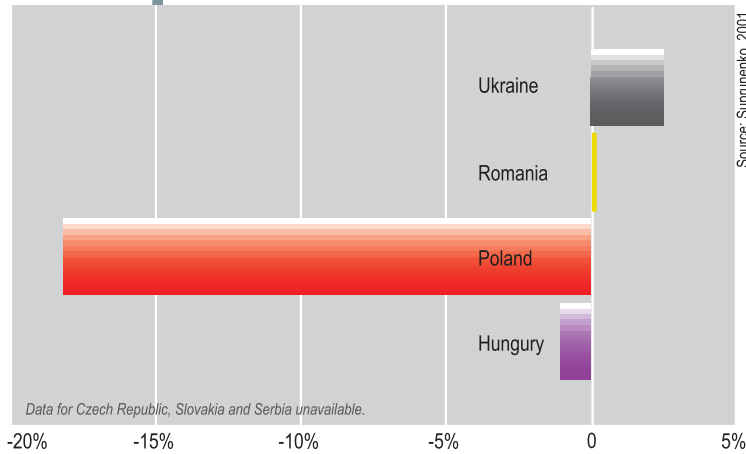


Figure 3.10 Increase/decrease in agricultural land in some Carpathian countries in the second half of the 1990s (data for Czech Republic, Slovakia and Serbia unavailable). (Suprunenko 2001)



quantitatively. Forest cover changes from 1987 to 2000 on the border between Poland and Slovakia confirmed that there was a net increase of the forest area over the last few decades in the Western Carpathians (Kozak et al. 2007). It has also been shown that the dynamics of land use change are dependent on elevation. Afforestation and deforestation processes were more rapid at lower elevations (up to 800 m above sea level) than at higher altitudes.

Today, the main factor governing land use in the mountain region is economics. Only in some areas, particularly the foothills, is agriculture a profitable activity. According to Delbaere and Nieto-Seradilla (2004), economic decisions are leading to an intensification of agriculture (see Figure 3.11). Economic gain forces farmers to intensify their activities and adopt practices resulting in large-scale production and specialization in one crop or animal product. Modern agricultural practices include mechanization, fertilization, excessive use of pesticides, herbicides and biotechnology, without assessing their negative consequences for landscapes, habitats and the species living on or near conventional agricultural areas (Suprunenko 2001).

Many examples of such farming practices can be observed across the Carpathians: excessive fertilization of ploughed fields in Poland with negative consequences on adjacent streams and rivers, large-scale farming in Slovakia and con-

sequent increased deforestation, high density of stock farming in the Ukrainian Carpathians with negative impacts on soil erosion processes, and use of biotechnology and GMO crop production in the Romanian Carpathians (Burdusel et al. 2005).

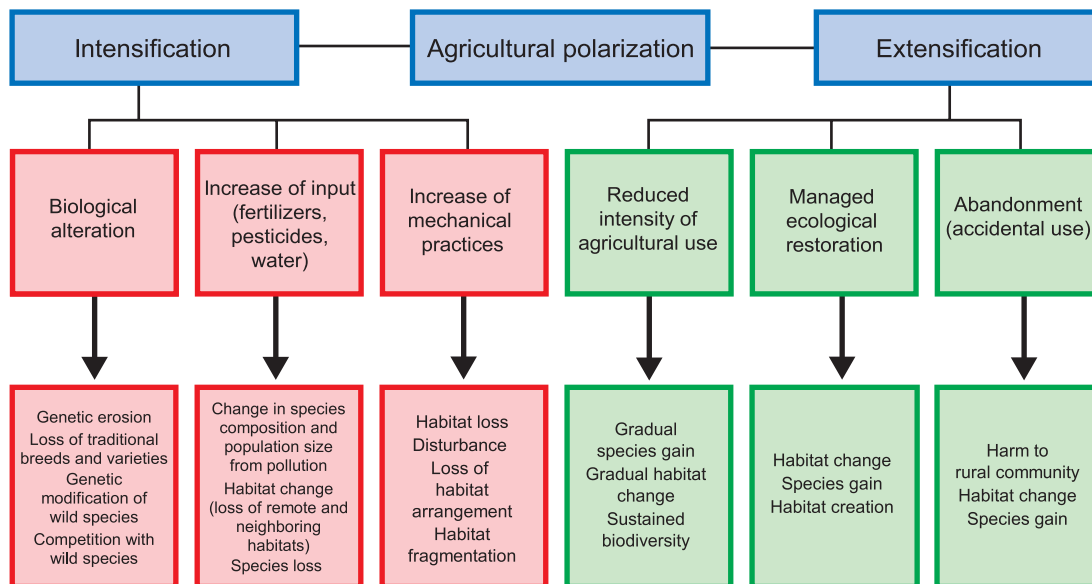
On the other hand, the “extensification” of land use (and land abandonment) is an opposite phenomenon, also driven by market forces (Figure 3.11). In recent years, many farmlands have been abandoned and become fallow in the Carpathians. The land may also be kept by the owner in a semi-abandoned state, neither formally abandoned nor cultivated, but simply kept available for future alternative use. This phenomenon can be observed on the Polish-Slovakian border and in the Romanian Carpathians, where lands are being set aside for tourism purposes (CERI 2001).

The abandonment of pasturage has particularly negative consequences for the environment. In some traditional grazing areas, cattle and sheep stocks are falling below the level required to maintain biodiversity-rich pastures and hay grasslands. Only in the Ukrainian Carpathians is the process of land abandonment limited, with farming being one of the most important responses to unemployment. Traditional agriculture and cattle breeding remain basic sources of food and fuel for local communities there.

Conversely, land abandonment had positive consequences on meadow-forest ecotone habitats, where the density and number of species increase due to the slow process of forest succession in open habitats. Following this process, forest species of high shade tolerance penetrate the ecosystem, slowly eliminating open habitat species. Such processes were observed in the Carpathians after the Second World War, when many Carpathian regions were abandoned.

Despite such tendencies, contemporary data suggest that both the processes of intensification and extensification of agriculture have overall negative impacts on the environment. In the Czech Republic, they have changed the landscape pattern and led to a decrease in landscape diversity (Lipsky 1996).

Figure 3.11 Some generalizations on the impact of agriculture on biodiversity (simplified scheme of Delbaere and Nieto-Serradilla 2004)



Traditional, extensive multi-functional small farm management is beneficial for biodiversity. Small farms and traditional farming practices are accompanied by more diverse landscapes, less intensive use of fertilizers, use of permanent meadows for hay and pasture, coppicing of trees for fuel wood, and afforestation of areas improper for agriculture (e.g. those with poor soils or

steep slopes). Some traditional small farms have been converted into organic farms, particularly in the Czech Republic and Hungary. This process is supported by the EU's Common Agricultural Policy (CAP), with financial aid directed to less favourable areas and agro-environmental schemes aimed at preserving biodiversity (see Policy Measures and Responses below).

## Threats and Impacts

### Tourism and recreation

One major change observed in the Carpathian Mountains is the development of residential property in the countryside by urban dwellers. Such developments now occupy many scenic slopes and valleys in the Carpathians, particularly where landscape planning is weak.

New investments in tourism and recreation are currently being made in many attractive areas in the Western Carpathians. Some of these facilities are nature-friendly, such as hiking and horseback riding, while many adverse effects of mass tourism are due to motorised recreation (e.g. quad

bikes) in the mountains. Overcrowded recreation areas may be found around the Tatra Mountains, Slovensky Kras or Pieniny Mountains in the Western Carpathians, as well as Retezat and Poiana Brasov in the Southern Carpathians.

Tourism attractions lead to increases in local resident populations and higher administrative status. For example, Slovak regions around the Tatra Mountains are now merged into one administrative town unit. On the Polish side of the Tatras, the small town of Zakopane has experienced a significant rise in the number of inhabitants, becoming a regional administrative centre. A similar trend of concentration of human settle-

ments is observed in other attractive mountain areas in the Hungarian, Polish, Romanian and Slovak Carpathians.

### Other pressures

In the second half of the 20th century, and particularly in the 1970s, large-scale pollution influenced habitats and species in the Western Carpathians. Heavy metal accumulation in soils and soil acidification were observed in many places. These processes influenced tree stands in large areas. A decrease in the annual increment of wood was recorded (Muzika et al. 2004), along with outbreaks of cambio-phagous (wood-eating) and phyllophagous (leaf-eating) insects (Witkowski et al. 1987).

Furthermore, the development of waterworks, particularly the Czorsztyn-Sromowce Niżne hydropower station, in one of the most scenic Carpathian historical landscapes near to the Polish-Slovakian border, induced ecological effects that are still being investigated and are contested in both countries.

New highway construction through the Carpathians is also proposed. Following Romania's EU accession, EU planners suggest implementing a new trans-national highway running from Estonia through Carpathian countries to Greece (see section 3.1 for more details), which would cross the Carpathians at least twice.

## Policy Measures and Responses

The Carpathians' high-quality landscapes and rich biodiversity evolved during a centuries-long process of gradual modification due to interaction between humans and nature. The resulting historical and biological heritage is one of the most vital in Europe. Carpathian peoples used their fields, meadows, pastures and forests in a sustainable way, maintaining high levels of landscape and species diversity. Their future prosperity and the preservation of mountain landscapes, habitats and species depend on the level of awareness and will to act of local communities, and the effective use of a number of available instruments.

EU directives are among existing instruments to achieve sustainable development in the region. Today, nearly 90% of the Carpathian area belongs to the EU. The EU's CAP is important for an emerging more environmentally-friendly agriculture. A crucial element of environmental policy within the CAP is Regulation No 1257/1999 including its later amendments. Within the first pillar of the CAP, which comprises traditional market support measures and new decoupled direct payments to farmers, the Agenda 2000 Reform of the CAP requires

member states to take appropriate environmental measures for agricultural production. Three policy instruments are available in this context: Codes of Good Farming Practice, Environmental Cross-Compliance and Agro-Environmental Schemes (European Environment Agency 2004).

Good Farming Practices will be a precondition for implementing agro-environmental schemes and for payments to Less Favoured Areas (LFAs). The cross-compliance scheme will be optional for new EU members. The third instrument – agro-environmental schemes – is among the most promising, particularly within LFAs and Natura 2000 areas. New forms of environment-friendly production schemes, including forest cultivation schemes and maintenance of rare and vanishing species (by farmers) will be considered in the future.

These funds supporting bio- and landscape diversity are administrated by Ministries of Agriculture, while environmental management duties are under the competency of Ministries of Environment. Therefore, the proper use of funds for agro-environmental schemes supporting Natura 2000 sites, habitats and species requires close

cooperation between two key ministries, along with preparation of precise management plans.

Another factor to take account of is national regulations which may support (or to the contrary neglect) mountain regions. Among the Carpathian countries, only Romania and Slovakia have specific mountain laws, geared to supporting mountain residents, their economies and environments.

The Carpathian Framework Convention is another major instrument that is devoted to the conservation and sustainable development of the Carpathian Mountains. The Convention has a particular value for Serbia and Ukraine, the only two Carpathian countries which are not EU members, as it facilitates their conducting close economic, social and environmental interactions with the Carpathian EU members.



© Piotr Krzan

## 3.4 Mineral Resources

**K**nowledge of the origins of mineral deposits, their history and methods of exploitation help to understand how mining activities affect the environment, and impact upon local and regional ecosystems. The effects of environmental pollution have become increasingly evident as extraction techniques, transport of and manufacturing from larger volumes of ore have been developed, while waste, tailings and slag dumps produced by these activities cover substantial areas, reducing productive land and spoiling the landscape.

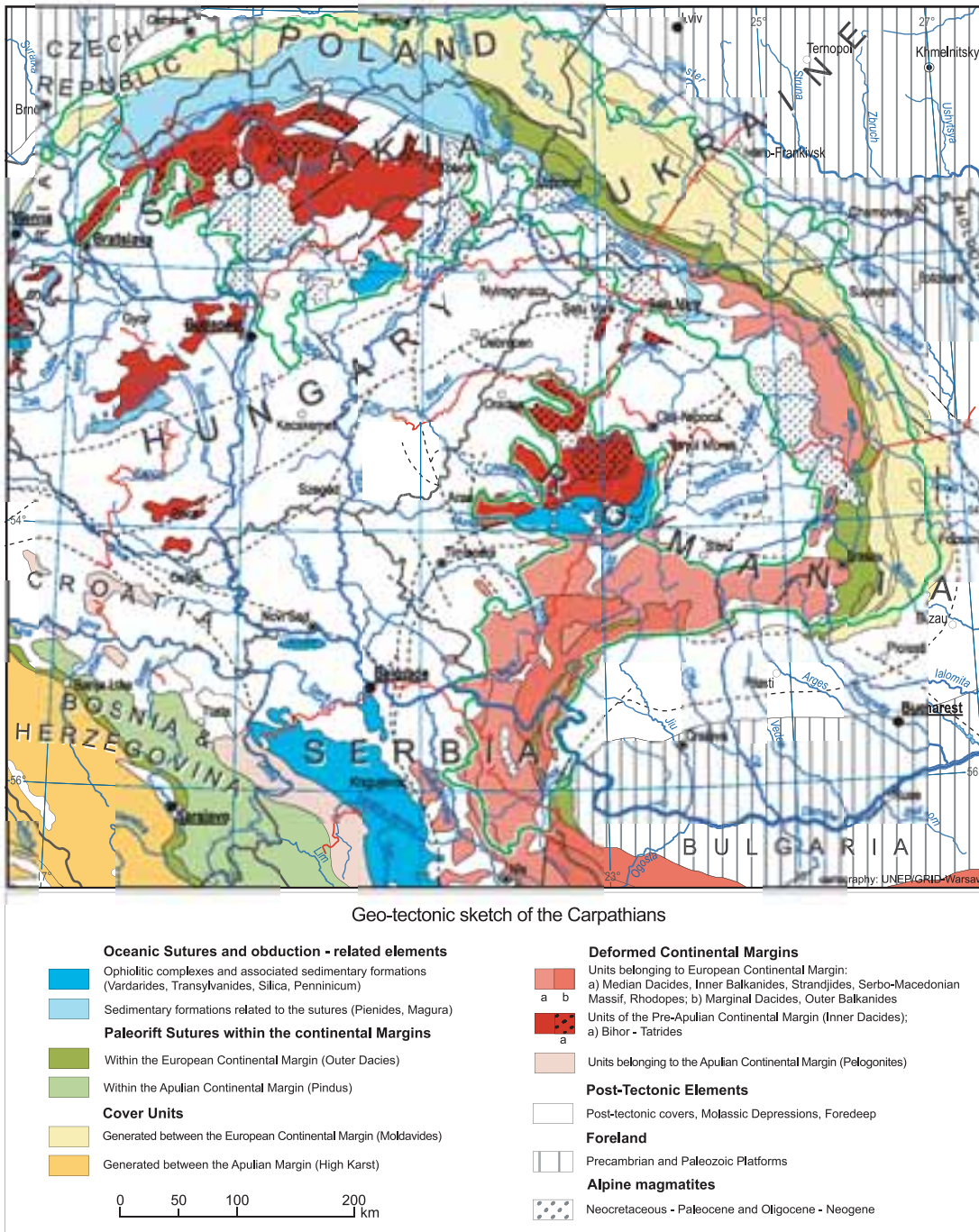
The first effects caused by mining sites date to antiquity, and have progressively expanded since feudal times. In the 19th century, the exploitation of industrial minerals, coal and hydrocarbons became very common, and such activities have continued to expand, but at a slower rate up to the present day. They affect nearly all of the abandoned mining areas called 'remnant pollution zones'. Under communist systems based on centrally planned economies (1950-2000), intensive, brute-force exploitation methods were used in the Carpathian region, even on deposits without economic value. As the number of processing plants and metallurgical centres increased, so did the waste, plant-released tailings

and slag dumps. In the meantime, the exploration and exploitation of old, abandoned deposits situated in traditional regions was resumed, and new sites were identified in other areas, increasing overall mining activity in the region and inducing greater pollution.

After 2000, strong environmental protection measures in line with European norms were put in place. Physical changes (modifications of the land morphology and landscape) and chemical ones (soil, water and air pollution and contamination by noxious elements) have led to degraded biological conditions, sometimes inducing labour out-migration, or even abandonment of settlements. Such cumulative negative effects engendered so-called "critical environments" – habitats already modified beyond their rehabilitation capacity, or on their way to being gravely or irreversibly modified by human activity.

Mining activities seriously modify the environment, which may then no longer sustain current levels of resource exploitation; hence, human health and even lives can be jeopardized (Kasperson et al. 1995). In the last period of intensive/excessive and selective mineral exploitation, the habitats of several zones in the Carpathian region

Map 3.7 Geo-tectonic sketch of the Carpathians



were critically degraded. In time, some of the toxicity was reduced and these areas were assimilated to remnant pollution zones, where poisonous materials remained two or three times above permissible standard values. Currently, when the richest parts of ore deposits are exhausted, future exploitation projects mainly target ore deposits with low contents, exploitable in open pits. In this situation, disputes between

opposing interests – mining companies versus governmental agencies and non-governmental organisations for environmental protection – may become more serious.

The Carpathian fold belt (Map 3.7) originates in Cretaceous (135-65 million years ago) and Tertiary (65-1 million years ago) tectogenetic events. Within this belt, Precambrian and Palaeozoic



metamorphic and magmatic rocks, as well as Upper Palaeozoic, Mesozoic and Tertiary sedimentary rocks resulted from several crustal deformations. Magmatic activities – intrusions and extrusions – occurred in different areas during the entire Carboniferous-Neocene time span. Above the Cretaceous-folded Inner Carpathian units, two important Tertiary post-tectonic basins were formed: the Pannonian Basin and the Transylvanian Basin, which overlap the so-called 'Inner Carpathian' structures.

Within the Carpathian region, Precambrian, Palaeozoic, Mesozoic and Tertiary (including Quaternary) formations contain a large variety of mineral resources: metalliferous, radioactive and industrial mineral ores, coal and hydrocarbon deposits. The genesis of these deposits is mostly magmatic and sedimentary, but metamorphic processes are also involved. The spatial and temporal distribution of the mineral deposits is strictly connected with their origin, size and morphology (see the box below).

### Typology of mineral resource occurrences in the Carpathians

Taking into account the nature and origin of mineral deposits in the Carpathian area, the following chronostratigraphical classification can be used:

*Precambrian metamorphic and magmatic formations:*

- metalliferous ore deposits: ferrous, base metals and gold-bearing ores: iron (Fe), manganese (Mn), copper (i+Cu), cobalt (Co), lead-zinc (Pb-Zn), gold-silver (Au-Ag);
- radioactive ore deposits: radon-thorium (Rn-Th); and
- industrial mineral deposits: graphite, cyanite, andalusite and garnet.

*Palaeozoic metamorphic, magmatic and sedimentary formations*

- metalliferous ore deposits: ferrous (iron – Fe, manganese – Mn, chromium – Cr, nickel – Ni, cobalt – Co), copper (Cu±Mo; Py-Cu), base metals (Cu, Pb, Zn±Py±Au-Ag±Sn) and antimony (Sb) ores;
- radioactive ore deposits: uranium (U, U-TR);
- industrial mineral deposits: feldspar, mica, quartz, pure quartz, beryl, spodumene, magnesite, talc, asbestos, barite, aragonite; and
- coal deposits: black coals.

*Mesozoic magmatic and sedimentary formations*

- metalliferous ore deposits: ferrous (Fe, Mn, Cr), copper (Cu+Fe, Cu+Mo) and tungsten-molybdenum (W-Mo) ores, basic metal ores (Cu, Pb, Zn) and gold-bearing ores (Au-Ag);
- radioactive ore deposits: U, U-TR;
- industrial mineral deposits: bauxite, bentonite, aragoni-

te, glauconite, phosphates, flint clay, and propylite; and

- coal deposits: black coals.

*Tertiary magmatic and sedimentary formations*

- metalliferous ore deposits: gold-bearing ores (Au-Ag; Py-Au; Pb-Zn±Au-Ag), copper-gold-bearing ores (Cu±Au-Ag±Mo), base metal ores (Cu, Pb, Zn), mercury, stibium ores (Hg±As-Py), ferrous ores (Fe, Mn) and titanium-zirconium (Ti-Zr) accumulations;
- radioactive ore deposits: U-Cu;
- industrial mineral deposits: rock salt, potash salt, anhydrite, kaolin, bentonite, diatomite, phosphates, glauconite, flint clay, alabaster and celestite;
- coal deposits: black coals, brown coal and lignite; and
- hydrocarbon-bearing rocks: bituminous clays and bituminous silicolites, clay and marls.

*Quaternary to actual*

- alluvial formations, thermal-mineral springs; and
- metalliferous ore deposits and industrial mineral deposits: gold (Au), iron (Fe), titanium (Ti), Zr±Fe, sulphur (S), boron (B), phosphorus (P), and garnet.

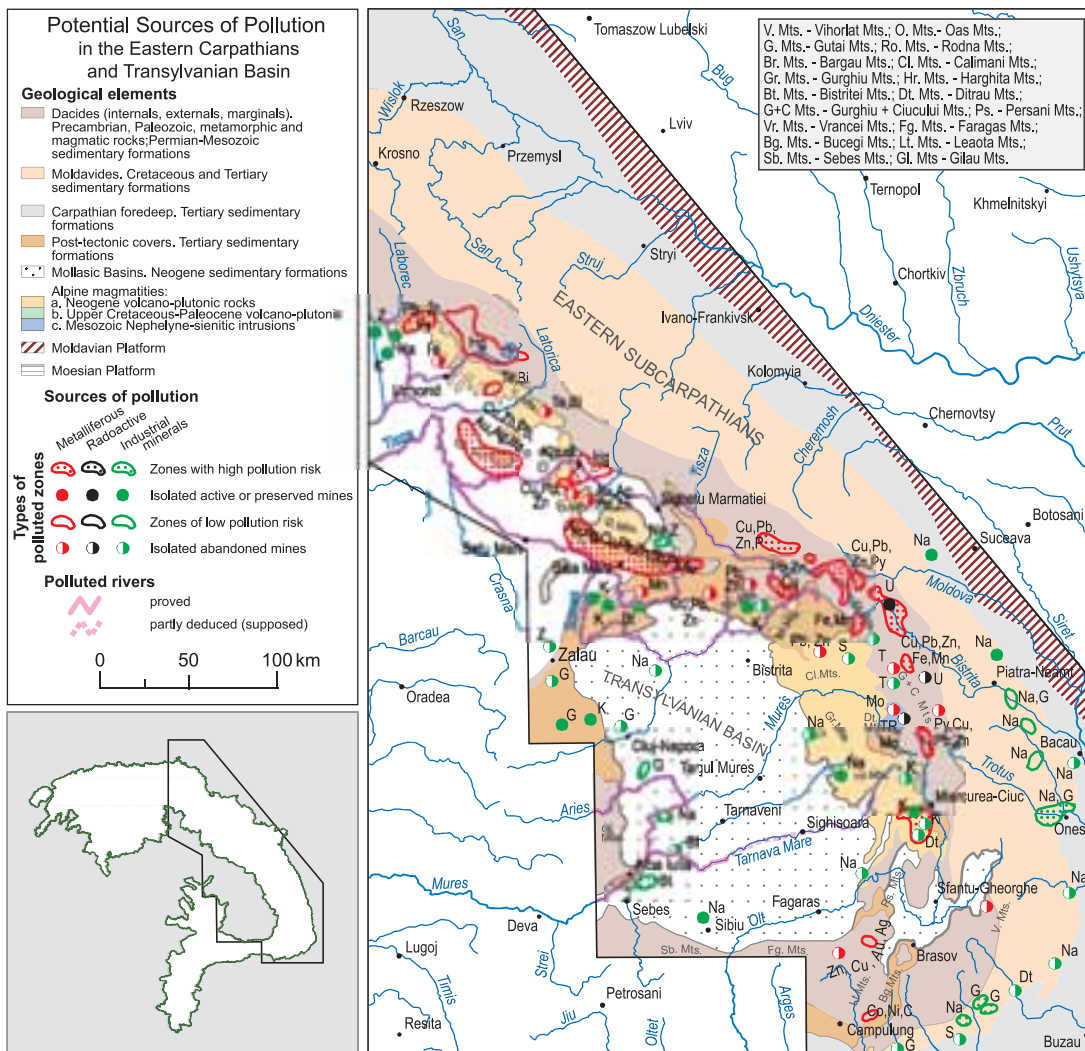
Some of these deposits may be identified within the major Carpathian geological units, cropping out or covered by younger formations (mine fields, districts or zones, coal basins or hydrocarbon fields). Usually, such areas show a dense agglomeration of different stages of exploration and/or exploitation. In many situations the ores have been intensely mined in their rich segments, and even depleted.

## Metalliferous Ore Deposits

High pollution risk regions showing the greatest density and diversity of active pollution sources, as well as latent pollution regions, are located in the central and northwestern part of the Eastern Carpathians, western and south-central part of the Apuseni Mountains, Western Carpathians and western and southwestern parts of the Southern

Carpathians. The Pannonian Basin and the Transylvanian Basin are only polluted in marginal areas. Advanced pollution may be found in regions where there is a great diversity of mineral resources, further enhanced by the activity of associated plants and particularly by the toxic effect of the resulting waste. Although after 2000

Map 3.8 Potential Sources of Pollution in the Eastern Carpathians and Transylvanian Basin



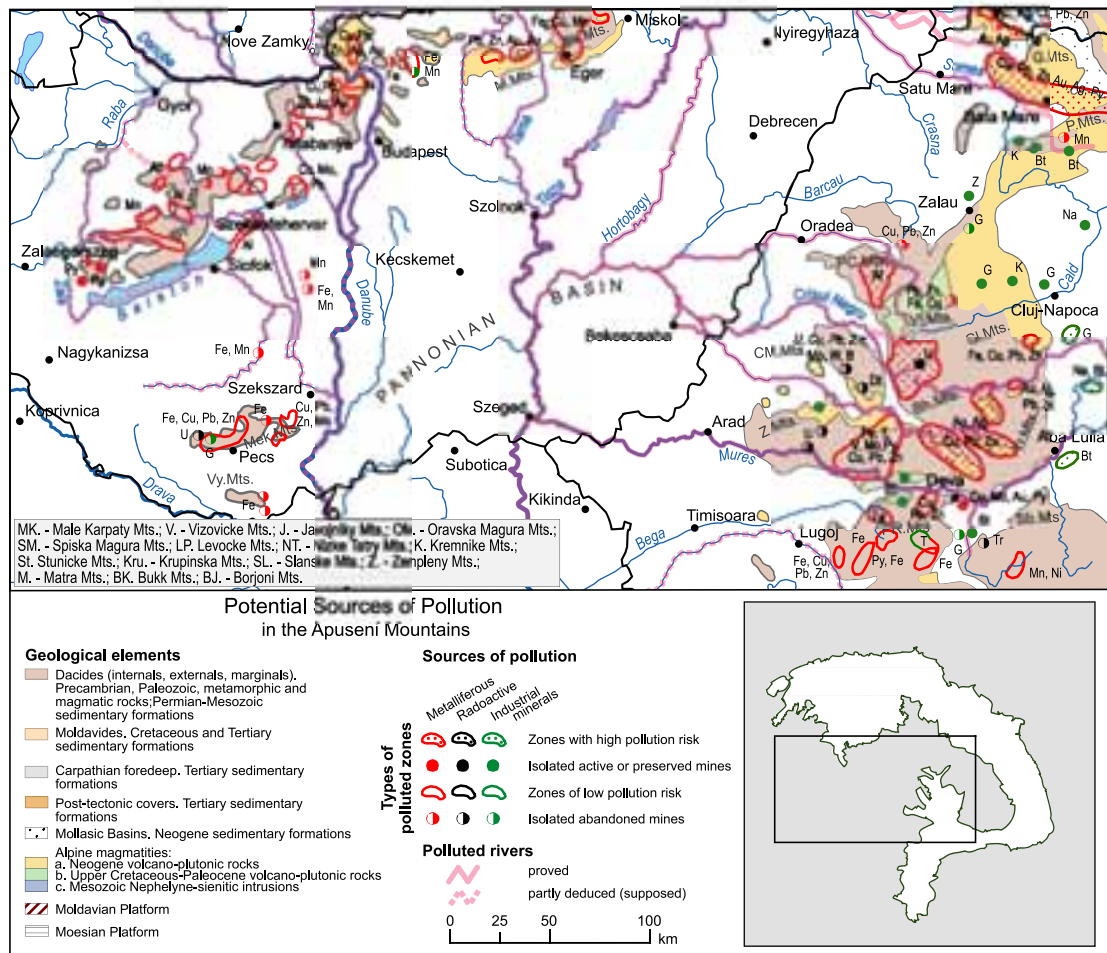
the majority of such mining sites were closed down or subject to conservation regimes, the pollution process persists, sometimes actively, because of large mining and industrial waste deposits drained by waters or carried by the wind.

Normally, evacuated acid mine waters contain micronic and sub-micronic elements, as well as metal ions (chromium, copper, manganese, nickel, zinc, uranium), calcium, barium, chlorides and sulphates in various proportions, depending on sources. Degraded wastewaters from ore dressing activities contain similar impurities – cyanides, phenols, xanthates, reagents, frothers, oil, etc. Large volumes of contaminated acid mine waters and degraded wastewaters are evacuated in streams, spreading within the respective drainage basins and having harmful

consequences for the natural environment. The air surrounding the exploitations and the ore dressing and metallurgical plants is impure, with particle emissions (rock particles from extraction and ore preparation activities) and gaseous emissions produced by explosions in mining extraction works and vapours containing metal oxides from metallurgical plants. In periods of maximum activity, estimated losses were of 50-60 kg/t of lead, about 75kg/t of zinc, 60 kg/t of copper, accompanied by significant amounts of tellurium, phosphorus, mercury, cadmium and hydrogen sulphide H<sub>2</sub>S.

The soil constitutes the main receptor of mining contamination by the infiltration of mine waters and degraded industrial wastewaters, as well as sedimentation of particles from the air, in the

Map 3.9 Potential Sources of Pollution in the Apuseni Mountains and Pannonian Basin

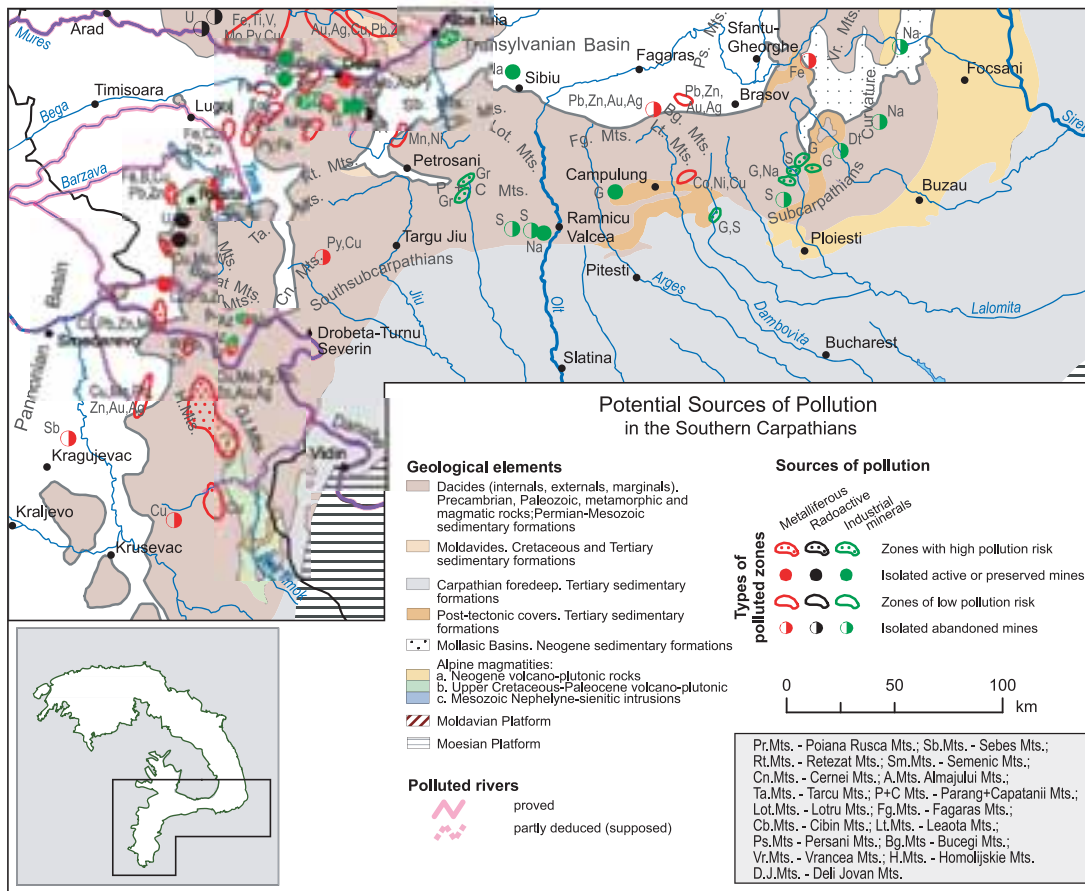


form of aeolian deposits on soil, water and vegetation. These deposits increase the soil's content of highly toxic chemicals (Pb, Cu, Zn, Mn, Hg, Cr, Cd, B), especially in close proximity to manufacturing sources. Their negative effects are propagated in the associated biotope, and sometimes even in the upper levels of underground waters. Among pollutants, residual water has proven to be the most polluting agent, with the greatest transport and contamination capacity through the extended river network. The Danube River, recipient of most watercourses coming from the Carpathians, contains approximately 2-5 parts per billion (ppb) cadmium, 20 ppb copper, up to 100 ppb zinc, 50 ppb manganese, 20-51 ppb lead and 50 ppb nickel before reaching the Black Sea. These values correspond to class II-IV waters (see section 3.5 for more details).

In the Eastern Carpathians (Map 3.8), pollution is largely due to poisonous substances released

by mining and industrial waste deposits that derive from predominantly poly-metallic and ferrous ores (resources in the Rodna Massif, Maramureş, Bistriţa and Giurgeu-Haşmaş Mountains), as well as gold-bearing and poly-metallic ores from resources in the Vihorlat Mountains, Vyshcovo-Beregovo trans-Carpathian zone (where before 2002 allowed air pollution limits were often surpassed by 16 times for lead and 10 times for cadmium) and the Oaş-Gutâi Mountains. High levels of polluting substances released by mining exploitations and industrial preparation activities (such as copper, lead, zinc and cadmium) contaminate Carpathian environments. After 2002 and until the present day, the situation has slowly improved: the concentration of toxic elements (Cu, Pb, Zn, Cd, Mn, Cl and cyanides) in the Tisza's tributaries (Mureş, Someş, Tur, Latoriţa etc.) from the source area up to Miskolc rarely exceeds imposed limits (or does so only in the areas near to sources). The

Map 3.10 Potential Sources of Pollution in the Southern Carpathians



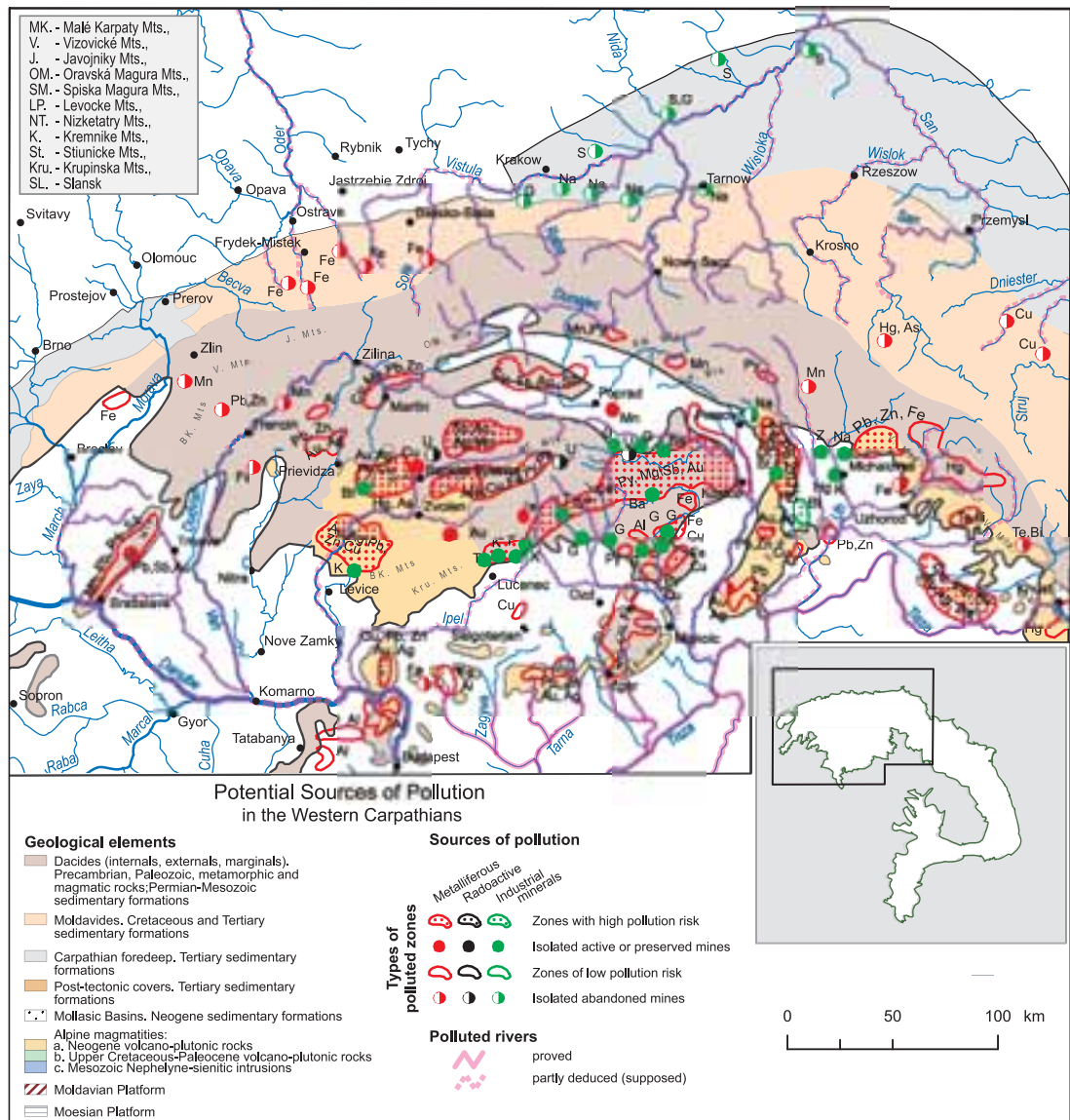
same level of pollution risk exists in the air and soil, where preparation and metallurgical plants are being operated, as in Baia Mare or Vyshcovo-Beregovo areas.

In the Apuseni Mountains (Map 3.9), the degree of pollution and its environmental effects are comparable to the ones mentioned in the Eastern Carpathians. Highly polluted regions are the gold-bearing mining districts with poly-metallic gold and copper sulphide ores in the Metaliferi Mountains and poly-metallic and uranium ores in the Bihor Massif. These areas have experienced severe environmental pressures until 2000, with lower pollution intensity nowadays. The drainage basins corresponding to the Crişul Repede, Crişul Negru, Crişul Alb and Mureş rivers show pollutant values that fluctuate within permitted limits, but appreciably higher (over twice the limit) in the vicinity of pollution sources (e.g. Zlatna was under the influence of extreme pollution levels until 2002). The Roşia Montană project of gold-bearing pyrite exploita-

tions may represent an unprecedented risk in the mining history of the Carpathian space. There, the destructive effects of environmental degradation (morphological and landscape changes, contamination of soil, biotopes and surface and ground waters), accompanied by predictable long-term severe socio-economic consequences, are currently and in the future will be very difficult to deal with.

In general, the Southern Carpathians are less impacted by mining pollution (Map 3.10). The most polluted areas are only located in the surroundings of the Bor settlement. The main contamination sources are the mining of copper-bearing and poly-metallic ores, their industrial preparation and metallurgy, as well as resulting waste deposits. Copper-bearing exploitations of Banat, and the poly-metallic and ferrous mines at Poiana Ruscă, though nearly closed down, pollute through mining activities and industrial waste deposits; the main pollutants identified in water and soil in these areas are heavy metals,

Map 3.11 Potential Sources of Pollution in the Western Carpathians



with concentration values slightly exceeding permissible limits, and somewhat higher in the Moldova Nouă-Ciclova-Oravița zone.

The Western Carpathians (Map 3.11) represent the largest Carpathian mining region. As a consequence, numerous and vast mining and industrial waste deposits are found in the region. The type and quantitative distribution of pollution agents vary regionally. The central zone (Slovenske Metalliferous Mountains) is dominated by copper-bearing, ferrous and poly-metallic ores, along with gold, silver and antimony deposits; the eastern marginal zones (Slanske Mountains and Zemplény Mountains), and western (Krupin-

ska Mountains, Štiavnicke Mountains, and Kremnicke Mountains) and southern zones (Borjoni and Mátra Mountains) are characterized by the presence of gold-bearing poly-metallic deposits and gold-silver deposits. Many of these areas experienced extreme pollution levels in the 1945-2000 period. Unlike other parts of the Carpathians, this region is characterized by much larger-scale mining, along with corresponding industrial activities and significant pollution levels.

In the Pannonian Basin (Map 3.9), the Danube and Tisza Rivers, together with their tributaries (the Sarvis, Tarna, Eger, Sajó, Someș, Crișul

Repede, Crişul Negru, Mureş and Timiş) form water corridors polluted by heavy metals, cyanides and various other substances with variable contents, usually small but still beyond permissible levels. Pollution may also be significantly increased through human errors and natural events, as demonstrated by past events (e.g. the cyanide spill at Baia Mare in January 2000).

Only in some marginal mining areas and areas with industrial waste deposits resulting from bauxite preparation and metallurgy, fluoride gases and saline emissions (sulphur dioxide, tar and other detrimental powders) may exceed permissible limits and greatly affect the ecosys-

tem. The same situation is seen on the eastern boundary of the Crişul Repede River, close to the city of Oradea, where pollution is mainly due to ore dressing waste coming from the preparation of bauxites extracted in the Pădurea Craiului Mountains (Apuseni range).

The Transylvanian Basin (Map 3.8) presents a single active pollution source, the lead/zinc metallurgy plant at Copşa Mică, with large negative impacts on the area due to important metal ion emissions. The emissions are two or three times higher than permissible limits, with noxious elements dispersing into the land, soil and water, especially the Târnava Mare River.

## Radioactive Ore Deposits

The extraction and processing of uranium ores represent increased environmental pollution hazards. Air and water are vectors for rapid dissemination of radioactive elements, with a significant impact on the areas surrounding the extraction and processing works. The environment can easily be contaminated with nearly all the elements of the uranium family. In the Carpathian region, the main uranium deposits are found in the Apuseni Mountains (Bihar and Drocea massifs), Southern Carpathians (Banat Mountains) and Eastern Carpathians (Bistriţa Mountains). The degree of natural uranium, radium226, radium222, radon and thorium pollution may be two or three times higher than

permissible limits. Current pollution sources are primarily massive wastes dumped from old extractions, rather than current exploitations of ores and radioactive metals. According to estimations, a volume of some 5 million cubic meters of uranium material covered up to 140 hectares during 2000-2001. The contamination is perpetuated by radioactive polluted mine waters and liquid and solid radioactive wastes, as well as gas emissions with powders and aerosols released by the Feldioara preparation station. These elements represent a major source of radioactive contamination in this area, requiring permanent surveillance and mitigation/recovery activities and measures.

## Industrial Mineral Deposits

With the exception of salt deposits and related preparation installations, the impact of these sources is less intense, affecting areas situated in close proximity to mining extraction and preparation sites. The exploitation of industrial mineral deposits (gypsum, bentonite, zeolite, barite, sulphur, kaolin, talc, etc.), dispersed unevenly in

many parts of the Carpathian Mountains (see Maps 3.8 to 3.11), has mainly led to changes in terrain morphology due to numerous excavations, and deposits of sterile waste and removed surface material. In most cases, pollution occurs due to raw material preparation processes and complex physical and chemical methods of pu-

rification. These effects result in the accumulation of large volumes of industrial waste, with moderate impacts on soil (through waste dumps and discharges), air (with small colloidal dispersions) and water (with tailings and floating reagents). The exploitation of salt deposits can have severe consequences. The underground voids cause irregularities of the surface, sometimes associated with brine outflows that have a serious impact in the vicinity of, or within neighbouring localities. At the same time, the exploitation of

salt also modifies the chemistry of groundwaters – the fluorine content of phreatic waters being up to three times higher than permissible values. Environmental pollution caused by preparation activities related to major deposits only exceeds established limits when/where accidents occur. Such situations are characteristic of salt deposits in the eastern and southern sub-Carpathian areas of the Eastern Carpathians and the peripheral zone of the Transylvanian Basin, the only regions where Carpathian salt is exploited.

## Coal Deposits

Regional coal deposits are found in Upper Carboniferous formations (in the Southern Carpathians), Lower Jurassic formations (Southern Carpathians – Banat, Pannonian Basin, Apuseni Mountains), Oligocene deposits (Petroșani Graben in the Southern Carpathians, as well as in the northeastern part of the Transylvanian Basin and northern Pannonian Basin), and Neocene deposits (Southern and Eastern sub-Carpathians, as well as the Transylvanian and Pannonian basins) (see Map 3.12). The Palaeozoic, Jurassic and Palaeocene coal deposits are in some cases (e.g. in the Southern Carpathians) anthracite coal formations of small importance.

Pollution related to coal mining processes may be summarized as follows:

- important wind transport of dust generated by open quarries;
- pollution of the aquiferous levels generated in operational or closed mines;
- pollution of surface waters which may be contaminated by rain, mostly in open quarries, but also by dumps of active or closed mines;
- important changes of the landscape and relief in areas of open quarries; and
- large disturbances of roads in areas where coal transport takes place.

## Hydrocarbon Fields

Hydrocarbon deposits are found in the Carpathian and sub-Carpathian areas in Palaeocene and Neocene formations of the Outer Eastern and Western Carpathians, Eastern and Southern sub-Carpathians, as well as in the Transylvanian Basin and the eastern part of the Pannonian Basin (see Map 3.13).

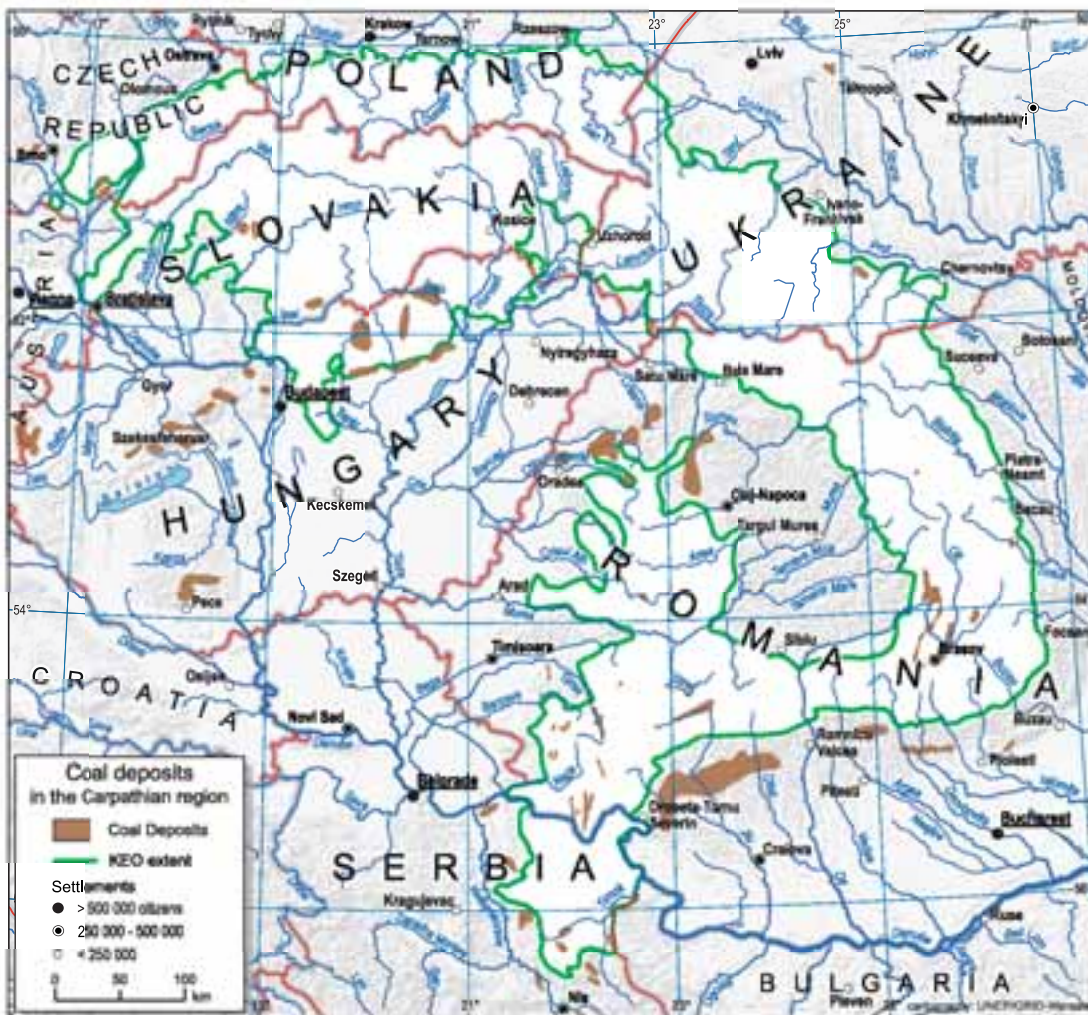
The Outer Eastern Carpathians (Moinești area) and the Eastern (Buzău-Moreni area) and Southern (Pitești-Târgu Jiu area) sub-Carpathians have the largest share of oil and gas fields in the Carpa-

thians. Less important oil and gas fields are also found in the Outer Western Carpathians (Vienna Basin, Eastern Polish and Ukrainian Outer Carpathians), as well as the Eastern Pannonian Basin (in the western part of the Apuseni Mountains). The most important gas fields are in the central part of the Transylvanian Basin.

Pollution connected to the hydrocarbon deposits relates to:

- prospecting and operational drillings, in the case of technical errors;

Map 3.12 Coal Deposits in the Carpathian region



- oil processing, with the largest impact on the environment (air, soil and water);
- oil storage, which may also accidentally damage the environment;
- accidents that occur during drilling and may cause great damage to the environment (mud-slides, fires, destruction of agricultural crops and/or forests) in the case of errors;
- accidents occurring during the transport through pipelines due to technical or human errors.

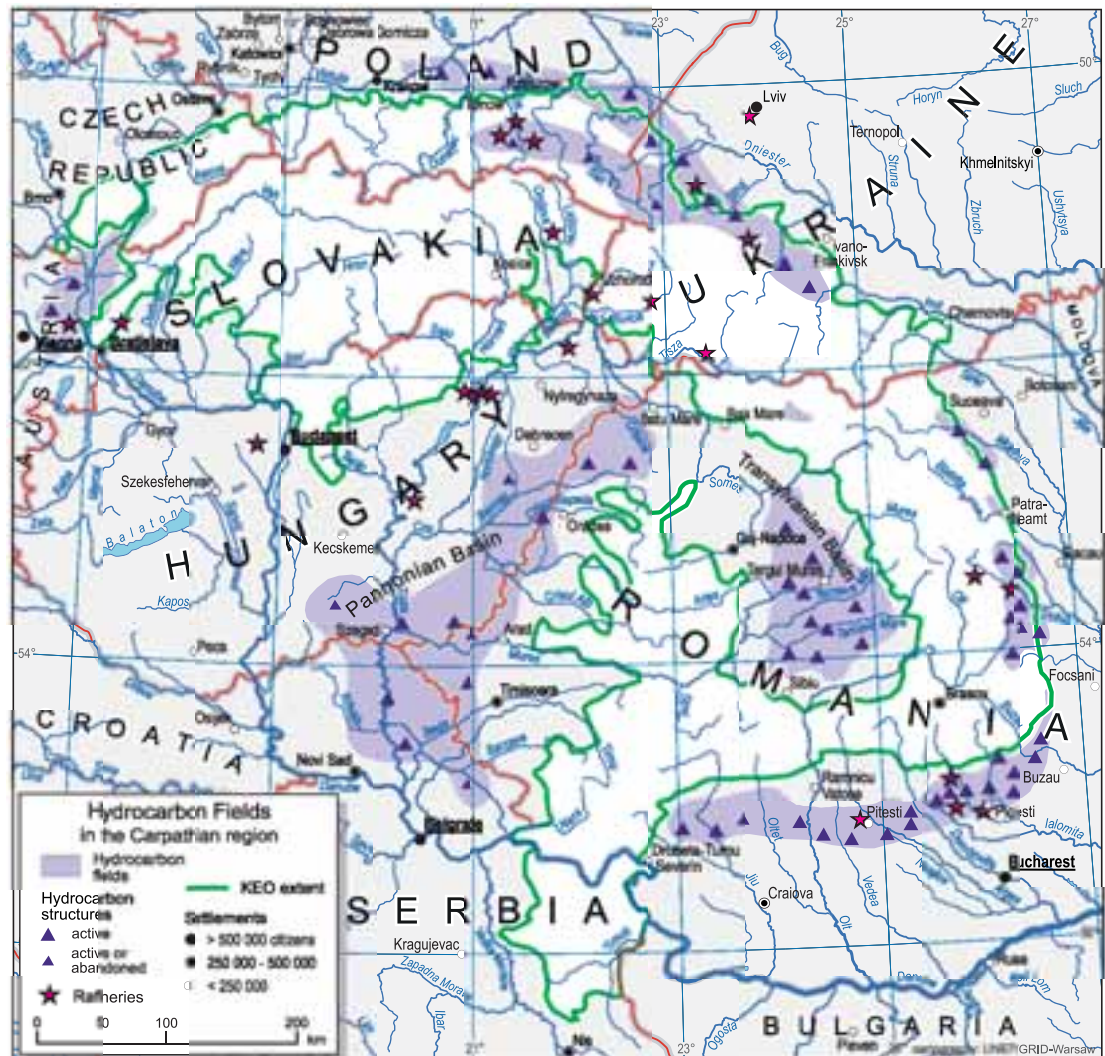
## Policy Measures

The pollution of the Danube, Tisza and other rivers caused by the cyanide spill following a dam break at a tailings pond in Baia Mare, Romania, has increased public awareness of the environmental and safety hazards of mining activities. The Baia Mare accident showed that

the level of public knowledge and understanding of risks inherent in mining and related industrial processes was very low in the region. It also showed that there was insufficient communication between the various levels of officialdom and between these authorities, non-governmental



Map 3.13 Hydrocarbon Fields in the Carpathian region



organisations (NGOs) and the public concerning emergency preparedness, emergency response and damage prevention options and possibilities (EC 2000).

Within the Carpathian EU member states, there are a number of existing EC legal instruments which address the environmental aspects of mining activities intended to prevent such disasters:

- Council Directive 85/337/EEC (as amended by Council Directive 97/11/EC) on the assessment of the effects of certain public and private projects on the environment requires an environmental impact assessment of a large number of economic activities, including mining activities and dams, in the case such activities are

likely to have significant impacts on the environment.

- Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances (Seveso II Directive) aims at the prevention of major accidents which involve dangerous substances and the limitation of their consequences for humans and the environment.

- Directive 99/31/EC on the landfilling of waste contains a number of requirements which are relevant to waste management in connection with mining activities:

- The location of the landfill must take into consideration the distance from groundwater or superficial water and the risk of flooding, subsidence, landslides or avalanches.
- Appropriate measures must be taken to

control water from precipitation and prevent it from entering into the landfill body.

– The emplacement of waste on the site must be done in such a way to ensure the stability of the waste and the associated structures, particularly to avoid slippages.

▪ Council Directive 96/61/EC concerning integrated pollution prevention and control (IPPC Directive) covers the overall environmental impact of the production process; i.e. air, water and soil pollution, generation of process residues, etc.

Further to recent mining accidents, including the cyanide spill at Baia Mare, the Directive 2006/21/EC on the management of waste from extractive industries was adopted to prevent adverse effects on the environment, in particular water, air, soil, fauna and flora and landscapes, and any resultant risks to human health brought about as a result of the management of waste from mining activities, and to minimise the risk of accidents.

## Conclusions

Qualitative and quantitative analyses of environmental pollution due to mining activities in the Carpathians show that the region faces serious problems and potential dangers, primarily due to the toxic action of mine wastes from old and currently active mines, mine tailing dam failures, dumps and tailing dams and ponds, slag dumps from metal smelting plants and tailings from oil and gas refining. Industrial activities related to the extraction and preparation of mineral resources produce large volumes of pollutants of various types, susceptible to rapid dispersion across the region, and dissemination in water-courses, air and soil. Natural disasters and technological accidents may also trigger unprecedented consequences for the environment.

The mining sector is an important contributor to local and national economies in the Carpathian countries, but is often characterised by inappropriate planning, and operational and post-operational practices taking place within inadequate regulatory frameworks. A set of key measures could be developed and applied under a programme convened and monitored by a common body for the entire Carpathian region. Such a regional-scale programme could involve the following steps:

- Preparation of a cadastral inventory, periodically updated, of all the mentioned storage site failures, supplying information on the location, size, volume, composition, stability and risks posed by these deposits.

- Periodic preparation and publication of special maps (scale 1: 1000000), mandatory for all Carpathian countries, marking the types of mineral resource accumulations (with operational activity stages), as well as mining and plant failures.
- Stimulation of scientific and technological research in order to neutralise pollution sources and rehabilitate environmental factors through:
  - Increasing the stability and compactness of dumps and tailings by physical and chemical procedures, by vegetation or other methods;
  - Processing of dumps and tailing failures with a view to recovering useful elements and substances (copper, lead, zinc, iron, titanium, tungsten, chromium, nickel, gold, silver, mercury, arsenic etc.), along with minor elements (cadmium, indium, gallium, germanium) and industrial minerals (feldspar, quartz, garnets, boron, etc.);
  - Decontamination of residual mine waters;
  - Reduction of pollution from ore metallurgy.
- Promotion of environmental rehabilitation through:
  - Converting abandoned waste deposits and quarries into useful land uses (for agriculture, forestry, fisheries, septic pockets, industrial and residential areas, cultural and recreational areas and even tourist attractions).
- Prevention of mining pollution through:
  - Review and improvement of environmental protection laws and their implementation in the Carpathian countries;
  - Involvement of specialized institutions and

research centres as consultants in technical-scientific decision-making;

- Adoption of special protection measures for subterranean aquifers, with a view to present and potential climatic conditions and future length of drought episodes; and

- Organisation of a monitoring network (similar to the meteorological one) for high-pollution risk zones, with surveillance points to periodically check water, soil and air pollution levels and/or in cases of natural disasters.



## 3.5 Water Resources

In the Carpathians, water resources are a key factor for development, in particular for agriculture, fisheries, industry and power generation, tourism and direct human consumption. Favourable climatic and hydro-geological conditions offer plentiful fresh water resources supporting fundamental needs of human well-being and natural life in the Carpathian region, as well as in adjacent areas.

This section deals with qualitative and quantitative water resource availability and use, although for the latter very limited data exist, particularly on the Carpathian region alone.

Herein, the method used to establish overall water balance is based on long-term measurements of rainfall and evapotranspiration values and on the assessment of surface and groundwater runoff. Surface water resources are usually computed by measuring or assessing the total annual river flow of a country. The groundwater part of the water balance has been quantified on the basis of hydrographic separation, lysimeter measurements and river runoff analysis. There is an overlap in the volume of water resources common to both surface and groundwater. Two types of exchanges produce this overlap: the contribution of aquifers to surface flow and the recharge of aquifers by surface runoff (see Table 3.7).

### Main Quantitative Data on Surface Waters

Due to the difficulty to divide the groundwater component of each geographical sub-unit (mountains, hills and plains), national water balances for the seven Carpathian countries are synthesized in Table 3.7. For evaluating

Carpathians' river resources (row 3 in Table 3.7), the mountainous area ( $\text{km}^2$ ) of each country was multiplied by the surface runoff modulus (specific water renewal yield; liter per second ( $\text{l/s}$ )  $\times \text{km}^2$ ).

**Table 3.7 Main quantitative data on water resources in the Carpathian countries  
(average annual values 1977-2001)**

Characteristics	Czech Republic	Poland	Slovakia	Hungary	Ukraine	Romania	Serbia
Internal renewable resources, m <sup>3</sup> /year	13	66	15	12	70	50	45
Surface water produced internally, km <sup>3</sup> /year	13	53	13	6	50	42	42
Surface resource in the Carpathians, cubic km/year	1.5	5.0	12.2	1.8	5.7	23.3	2.1
Groundwater recharge, cubic km/year	1	13	2	6	20	8	3
Overlap, cubic km/year	1	12	2	6	17	8	1
Total internal renewable resources (TIRR) cubic km/year	13	54	13	6	53	42	44
TIRR per capita <sup>1</sup> , cubic meters	1,283	1,391	2,330	608	1,091	1,894	4,182
Natural renewable resources (NRWR), cubic km/year	13	62	50	104	140	212	209
NRWR per capita <sup>2</sup> , cubic meters	1,283	1,598	9,265	10,541	2,868	9,486	19,815
Total water withdrawals, cubic km	2.7	12.3	1.8	6.8	26.0	26.0	13.0
Withdrawals (%) of actual resources	20.7	20.1	3.6	6.3	17.4	12.0	6.2

Source: earthtrends.wri.org/pdf/library/country\_profiles

1. At the level of 2001. 2. Using national population data for 2002.

Surface water resources in the Carpathians total 51.6 cubic km/year, the national breakdown of which is 1.5 in the Czech Republic, 1.8 in Hungary, 5.0 in Poland, 23.3 in Romania, 2.1 in Serbia, 12.2 in Slovakia and 5.7 in Ukraine).

## Main Surface Rivers and Reservoirs

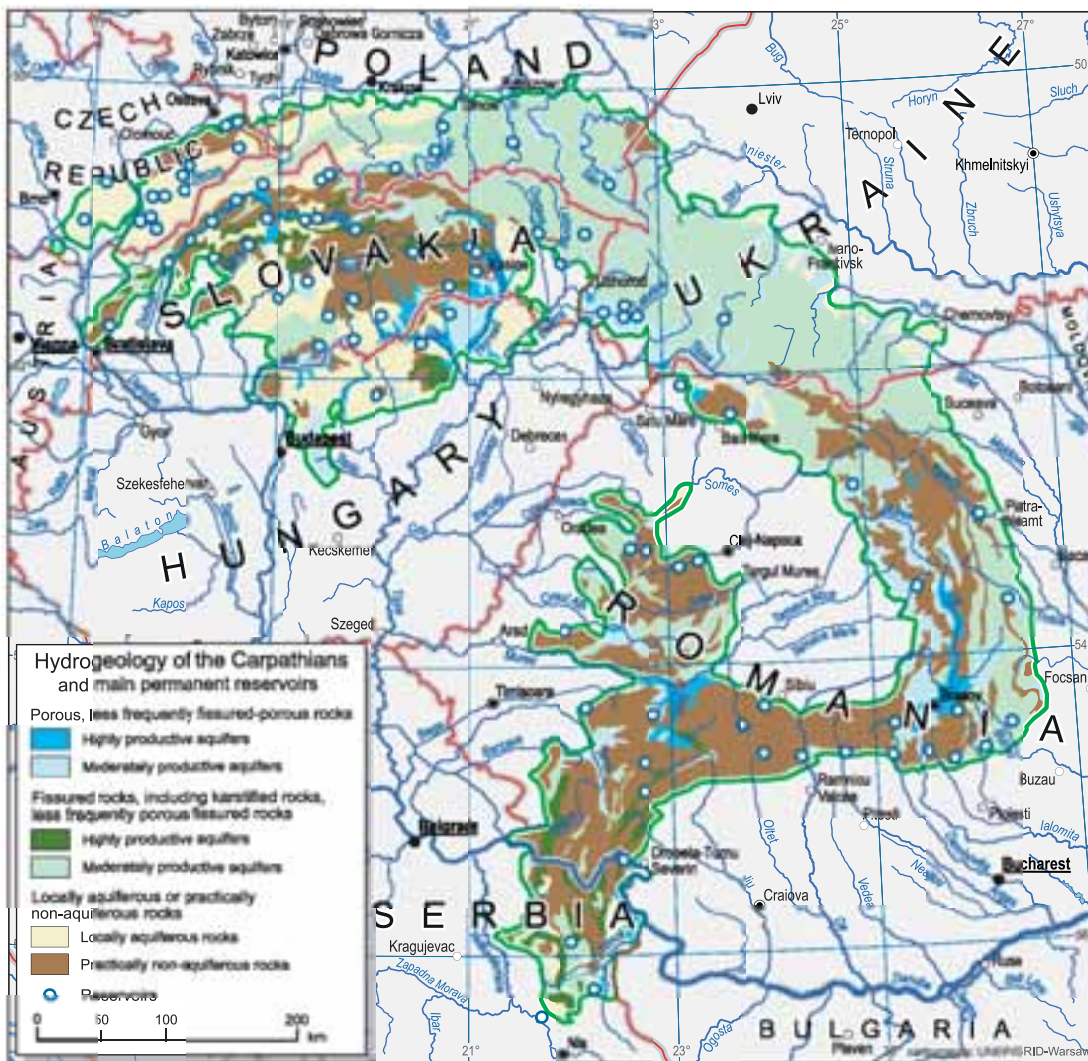
The major Carpathian tributaries of the Upper Danube Basin are the Morava River with the Dyje River on its right-hand side (Pasoι 2004). The total volume of nine permanent reservoirs in the Czech Republic is 0.045 km<sup>3</sup> (see Map 3.14).

The major Carpathian tributaries of the Middle Danube Basin are the Váh, Hron, Ipel' and Tisza (the largest tributary of all) and Južna Morava (on Serbian territory). The total amount of 33 permanent reservoirs pertaining to Slovakia is 1.84 km<sup>3</sup>. In Hungary's Carpathian sector, there are only three permanent reservoirs (0.02 km<sup>3</sup>). Ukraine has five reservoirs on the right-hand side tributaries of the Tisza (0.052 km<sup>3</sup>).

The Lower Danube Basin contains the following Carpathian rivers: the Timok, Jiu, Olt, Argeş, Ialomiţa and, most importantly, the Siret and the Prut. Portile de Fier I – Iron Gate I and Portile de Fier II- Iron Gate II reservoirs (on the Danube River, shared by Romania and Serbia) have a total volume of 2.9 km<sup>3</sup> and 1 km<sup>3</sup> respectively, and were built mainly for energy production and navigation purposes.

In the Carpathian sector, Serbia has only three permanent reservoirs, Bovan, Grlişte and Borsko Jezero, totalling a volume of 0.73 km<sup>3</sup> water. In Romania's Carpathian territory, 30 permanent reservoirs add up to 4 km<sup>3</sup> water. Situated in the

Map 3.14 Hydrogeology of the Carpathians and main permanent reservoirs (simplified map)



hilly and mountainous part of the Carpathian chain, the mean multi-annual discharge of the Danube's tributaries in Slovakia ranges from 21 to 170 m<sup>3</sup>/s. In Hungary, situated in the lowest part of the Carpathian Basin, mostly lowland plains prevail. Rivers enter the country from the west, north and east and drain towards the south. Given this abundance and thanks to the state's efforts, the level of public drinking water supply has reached the highest feasible rate; 98% of the population receives piped drinking water. In Romania, about 4,100 inland rivers are classified in the Water Cadastre. The major source areas

for groundwater recharge are found in the higher parts of the inner-basin mountain range, richer in precipitation than the adjacent units. The estimated surface water resources are of ca 656 m<sup>3</sup>/s (207 billion m<sup>3</sup>/year), of which only 37 billion m<sup>3</sup>/year come from internal rivers; the difference is attributed to the Danube River (170 billion m<sup>3</sup>/year). Of all the registered waterways, only some 1,200 rivers include reservoirs. The 70 largest reservoirs (each having more than 5-10 million m<sup>3</sup>) have a total volume of approximately 11 billion m<sup>3</sup>.

## Main quantitative data on groundwater resources

The age of rocks and tectonic activities control the degree of diagenesis<sup>4</sup> and the relationship between inter-granular and fissure porosity of rocks, determining transmissivity rate, from more than 1,000 m<sup>2</sup>/day to less than 0.1 m<sup>2</sup>/day (Krásný 2002). According to permeability and dominant flow characteristics, the natural associations of rocks were classified into three different hydrogeological units, refined in six classes on the basis of their productivity (in l/s/m).

For a semi-quantitative outline of the Carpathian groundwater resources (see Map 3.14), the information supplied by the “Warsaw”, “Budapest” and “Bucharest” Hydrogeological Sheets, scale 1:1 500 000, was processed using the Gilbrich et al. (2000) criteria. Using the Guide of the International Association of Hydrogeologists

<sup>4</sup> Diagenesis is the physical, chemical or biological alteration of sediments into sedimentary rock at relatively low temperatures and pressures that can result in changes to the rock's original mineralogy and texture.

(Struckmeier and Margat 1994) for the mapping of underlying rocks according to their capacity to transmit and/or store water, six classes of formations were separated (Table 3.8).

1. The first class of “porous rocks having highly productive aquifers” represents some 44% of the total area in Slovakia (along the Uh, Ondava, Latorica, Hornad, Nitra and Vah floodplains) and only 27.85% in Romania (due to multi-aquifer systems of intra-mountainous Ciuc, Braşov, Petroşani Basins infill).

2. The second class of “porous rocks having moderately productive aquifers” are preponderant in Ukraine (26.38%) and Romania (38.64%). In Hungary, Romania, Slovakia and Ukraine

<sup>5</sup> Data were computed as follows: simplification of the Hydrogeological Map and conversion of the rock-water features into six hydro-lithological units (according to Struckmeier and Margat 1995); computation of the areas (km<sup>2</sup>) of each unit/class for each country and total Carpathian surface occupied by each unit.

Table 3.8 Surfaces (km<sup>2</sup>) and percentages for the six main types of aquifer formations<sup>5</sup>

Country	I. Porous, less frequently fissured-porous rocks		II. Fissured rocks, including karstified rocks,		III. Locally aquiferous or practically non-aquiferous rocks	
	Highly productive aquifers	Moderate productive aquifers	Highly productive aquifers	Moderate productive aquifers	Locally aquifers	Practically non-aquifers
Czech Rep.	130	202	0	0	5,277	1,195
%	1.32	0.91	0	0	19.49	2.14
Poland	0	3,006	0	11,643	3,055	1,202
%	0	13.57	0	19.15	11.28	2.16
Ukraine	323	5,838	0	17,882	1,364	624
%	3.28	26.38	0	29.43	5.04	1.13
Slovakia	4,330	1,463	3,220	7,952	9,926	11,677
%	43.97	6.61	41.71	13.08	36.67	20.94
Hungary	1,474	2,678	366	21	4,481	863
%	14.97	12.09	4.74	0.03	16.56	1.54
Romania	2,742	8,554	1,938	21,022	1,204	38,317
%	27.85	38.64	25.11	36.08	4.45	68.73
Serbia	847	397	2,195	1,335	1,763	1,876
%	8.61	1.79	28.43	2.19	6.51	3.36
Total km <sup>2</sup>	9,846 km <sup>2</sup>	22,138	7,719 km <sup>2</sup>	59,855	27,070	55,754
Weighted	5.39%	12.14%	4.24%	32.82%	14.84%	30.57%

these aquifers are hosted in volcano-sedimentary formations.

3. “Fissured rocks, including karstified rocks, having highly productive aquifers” are frequently found in Slovakia (41.71%), Serbia (28.43%) and Romania (25.11%).

4. The class of “fissured rocks, including karstified rocks, having moderately productive aquifers” are found in flysch formations largely developed in Romania (36.08%), Ukraine (29.43%) and Poland (19.15%). Some of the main springs are bottled as curative/medicinal waters (Slănic Moldova, Poiana etc) or used as carbonate-sparkling waters for spa cures.

5. The class of “locally aquiferous, porous or fissured rocks” representing 36.67% of the total area in Slovakia, and 19.49% in the Czech Republic, corresponds mainly to areas with pyroclastic rocks.

6. As column 6 of Table 3.8 indicates, “practically non-aquiferous rocks” are found in over 30.57% of the Carpathian region. In fact, one-third of the Carpathian area is occupied by crystalline and magmatic rocks. Their permeability typically decreases with depth. These formations are extensively developed in the Eastern and Southern Carpathians, and are mainly found in Romania (68.73%).

Table 3.9 Weighted (%) main types of formations compared with the total surface area (km<sup>2</sup>) of each country (data derived from Table 3.8)

Country	I. Porous, less frequently fissured-porous rocks		II. Fissured rocks, including karstified rocks,		III. Locally aquiferous or practically non-aquiferous	
	Highly productive aquifers	Moderately productive aquifers	Highly productive aquifers	Moderately productive aquifers	Locally aquifers	Practically non-aquifers
Czech Rep.	130	202	0	0	5,277	1,195
%	1.89	2.97	0	0	77.57	17.57
Poland	0	3,006	0	11,643	3,055	1,202
%	0	15.90	0	61.58	16.17	6.35
Ukraine	323	5,838	0	17,882	1,364	624
%	1.24	22.43	0	68.70	5.23	2.40
Slovakia	4,330	1,463	3,220	7,952	9,926	11,677
%	11.22	3.81	8.35	20.62	25.73	30.27
Hungary	1,474	2,678	366	21	4,481	863
%	14.92	27.09	3.71	0.22	45.33	8.73
Romania	2,742	8,554	1,938	21,022	1,204	38,317
%	3.71	11.59	2.62	28.49	1.64	51.93
Serbia	847	397	2,195	1,335	1,763	1,876
%	10.07	4.72	26.08	15.86	20.95	22.30

## Water Availability and Use

The difference between Total Internal Renewable Resources (row 6 of Table 3.7) and Total Water Withdrawals (row 10) was analysed and weighted for each Carpathian country. Results show that only 3.6% (Slovakia), 6.2% (Serbia), 6.3%

(Hungary), 12.0% (Romania), 17.4% (Ukraine) and 20.1% (Poland) of the water resources available are currently being used. Freshwater is thus abundantly available, particularly in the mountain areas.



**Table 3.10 Relationship between climatic and hypsometric conditions and groundwater runoff (according to Krásný, 2002)**

Morphological (hypsometric) unit	Approximate elevation (m asl)	Mean annual precipitation (mm)	Mean annual evapotranspiration (estimation, mm)	Groundwater resources (l/s/km <sup>2</sup> )
Mountains	1,200-1,600	1,000-1,200	450	10-15
Lower mountains	800-1,200	800-1,000		7-10
Piedmont areas	300-800	600-800		3-7
Flat areas	< 300	500-600	650	1-3

In the Carpathian region, climatic and hydro-geological conditions favour an adequate replenishment potential. Groundwater in the Carpathian region is extracted mostly from porous (intergranular) and karstic aquifers. Over 80% of human water consumption in the Carpathians is supplied by groundwater. In some catchments, and in the vicinity of mountain peaks, the long-term specific groundwater runoff from hard rock areas reaches values of 15 l/s/km<sup>2</sup>. With decreasing elevation (see Table 3.10), and mostly due to decreasing precipitation, the rate of groundwater runoff generally diminishes to 1-2 l/s/km<sup>2</sup>.

There are four main types of water supply: groundwater tapping from Quaternary sediments (mostly alluvium), karstic spring water tapping, surface water use from reservoirs or directly from stream water, and combined systems.

Using the general water balance formula (considering mean yearly rainfall, volume of river runoff, evapotranspiration and intakes values), Romania has approximately 385 m<sup>3</sup>/s of groundwater resources. Exploitable resources, determined on the basis of quality, and technical and economic criteria, add up to a total of 304.9 m<sup>3</sup>/s (Bretotean 2002), of which some 149.4 m<sup>3</sup>/s (4.7 billion m<sup>3</sup>/year) pertain to phreatic waters and 155.5 m<sup>3</sup>/s (4.9 billion m<sup>3</sup>/year) to confined waters. Groundwater tapping consists of over 800 intakes, where supply is about 90 m<sup>3</sup>/s through over 1000 wells, 55 catchment lines and 70 spring sources (Cinetti 1992). In Slovakia, due

to different natural conditions and constraints, the reservoirs built on 21 streams are important drinking and industrial water suppliers. Their total mean discharge is about 3,037 m<sup>3</sup>/s (Pasoi 2004). On Ukrainian territory, total available renewable water resources total 53 km<sup>3</sup>/year (2.610 l/day/capita) with the following structure: 62% incoming waters; 14% groundwater recharge and 36% surface water produced internally (FAO Aquastat).

Unfortunately, only limited data exist on sectoral water use within the Carpathian region. FAO Aquastat provides data on sectoral water consumption for only five Carpathian countries (the Czech Republic, Hungary, Poland, Romania and Ukraine). In 2000, the highest water consumption level was reported for industry and power generation, ranging between 34 and 57% of total water withdrawals, households consumed 9-41% and agriculture 2-57%.

Natural mineral water is an ecologically pure product inducing beneficial health effects due to its composition. According to the EC Directive 80/777, the main criteria used for defining natural mineral water refer to its original purity and adequate protection against any pollution hazard. In the Carpathians, mineral water consumption is an old tradition. The geological setting and the existence of unpolluted areas favoured the development of mineral water sources of an outstanding quality, many of which also include carbon dioxide in a natural state.

## Surface and Groundwater Quality: Eutrophication

### Surface water quality

The main physical and chemical indicators determining the chemistry of surface waters are the following: transparency, temperature, pH, dissolved oxygen, organic substances, biochemical consumption of oxygen, total suspensions, sodium, calcium, magnesium and steady residuum. In addition, heavy metals are also included in monitoring programmes. The common sources of water pollution are industrial wastewater, solid waste dumps and residues from the processing of mining ore and smelting operations. For instance, in the Northern Carpathians (Spišská Nová Ves, Smolník and Banská Štiavnica mining areas), river waters have pH values of 2-3 and concentrations of 15 – 50 g l<sup>-1</sup> dissolved salt (Hudacek 1999, Šotník et al. 2002).

In the southernmost portion of Carpathians (Bor – Serbia), after the destruction of the Bor base ores processing plant in 1999, the “Joint Danube Survey Initiative” identified very high concen-

trations of copper, zinc and lead, as well as excessive cadmium values along the Timok River (Dobre, 2005). Most of the main rivers are polluted downstream of urban centres, mainly by organic slumps and heavy metals. But the main form of contamination is diffuse pollution from agriculture.

trations of copper, zinc and lead, as well as excessive cadmium values along the Timok River (Dobre, 2005). Most of the main rivers are polluted downstream of urban centres, mainly by organic slumps and heavy metals. But the main form of contamination is diffuse pollution from agriculture.

After 1991, as a result of pollution reduction measures, the percentage of “good-quality” rivers increased significantly in the Carpathians (for example from 40.5 to 65% in the Romanian

Carpathians). Seepages from agricultural terrains are responsible for most of the polluting elements identified in lakes and rivers: 60-70% nitrogen, 40-50% phosphorus (Ackermann 1994). By excessive enrichment of soils with nitrogen, phosphorus and ammonia, the eutrophication process is favoured.

At its entry point to Romania, the Danube's water is of quality class II in terms of nitrate and phosphate content (see Table 3.11). In comparison with current agricultural schemes in Romania, the upstream Danubian countries administer much higher concentrations of fertilizers per hectare. At the entrance point (Bazias), approximately 80% of nitrogen substances and 70% of phosphates come from upstream sources. In the 1989-1990 interval alone, the Danube carried 40 kilotons of phosphates and 500 kilotons of nitrogen to the Black Sea (ten times more than in 1960; Tomescu 1999). Every year the Danube carries to the Black Sea approximately 1,000 t of chromium, 900 t of copper, 60 t of

Table 3.11 River Water Quality – main classes (Serban and Galie 2006)

Rank Quality mark Country, year	I Good %	II Moderate %	III Satisfactory %	IV Degraded %
Poland, 1990	10	33	29	28
Czech Rep., 1990	12	33	27	28
Romania, 1990	40	28	11	21
Romania, 2003	65	23	6	6

mercury, 4500 t of lead, 600 t of zinc and over 50,000 t of oil products (Jelev 1999).

The overall length of river courses with a minimal ecological water discharge level is 120,000 km. Because only 48% of the waters being used by the population are treated, many rivers are polluted by urban refuse. Using as a reference the monitoring of the 20,500 km of water courses in Romania, only 55% are class I rivers, and therefore available for water supply if purified. Unfortunately, these river sections occur in

mountainous areas, far away from the main demand. Class II rivers represent 26% and are used only for fisheries with species less sensitive than the salmon. Class III rivers (8%) are used for irrigation, industrial cooling installations, car washing and hydropower plants and class IV (11%) are extremely polluted waters without fauna (Document of Common Strategy, European Union and Romanian Government for Environment Protection 2005). The main polluted rivers in Romania are the Siret (80% of its length), Ialomita (58%), Olt (24%) and Someş (24%).

### Groundwater quality

Generally, the Carpathians are situated in recharge areas, having potable waters of bicarbonate, calcium and/or magnesium types. The main chemical processes are the decomposition of silicates and dissolution of carbonates, sulphides, sulphates, iron and manganese oxides among others. However, some cases of nitrate pollution have been identified within the intra-mountain-

ous basins (Radescu & Dragusin 2004). Additionally, due to the decomposition of boron nitrate from phreatic aquifers, natural pollution in the Eastern Carpathians moffete aureole exceeds the screening value of the EU Directive 80/777 for boron (32%) and ammonia (17,5%) (Lupescu 2004). Special studies must be undertaken for arsenium-rich pirites (Hunedoara, Arad and Suceava counties) and low-pH rivers which are favourable to enrichment with radioactive substances crossing granite massifs.

The Programme for Action for Environment Protection in Central and Eastern Europe 1994 shows that the aluminium content of the first meter of phreatic groundwater is as high as 0.2-2.0 mg/l in some places of the Carpathian chain. An increasing number of negative ecological impacts and hydrological disasters (major reductions in groundwater levels associated with mining subsidence, serious deterioration of groundwater quality among other reasons) indicate the urgency for protection of water resources.

## Policy Measures and Responses

The Carpathian countries have full rights and duties within the EEA's European Environment Information and Observation Network (EIONET). One of the main EIONET components is EUROWATERNET, which provides qualitative and quantitative data on surface and ground waters. The following Environmental Quality Standards are applied within Carpathian EU member states: 75/440/EEC – Surface Water for Potabilisation, 76/160/EEC – Quality Water for Bathing, 78/659/EEC – Water Quality Protection and Improvement for Fish, 79/923/EEC – Water Quality for Molluscs, and 98/83/EEC Directive – Water Quality for Human Consumption (Şerban and Gălie 2006). Furthermore, the Directive 2000/60/EC establishing a framework for Community action in the field of water policy lays down the basic principles of sustainable water policy in the EU. The Water Framework Directive also provides incentives for integrat-

ing the protection and sustainable management of water into other policy areas such as energy, transport, agriculture, fisheries, regional policy and tourism.

At the regional level, a "Central and Eastern European Network of Basin Organizations" was founded following a Romanian proposal in February 2002. It promotes the integrated management of water resources in each hydrographic basin as an essential tool of sustainable development. An ecological approach to the environment, protection of water resources, determination of usage constraints and environment-friendly uses are the main points for future action. It is necessary to establish a hydro-ecological database in the form of an environmental information system, focusing on the present state of available water resources, their exploitation and the ecological situation of specific regions.

In all Carpathian countries, water management will face great challenges due to economic transition and privatisation of the public sector, as well as current socio-economic developments and human lifestyle tendencies in the Carpathians. Currently, the consumption of drinking water tends to decline in many countries of the region as a result of the transition in the industrial sector, measures to maintain the water infrastructure, and improved public awareness through education and advertisement of the necessity to rationalize consumption.

The adequate management of water resources and the corresponding policy should be based on

ensuring safe drinking water supply; preventing the further deterioration of water sources; protecting freshwater ecosystems; and using both ground and surface waters, artificially regulated in a sustainable manner.

Global climate change will profoundly affect hydrological systems. The management of surface- and groundwater will thus face new challenges in fulfilling not only the common objectives of securing water supplies, but also improving and protecting ecological health, while having to cope with greater climatic fluctuations and population pressures.



© Pavel Meisl

## 3.6 Atmospheric Processes

This section provides a general view of climatic changes in the Carpathian region over the second half of the 20th century, focusing on a quantitative assessment of the main climate parameters (temperature, precipitation and snow cover) over the period 1990-2005. An outlook of future climate change in the Carpathian region is also presented here, along with the impact of anthropogenic drivers on air quality, and policy measures and responses.

The “Summary for Policymakers of Working Group I Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change” (IPCC) (here after WGI-AR4 SPM 2007), approved in February 2007, summarized new research findings on human and natural drivers of climate change, observed climate change and estimates of future scenarios. Based on new data, more sophisticated methods of data analysis and improved simulation models, this report concluded that the warming of the climate system is unequivocal, as it is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea levels.

This warming phenomenon was more pronounced in the second half of the 20th century as a consequence of increasing greenhouse gas concentrations in the atmosphere due to human activities. The observed pattern of tropospheric warming and stratospheric cooling is very likely<sup>6</sup> due to the combined influences of greenhouse gas increases and stratospheric ozone depletion. Climate model simulations have shown that the anthropogenic influence on climate overlaps with natural influences such as solar radiation and regional distribution of land and water, leading to specific regional patterns of climate variability and change.

Difficulties remain, however, in simulating and attributing observed temperature changes at smaller scales. On these scales, natural climate variability is relatively larger, making it harder to distinguish between natural changes and those produced by external anthropogenic influences. Uncertainties related to local influences and feedback also make it difficult to estimate the contribution of global greenhouse

<sup>6</sup> Virtually certain > 99% probability of occurrence, Extremely likely > 95%, Very likely > 90%, Likely > 66%, More likely than not > 50%, Very unlikely < 10%, Extremely unlikely < 5% (IPCC 2007).

gas increases to observed small-scale temperature changes.

Among natural factors, orography plays a key role in determining regional climate characteristics by modulating the influences of large-scale processes. Europe is characterised by a very

complex orography that regulates the effects of global climate warming on a regional scale. The Carpathian chain is one of the largest mountain systems in Europe, a fact which leads to various specific effects in the regional climate variability (see Chapter 1 and below).

## Climate Change

### General overview of climate changes in the Carpathian region over the second half of the 20th century

A comprehensive overview of global warming over the period 1976 to 2000 is given by the IPCC Third Assessment Report (TAR) (2001). 1976 is widely acknowledged as the “climate shift” year (e.g. Trenberth 1990), when global mean temperatures marked a pronounced upward trend at least partially attributed to increases in greenhouse gas concentrations in the atmosphere (see the TAR, IPCC 2001). The Report includes Europe among the regions with the largest increase in annual mean temperature (between 0.8-1.0°C/decade).

Various detailed studies of the Carpathian region have shown different regional and local climate change features. For example, in the Southern and Southwestern Carpathians, Boroneant and Ionita (2005) found different ranges of warming in the annual temperature variability over the period 1962 to 2000: 0.3°C -0.5°C in the Bucegi Mountains (Vf. Omu), 0.5°C -0.7°C in the Semenic Mountains and 0.8°C -0.9°C in the Eastern part of the Southern Carpathian (Poiana Stampei) and Apuseni Mountains (Baisoara).

The temporal behaviour of some climate extremes in the Carpathians (e.g. dry/wet spells, tropical days, frost days) were analysed by Baciu et al. (2004), Cheval et al. (2005) and Dragne et al. (2005). Baciu et al. (2004) found that the annual frequency of rime days has significantly increased in the Bucegi Mountains (Southern Carpathians), while in the Southwestern Car-

pathians, significant decreases were noted, this last feature being in contrast with all surrounding areas in Romania. These increases were associated with the shift of the last rime day to late spring, causing problems for agriculture. Cheval et al. (2005) found increasing trends in the heat wave duration index and annual number of days with minimum temperatures below 0°C in the Romanian Carpathians.

On the other hand, precipitation extremes follow different tendencies. While an increasing number of consecutive dry days was noted, one can also observe a decrease in the number of cases with precipitation events above certain amounts (10, 20, 30, and 50 mm). A decreasing trend in annual precipitation was noted in the Southern and Southwestern Carpathians, more pronounced in the South (Boroneant and Ionita 2005).

The physical mechanisms responsible for climate variability in the Carpathian region (e.g. atmospheric circulation), including the Carpathian influence on regional climate, have also been assessed by several authors. According to Busuioc and von Storch (1996) and Busuioc (2001), the Southern and Southwestern Carpathians act as a barrier for southwestern circulations, transporting moist Mediterranean air masses, and leading to higher precipitation amounts in southwestern Romania (including the southern part of the Southwestern Carpathians). In addition, the northern part of the Southwestern Carpathians (Apuseni Mountains) blocks northwestern atmospheric circulations transporting moist North Atlantic air masses, leading to higher precipitation amounts over

northwestern Romania (including the Apuseni Mountains) and less precipitation over the Transylvanian plateau.

Changes in the frequency and intensity of these air circulations lead to changes in the precipitation regime over the areas under influence. For example, Busuioc and von Storch (1996) found that after 1970 the winter southwestern circulations became less frequent, leading to a decreasing trend in winter precipitation over Romania, more pronounced in the southwestern part. Boroneant and Ionita (2005) also identified a pronounced decreasing trend in the mountain area (e.g., 45 mm/decade at Vf. Omu station in the Bucegi Mountains), especially in the Southern Carpathians, which are more affected by southwestern circulations. Kaszewski and Filipiuk (2003) have reported a connection between decreases in precipitation in the Polish Carpathians and changes in the atmospheric circulation over Central Europe.

served in mid-late winter (January to March), occurred over the last half of the 20th century and appear to be associated with NAO variability (e.g. Hurrell 1996). Bojariu and Dinu (2007) show that diminishing snow depth over the Romanian territory, which is only significant in some areas including small mountain areas in the Eastern and Southwestern Carpathians, is related to the overall tendency toward the positive phase of the NAO. Nevertheless, local and regional factors have more influence on snowpack variability in the Carpathians than in the Alps, where large-scale influences play a dominant role in controlling the timing and amount of snow (Beniston 1997).

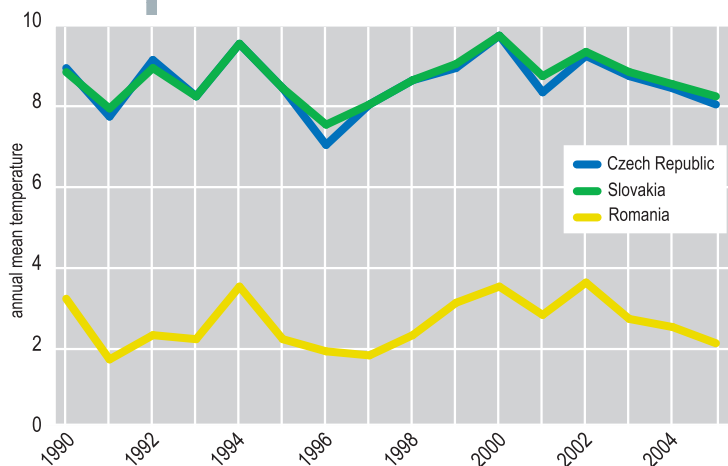
### Climate trends from 1990 to 2005

#### Temperature

Figure 3.12 presents a comparison of the average annual mean temperature in three Carpathian countries. The temporal evolution of the time series generally shows similar features, and some differences in the magnitude of values between the Northwestern and Eastern-Southern/Southwestern Carpathians. The temperature variability over the Northwestern Carpathian region is very similar with respect to the temporal evolution as well as the magnitude of values (spatial average between 7.0°C-9.7°C). Different results obtained in the Southern/Southwestern Carpathians (spatial average between 1.7°C -3.6°C) can only be explained by the lack of data homogeneity.

In the Northwestern Carpathians, 1996 was the coldest year and 2000 the warmest. In the Southern/Southwestern Carpathians, 1991 was the coldest year and 2002 the warmest. No significant linear trend was noted, the inter-annual variability being the dominant feature of temperature variability over the period under analysis. This result shows that large-scale mechanisms (e.g. atmospheric circulation) could be the main drivers of this behaviour. For example, 2000 was for a long period under the influence of anticyclonic weather in Central and Southeastern Europe. The time period analysed is, however, too short to draw a clear conclusion about the causes that determined this behaviour, namely if they are of natural or anthropogenic nature, or a combination of both. Most

Figure 3.12 Spatial averages (country level) of annual mean temperature over the period 1990 to 2005



The number of stations used in computing each spatial average is noted: 17 for Romania, 19 for Czech Republic and 62 for Slovakia.

These changes in atmospheric circulation on a regional scale are consequences of changes in larger-scale circulation patterns, such as the North-Atlantic Oscillation (NAO), the dominant variability mode over the Atlantic-European area. Various studies have documented that the strongest warming during the winter season, and associated downward trends in snow depth ob-

probably, both factors had an influence. The most recent IPCC report (WGI-AR4 SPM, 2007) reached a similar conclusion, namely that the characteristics of global climate variability over the 20th century can be explained by a combination of natural and anthropogenic factors.

**Precipitation**

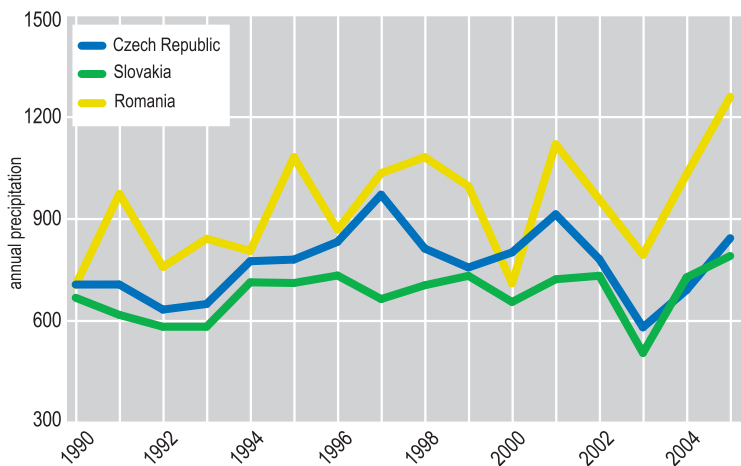
A slightly increasing trend in the average annual precipitation was identified in the Romanian and Czech Carpathians over the period 1990 to 2005, along with high inter-annual variability (see Figure 3.13). The largest annual precipitation amount was recorded in 2005 in the Southern Carpathians (1260 mm/year) and in the western part of the Northwestern Carpathians (791 mm/year). In the eastern part of the Northwestern Carpathians, the largest annual precipitation amount was identified in 1997 (971 mm/year). The year 2003 was the driest one in the Western Carpathians (506-581mm/year), associated with a very hot summer over Central Europe. In the Romanian Carpathians, 1990 and 2000 were the driest years (706 mm/year and 711 mm/year, respectively).

On a local scale, only a few stations exhibited a significantly increasing trend in the precipitation pattern (six stations in the Romanian Carpathians and eight stations in the Slovak Carpathians), but are not necessarily part of a long-term precipitation trend. It is difficult to conclude that the characteristics of precipitation variability in the analysed regions belong to the natural decadal and/or interdecadal variability that is a characteristic of precipitation variability (see WGI AR4 SPM, 2007). Future global warming may nevertheless induce more frequent and severe climate events, both "positive" (extreme precipitation and floods) and negative (such as droughts).

**Snow cover**

The annual number of days with snow cover exhibits significant spatial and temporal variability. These characteristics are in agreement with the temperature and precipitation variability patterns presented above. Firstly, there are large differences between the Western Carpathians (56-60 annual average number of days) and the Southern/Southwestern Carpathians (163 annual

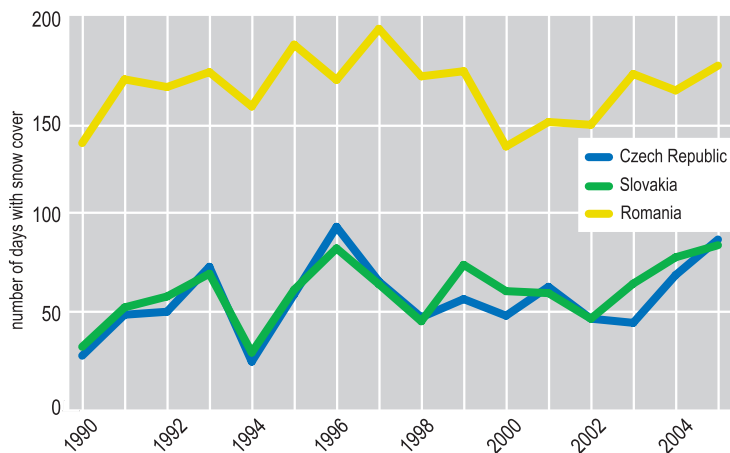
Figure 3.13 Spatial averages (country level) of annual precipitation over the period 1990 to 2005.



The number of stations used in each spatial average is noted: 17 for Romania, 86 for Czech Republic and 62 for Slovakia.

average number of days), as shown in Figure 3.14. This may also be due to a lack of data homogeneity. Secondly, a slight increasing trend was noted over the Northwestern Carpathians (nine stations in Czech Carpathians and 20 stations in the Slovak Carpathians) and a slight downward shift for some stations in the Romanian Carpathians (Calimani, Ceahlau-Toaca and Vladeasa). These spatial details are represented in Map 3.15.

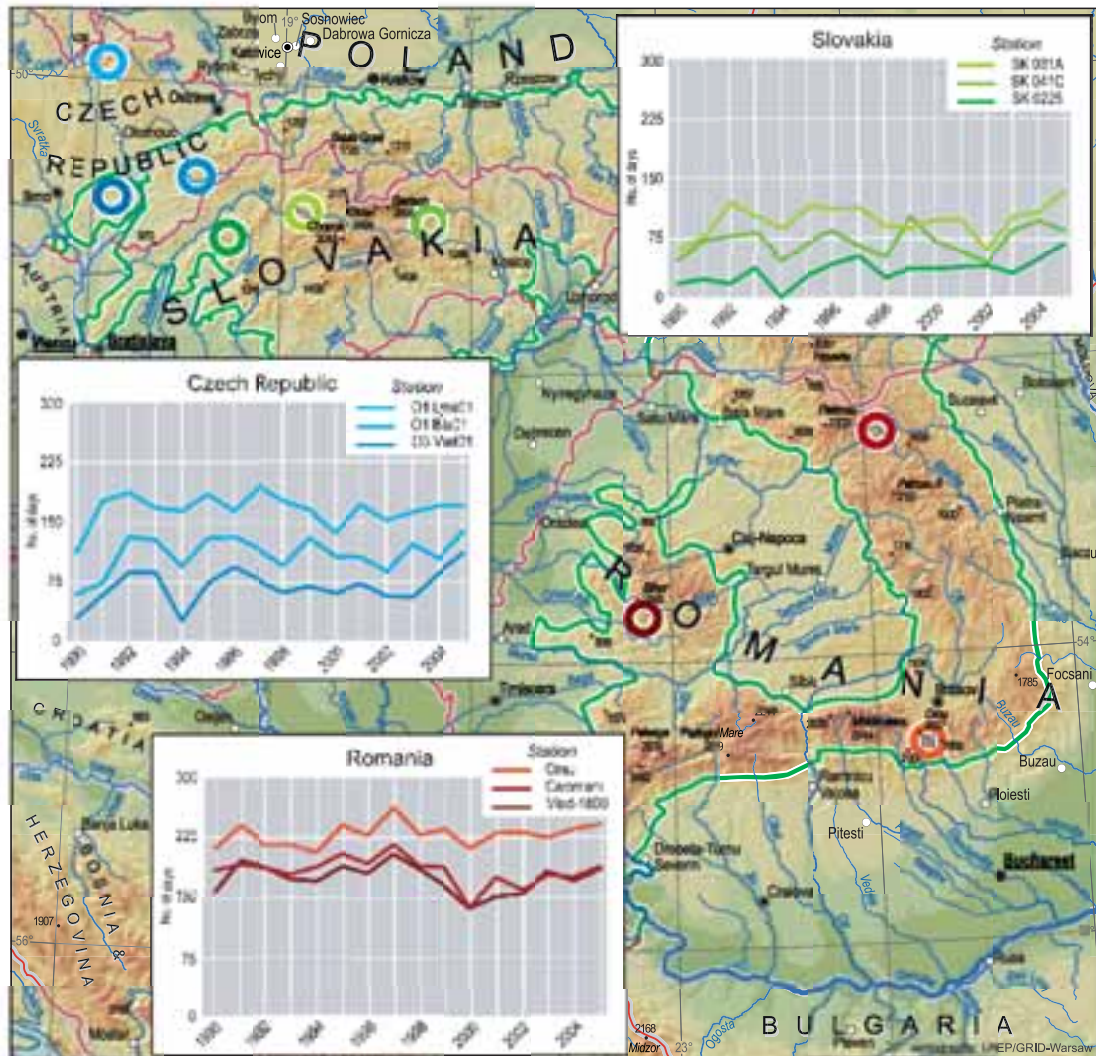
Figure 3.14 Spatial averages (country level) of the annual number of days with snow cover over the period 1990 to 2005



The number of stations used in each spatial average is noted: 17 for Romania, 86 for Czech Republic and 62 for Slovakia



Map 3.15 Annual number of snow cover days in the Carpathian region. Local details are presented for the Slovak, Czech and Romanian Carpathian areas



### Outlook on future climate change

In February 2007, the IPCC approved a “Summary for Policy Makers” (WG1 AR4 SPM) as the first of a series of publications associated with the panel’s Fourth Assessment Report. It summarized the main results of research on climate change projections for the 21st century, using various global and regional climate models of increasing complexity and realism under various emission scenarios. Model simulations cover a range of possible futures including idealised emissions or greenhouse gas (GHG) concentration assumptions, according to the IPCC Special Report on Emission Scenarios (SRES).

Model experiments show that even if all climate forcing agents are held constant at their 2000 levels, a further warming trend would occur in the next two decades at a rate of approximately  $0.1^{\circ}\text{C}$  per decade, mainly due to slow ocean feedback. Globally, snow cover is projected to decrease, and widespread increases in thaw depth are projected over most permafrost regions. On the European scale, including the Carpathian region, almost all models and SRES scenarios show a warming between  $1.0^{\circ}\text{C}$  and  $1.5^{\circ}\text{C}$  for the period 2020 to 2029 compared to the baseline period 1980 to 1990 (WG1 AR4 SPM, 2007).

Details on mountain regions (including the Carpathians) cannot be found in global climate

change scenarios. Such details can only be obtained by using downscaling techniques to infer regional climate information on a finer scale: dynamic approaches given by regional climate models (RCMs) (Giorgi et al. 2001) and statistical downscaling models (SDMs) (e.g. Busuioc et al. 1999, Huth 2001). When both approaches show similar climate change signals, confidence in the results obtained increases. SDMs have the advantage to obtain climate change information on a station scale. Unfortunately, only a few studies have systematically compared the two downscaling techniques.

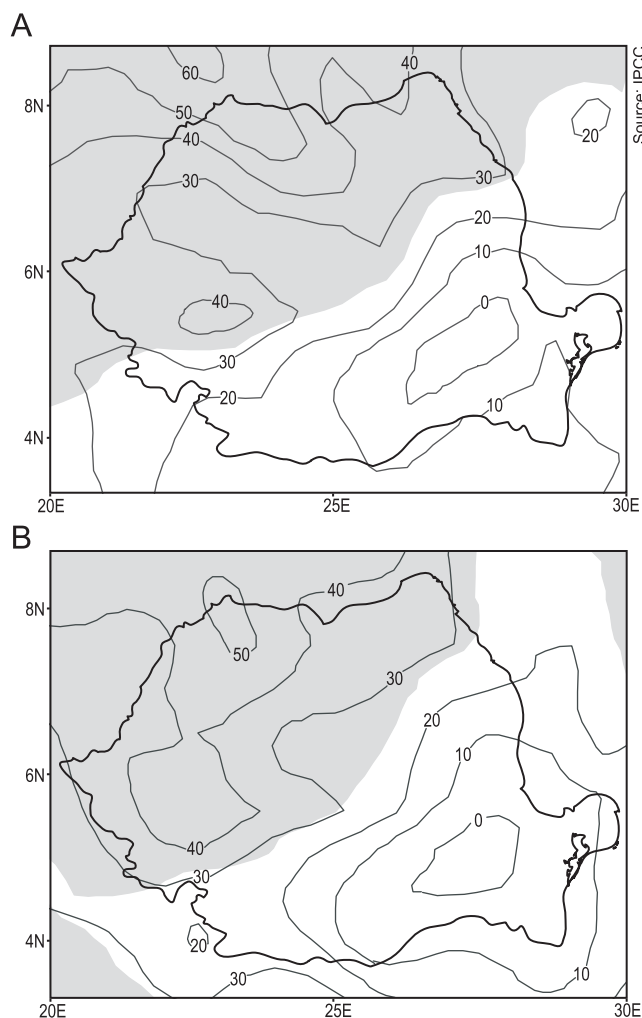
For example, Busuioc et al. (2006a,b) compared the ICTP RegCM regional climate model and SDM simulations generating winter precipitation scenarios for Romania (under IPCC A2 and B2 scenarios for the period 2070 to 2099), and found similar signals in the Southwestern and Northeastern parts of the Romanian Carpathians (see Figure 3.15). RCM simulations show that winter precipitation is projected to increase by 40-50 mm under both scenarios, when SDM simulations produce lower rates of increase. The results obtained for the Romanian Carpathians are in agreement with those noted in AR4 SPM. For extreme temperatures, Busuioc et al. (2005) found similar RCM-SDM signals, especially for winter minimum temperatures (under the A2 scenario), with greater warming in the eastern part of the Romanian Carpathians (above 5°C) compared to the Southern/Southwestern Carpathians (4.5°C-5°C).

### Overview of climate change impacts

Based on observational evidence, the last WGII IPCC Report (IPCC WGII SPM 2007) concluded that recent warming is strongly affecting hydrological and terrestrial biological systems in mountain regions through increased runoff and earlier spring peak discharge in many glacier- and snow-fed rivers, warming of lakes and rivers with effects on the thermal structure and water quality, earlier timing of spring events, such as leaf-unfolding, bird migration and egg-laying.

Nearly all European regions are anticipated to be negatively affected by future climate change

Figure 3.15 Changes in winter precipitation over Romania derived from RegCM simulations under IPCC A2 (a) and B2 (b) scenarios. Units are mm/season. Grey areas indicate statistical significance at the 5% level



impacts, particularly the increased risk of inland flash floods and erosion, which will pose challenges to human lives and livelihoods, and for many economic activities. The great majority of montane organisms and ecosystems will have difficulties in adapting to climate change. Mountainous areas will face reduced snow cover and extensive species loss (up to 60% by 2080 in some areas, under high emission scenarios). Forest productivity is expected to decline and the frequency of peatland fires will increase. In addition, some specific regional features of climate change impacts in the Carpathians are noted below.

*Impact of climate change on agriculture*

During the last 10-15 years, agricultural production, including crop production and animal husbandry, decreased in the Carpathians, and large areas became fallow land (see section 3.3).

Climate change impacts on agriculture were mostly detailed in the Slovak Carpathians (MoE of the Slovak Republic 2005). It was found that increased temperatures induce an acceleration of plants' physiological processes and an early start of physiological development and vegetation periods. The extension of the vegetation period is forecast to reach up to 84 days in the Slovak Carpathians by 2075. It is estimated that there will be an increase of 126 mm in the evaporation deficit in southern Slovakia, and as much as seven times the current value in the northern part. Gradual changes to the water balance would be caused by reductions in the snow stock, increased mean temperature in early spring and increased evapotranspiration in winter months. By 2075, the biomass production potential is projected to increase by 25% in the northern mountainous part of Slovakia, and corn farming could expand from the present limit of 100-400 m altitude up to 800 m.

*Impact of climate change on forests*

Generally, environmental degradation in mountain regions can be driven by numerous factors, including deforestation, over-grazing and cultivation of marginal soils. Mountain ecosystems are highly susceptible to soil erosion, landslides and the rapid loss of habitat and genetic diversity (Beniston 2003). Changes in climate conditions will also have an impact on forest ecosystems. As case studies for climate change impacts on forests, the Western Carpathians (Slovakia) and Southwestern Carpathians (Romania) are presented here.

In the Western Carpathians, it was found that climate change would increase the water deficit during the vegetation period. Increasing air temperatures and decreasing precipitation in warm periods will lead to a decrease of relative air humidity. This will result in less favourable conditions for high forests and the expansion of xerothermic shrub vegetation and steppe vegetation.

Climate change will also result in changes to biodiversity. The dendroclimatic model for the region of upper Orava showed that 11.5% of individual trees will be negatively impacted by climate change, 34.6% will be unaffected and 53.9% will react positively. The research also showed that climate change would mostly affect forest cover at higher altitudes (Lapin et al. 1996, 2000). Jankovsky and Cudlín (2002) showed that high mountain forests would be impacted by a precipitation deficit that will result in weakened spruce and mountain pine communities, making them vulnerable to windstorms and intensive rains. Table 3.12 presents the forest areas in Slovakia endangered by climate change, under present climate conditions and projected future conditions. Nearly half of the forest area is projected to be at risk by 2075.

Furthermore, climate change would induce the migration of species and current life zones towards higher altitudes. The present sub-polar tundra zone (according to the Holdridge classification) is projected to disappear from the Romanian Carpathians, while other zones typical for the current plain and hill climate (e.g. cool temperate steppe and cool temperate moist forest), are projected to expand in higher mountain areas (Alexandrescu et al. 2003).

*Impact of climate change on health*

Climate change will also impact human health, either directly through the physiological effects of heat and cold, or indirectly, through the spread of vector-borne pathogens. An increase in such impacts has already been observed during recent decades. Direct impacts on human health are mainly associated with heat waves and floods. Extreme hot or cold conditions can be detrimental to many human body functions and may have an important effect on daily mortality (EEA 2005).

As an example, studies on the Slovak Carpathians found that extreme positive temperatures during wintertime can provoke increased occurrence of influenza. During the last decade, one to two million people were affected every year by influenza or influenza-like infections. The highest age-specific morbidity is reported for the pre-school age category (children up to five

Table 3.12 Forest ecosystems in Slovakia endangered by climate change

Endangered forest ecosystems	Area (ha)	% of total forest area
Acute endangered forest ecosystems (endangered at present)	29 000	1.5
Directly endangered forest ecosystems (endangered up to 2030)	260 000	13.0
Potentially endangered forest ecosystems (endangered up to 2050-2075)	964 000	48.3

Source: MoE of the Slovak Republic 1997

years) and for school-age children (6 to 14 years). There were occasional reports of deaths from influenza, most of them occurring during the 2002 and 2003 winter seasons (MoH of the Slovak Republic 2005, PHA of the Slovak Republic 2005).

The incidence of water and food-borne diseases may also increase with climate change, particularly when water availability decreases and high temperatures affect the quality of food (EEA 2005). The projected rise in temperature is likely to increase the geographical extent of ticks and

lead to infestations in areas that are currently tick-free.

Lastly, the increasing intensity of heavy rainfall, as projected along with future climate change, is likely to result in more extreme floods. The number of deaths can be particularly high during sudden flash floods. In 2005 in Slovakia, floods in 237 villages and towns affected nearly 1,800 homes. The largest loss of human life occurred during floods in July 1998 in Eastern Slovakia, with 46 victims and four missing persons (MoE of the Slovak Republic 2005).

## Anthropogenic impacts on air quality

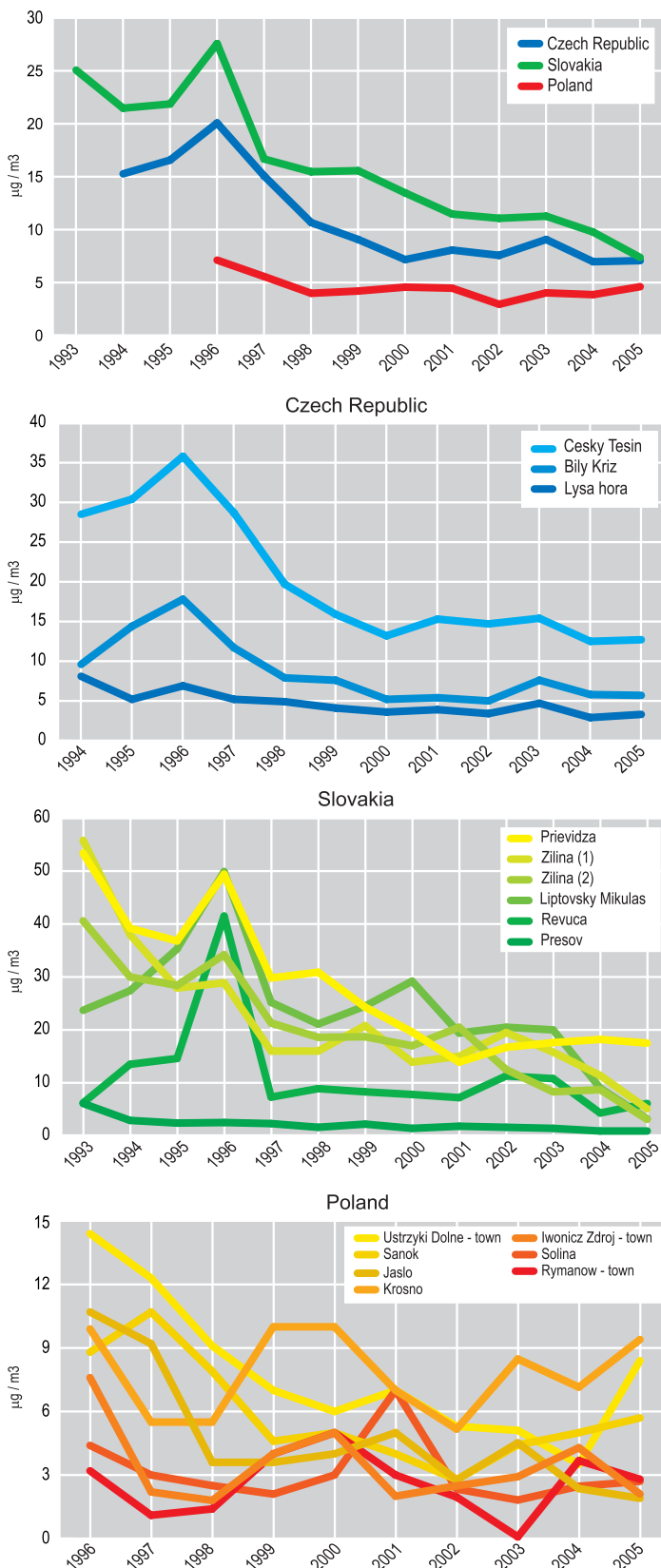
The main sources contributing to air pollution are incineration processes, industry, transport and agriculture. Carbon dioxide also enters the atmosphere via the conversion of grasslands and forest areas into agricultural land and via forest fires. The major sources of methane are agriculture, large-scale beef cattle and pig breeding, leaking of natural gas from distribution networks, brown coal mining and biomass burning. In comparison with other greenhouse gases, the assessment of nitrous oxide (N<sub>2</sub>O) emissions and sinks involving the nitrogen cycle in the atmosphere is rather difficult. The primary sources of N<sub>2</sub>O are agriculture, waste treatment and fuel combustion (e.g. energy and transport).

Expressed as CO<sub>2</sub> equivalent, total emissions in Slovakia consisted of 80% carbon dioxide emissions, approximately 10% CH<sub>4</sub> emissions, 7% N<sub>2</sub>O emissions and less than 1% fluorinated gases (SHI 2006). In the Northwestern and North-

eastern Carpathians, the time series analysis of NO<sub>x</sub>, SO<sub>2</sub>, lead and other air pollutants illustrates that annual average emissions generally decreased under the influence of economic decline in most Carpathian countries. According to Romania's National Communication on Climate Change (2005), similar trends were noted in the Southern and Southwestern Carpathians.

In Slovakia, a reduction of 81.6% in SO<sub>2</sub> emissions was reported between 2000 and 2004, as a consequence of a reduction in energy production and consumption, and changes to better quality and more purified fuels. Over the same period, a 56% decrease in NO<sub>x</sub> emissions was mainly due to technical and technological improvements of the incineration process and denitrification. Ammonia (NH<sub>3</sub>) emissions dropped by 59% due to changes in agriculture, where livestock numbers were reduced. Organic and

Figure 3.16 SO<sub>2</sub> concentrations – annual spatial averages in the Czech Republic (three stations), Slovakia (13 stations) and Poland (10 stations). Local details are also presented



industrial fertiliser volumes on agricultural land were also reduced.

Figure 3.16 shows atmospheric SO<sub>2</sub> concentrations in several Carpathian countries, including country averages and local details at the district/station level. While similar decreasing trends are noted for all countries, some differences may be observed at the local scale with respect to the magnitude of concentrations and their temporal evolution.

As in other Carpathian countries, heavy metal emissions (lead, cadmium and mercury) have shown a significant decreasing trend in Slovakia between 1990 and 2002, followed by a slight increase. This was mainly due to closing down many inefficient production processes, extensive reconstruction of separation equipment, changes to raw materials used and, most of all, the transition to using unleaded petrol. Emissions of particulate matter have also diminished, due to using more purified fuels of better quality, and reductions in energy production and consumption (MoE of the Slovak Republic 2003).

The same trend was identified for non-methane volatile organic compounds (NM VOC). Emission abatement resulted from lower use of coating compounds and gradual introduction of low-solvent coating types. The introduction of gas technologies in incineration processes and of automobiles equipped with catalytic converters also generated NM VOC emission reductions (SHI 2005).

As a result of atmospheric pollution, acid precipitation is an important issue in the Carpathians, with nitrates contributing less to the acidity of precipitation than sulphates. Acid rain may have detrimental consequences for wildlife, forests, soils, freshwater and buildings. Incineration processes, industry and transport are main contributors to the formation of acid rain. A slightly diminishing trend was nevertheless observed in the acidity of atmospheric precipitation from 1993 to 2003.

### Stratospheric Ozone Depletion

Stratospheric ozone depletion, observed since the 1970s, is primarily caused by higher atmos-

pheric concentrations of reactive chlorine and bromine compounds that are produced through the degradation of Ozone Depleting Substances (ODS), including halons, CFCs, HCFCs, methyl chloroform (CH<sub>3</sub>CCl<sub>3</sub>), carbon tetrachloride (CCl<sub>4</sub>) and methyl bromide (CH<sub>3</sub>Br). Each type of gas has different ozone depletion effects depending on historical emissions, lifetime and amount of chlorine and/or bromine existing in each molecule. Recent observations and model calculations suggest that global average ozone depletion has now stabilised.

Ozone depletion produces a negative radiative forcing (cooling) of the climate, which is related to the indirect effect of ODS. Reduced ozone causes the stratosphere to absorb less solar radiation, thus cooling the stratosphere. On the other hand, ODS are greenhouse gases with a direct warming effect. The warming due to

ODS, and cooling associated with ozone depletion, are two distinct mechanisms influencing the climate that do not offset one another.

As for tropospheric ozone, time series analyses of the ozone concentration in the Carpathian countries did not identify significant trends. As a common feature, during the heat wave of the summer of 2003, record-breaking levels of tropospheric ozone pollution were registered everywhere in the Carpathian countries. For example, in Slovakia increased values of ground-level ozone were detected at all monitoring stations (MoE of the Slovak Republic 2003). Compared to previous years, 2003 registered O<sub>3</sub> amounts exceeding threshold limit values for public information (180 µg/m<sup>3</sup>). Furthermore, during 2001-2003, this target value was largely exceeded at most monitoring sites, with the exception of several urban stations.

## Policy Measures and Responses

### Climate change

The United Nations Framework Convention on Climate Change (UNFCCC) “acknowledges that changes in the Earth’s climate and its adverse effects are a common concern of humankind.” The ultimate objective of the Convention is to achieve “stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.” The Carpathian countries participate in UNFCCC and Kyoto mechanisms designed to limit their emissions and adapt to climate change. According to the Protocol, the countries included in Annex B of the protocol agreed to reduce their aggregate emissions of all greenhouse gases (i.e. CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, HFCs, PFCs and SF<sub>6</sub>) on average by 5.2% compared to 1990 levels during the first commitment period of 2008 to 2012. The EU, including five Carpathian countries, accepted a target of -8%.

The emission reductions registered in the Carpathian countries since 1990 are the result of

a number of processes linked with the transformation of their economies during the transition period. These include a gradual decrease in energy intensity, higher share of services in GDP generation, higher share of gas fuels (as opposed to oil and coal), structural changes in industry, decrease of energy consumption in energy-intensive sectors (with the exception of metallurgy), less energy-intensive industries, and the impact of legislative measures influencing directly or indirectly GHG emissions (SHI 2006).

According to predictions of the future dynamics of GDP growth in the Carpathian countries, there is a legitimate assumption that GHG emissions will increase in the near future. It therefore seems necessary to prepare investment strategies and programmes to achieve GDP growth, while simultaneously maintaining emissions at levels that meet the requirements of the Kyoto Protocol.

One option to reduce CO<sub>2</sub> concentrations in the atmosphere is to apply Carbon Capture and Storage (CCS) technologies, as mentioned in the

“IPCC Special Report on Carbon Dioxide Capture and Storage” (IPCC 2005b). CCS is a process that entails the separation of CO<sub>2</sub> from industrial and energy-related sources, transport to storage locations and long-term isolation from the atmosphere. Furthermore, CCS is recognised by the UNFCCC as a “mitigation of emissions at source”, and thus represents an eligible mitigation action under emissions trading schemes and the Clean Development Mechanism (CDM).

Other mitigation options include energy efficiency improvements, switching to less carbon-intensive fuels and nuclear power, using renewable energy sources to a larger extent, enhancing biological sinks and reducing non-CO<sub>2</sub> GHG emissions (such as methane and nitrous oxide).

In addition, the importance of using biofuels for transport has also been stressed in strategy and action plans of the European Union (EC 1996, 1997). There is also an EU Directive on the promotion of biofuels and other renewable fuels for transport, that obliges member states to sell a certain amount of biofuels on their national markets for transport fuels in the period 2005 – 2010 (Directive 2003/30/EC). The opportunities for energy crop production are also acknowledged in the Common Agricultural Policy (CAP). Conversion of excess cropland to profitable energy crop production is regarded as one option for addressing several key challenges in the agricultural sector, such as the abandonment of cropland, increased unemployment and depopulation in rural areas.

At present there is a modest use of bioenergy in the EU; about 6% of the primary energy supply is biomass-based (EC 2003). Carpathian EU members have a substantial biomass production potential, and production costs are much lower than in Western European countries. If this potential would be realized, these countries could contribute to EU targets on bioenergy and renewable energy sources (Berndes and Hansson 2007).

Finally, according to REC/EURAC (2005), all Carpathian countries have National Environmental Programmes and other related programmes focusing on specific environmental issues. Only Romania reported a “Sustainable Development Strategy on the Mountain Region”, which was approved in 2004. A National Strategy on Climate Change for the period 2005 to 2007, and a National Action Plan on Climate Change for the same period have also been prepared. Also, Slovakia began a National Climate Programme in 1993.

### Ozone

Options related to safeguarding the ozone layer have been presented by the IPCC Special Report “Safeguarding the Ozone Layer and the Global Climate System: Issues Related to Hydrofluorocarbons and Perfluorocarbons” (IPCC 2005a). The report notes that some options for protecting the ozone layer could influence climate change, while climate change may in return influence the ozone layer. According to this report, direct GHG emissions from refrigeration appliances can be reduced by 10% to 30%.

A variety of policies, measures and instruments have been implemented to reduce the use of ODS. Their consumption and production is controlled under the Montreal Protocol on Substances that Deplete the Ozone Layer, and they are being phased out according to a rigid timetable. Among existing mechanisms, there are regulations, economic instruments, voluntary agreements and international cooperation. Furthermore, energy and/or climate policies also encourage ODS' regulation, their substitutes or “not-in-kind” alternatives (i.e. non-fluorocarbon options). It should be noted that policy considerations are dependent on specific applications, national circumstances and other factors. As an example, the requirements contained in EU regulations are more stringent than phase-out targets of the Montreal Protocol.



## 3.7 Waste and Hazardous Chemicals

**A** current evaluation of waste and hazardous chemicals in the Carpathian region (e.g. industrial and agricultural waste production, number of illegal waste deposits) provides a mainly positive picture as, in general, the situation has improved since 1989. The amount of waste generated, including industrial and hazardous waste, decreased from 1990 to 1996 mainly due to the economic recession and general decline of mining and heavy industry. Improvements related to toxic and hazardous waste sites are particularly significant. The region also has new, progressive waste legislation and newly-established related institutions.

Despite progress, several problems remain and some negative tendencies have emerged. The amount of waste is increasing again, accentuating environmental damage such as soil and water pollution and spoiling landscapes and aesthetic values. In many places, waste dumping is on the rise, sometimes dramatically, as old refuse dumps are full and there is a lack of acceptance of new sites being placed in local communities. Key issues related to waste management in the Carpathian countries are the predominance of landfilling as a waste management option, and the problem of low recycling rates.

The greatest problem appears to be municipal waste, where waste generation is worse than 17 years ago. The existence of obsolete hazardous chemicals remains a major issue. One emerging problem concerns new types of hazardous chemicals and the recent 'hazardous waste market'. A special category of problems is represented by brownfields and the numerous sites which have been ruined by a variety of waste-related problems.

Moreover, major new construction projects (e.g. large dams, highways, factories, harmful mining technologies, mountain winter sport resorts) have led to severe negative impacts on nature and landscapes, as well as producing additional wastes.

The import and mass utilization of non-recyclable materials have increased problems associated with waste management, especially at the local level, including a significant rise in the total amount of municipal waste. Finally, legislative, conceptual, organizational and technical ignorance of the scope of problems such as communal waste has caused the proliferation of thousands of small local waste sites, both informal and illegal.



## Municipal Waste

During the communist period, municipal waste management received little attention or funding. In the majority of the Carpathian countries, both relevant legislation and institutions did not exist. For example in 1989, Poland did not have an efficient system for collecting or recycling municipal waste. Every year, 40 to 46 million cubic meters of waste were dumped at disposal sites, with over 500 refuse dumps located in towns and 1,300 in rural areas. Simultaneously, there were over 10,000 illegal deposit sites located in forests or along country roads (Nowicki 1997). However a system did exist for collecting old paper and glass bottles.

Since the demise of communism, especially in the first period after 1989, the municipal waste situation worsened, in part because of the collapse of the system for collecting old paper and glass. Other causes were the increased use of non-reusable packages and lack of municipal waste recycling. With more processed food products, and the spread of supermarkets and other large chain stores, increased human consumption has resulted in greater waste production. Overall, municipal waste production in all Carpathian countries has grown significantly in the last decade by about 2 to 5% annually (Třebický et al 2002).

At the same time, total municipal waste production in the Carpathian countries remains below the EU and OECD averages. Hungary is the only exception, where the estimated per capita quantity of municipal waste corresponds to the average of the European OECD countries and is much higher than in other Visegrad countries. Hungary has the highest relative production of municipal waste among all OECD countries per unit of consumption. At the end of 1990s, Poland was fourth, Slovakia fifth and the Czech Republic tenth in relative terms (OECD 2001). With waste production in the Carpathian region now rising at a faster pace, the difference between the Carpathian and OECD countries is diminishing.

Despite general improvements since 1989, most communities next to rivers lack proper garbage sites and refuse is dumped on river banks. Furthermore, some polluting industries are still operational. The great majority of water purification stations are inadequately operated and/or their operational capacity is relatively low. Groundwaters are degraded by organic substances and other pollutants spilled by the chemical industries of large urban agglomerations, and by other sources such as oil and salt water.

### The waste situation in Hungary

In Hungary between 1985 and 1994, the quantity of waste generated dropped by approximately 20% due to reductions in economic output and consumption.

About 82% of municipal waste was collected at the end of the 1990s, of which most was disposed in waste disposal sites and 15% was incinerated. While the capacity of existing waste disposal sites is sufficient for several years, not all meet environmental standards. Moreover, numerous illegal dump sites and waste disposal sites near villages and towns also fail to meet environmental standards. Only about one-half of all production waste is re-used, representing 3% of total material use.

Various waste management projects, especially for waste minimization (e.g. re-use and recycling, methods, technologies, systems and investments) and waste disposal investments (under new rigid regulations) are launched and at least partially financed from the 'Central Environmental Protection Fund' and/or co-financed from international financial sources.

The state of sewerage and sewage treatment is unsatisfactory. In order to improve this situation, new programmes and financial means were introduced particularly from the mid-1990s to meet the requirements of EU accession (see more in Geller 2002).

## Hazardous Waste

Hazardous wastes and their management are a substantial problem in a majority of the Carpathian countries. The number of sources generating hazardous waste is fairly stable. Approximately 65% of the total amount of hazardous waste comes from manufacturing. The share from the processing industry is only about 27-29%, indicating large volumes of hazardous waste generation at individual sources. This may suggest that new, smaller industrial sources do not report waste in order to avoid fines. The agriculture and service sectors also generate small volumes individually, including pesticides.

The current status of hazardous waste production is less clear in other economic sectors such as mining and quarrying, construction, electricity, gas and water supply, wholesale and retail

trade, repair of motor vehicles, health and social work, as well as other community, social and personal service activities.

In Poland, hazardous wastes are and will continue in future to be a serious problem (Nowicki 1997). The annual production reached about 4.5 million tonnes in the year 2000, of which only 27% was recycled with the remainder dumped at more than 800 deposit sites. To date, over 400 million tonnes of hazardous waste, mainly from chemical and pharmaceutical industries, have been deposited in dumps.

In Hungary, a programme to build a network of regional hazardous waste landfills and incinerator plants was elaborated in the mid-1980s, but has not been fully completed due to limited financial resources.

### Foreign waste import to Ukraine

In the EU, hazardous waste export has a fairly extensive history and remains to this day a relatively inexpensive option. For example, before 1989, some 675,000 tons of toxic waste were transported annually from the former Federal Republic of Germany to the former German Democratic Republic. Today, much waste from EU countries continues to be transported to the East.

Bakta village, in Berehivschyna in the trans-Carpathians close to the Hungarian border, is a typical example of the new toxic import business. German journalist Ralf Arens published a story about Bakta and how it represents Ukraine being used as a frequent destination for hazardous wastes.

The story begins with Oksana Stankevych, an environmentalist from the local environmental NGO Ecosphere, and villagers examining bags on the territory of the State Institute of Agriculture in Bakta in the winter. Then, the chemical smell is hardly noticeable. In the summer, however, "there is a smell in the air, and the headache comes along in five minutes," she says.

The bags are labelled with "Premix" and contain red-brown powder of unknown origin. According to official information, from 1999 to 2005 the Hungarian company Eltex from Debrecen sold 1,500 tons of Premix to the trans-Carpathian company "Ozone" as raw material for manufacturing brake blocks. However, never reaching

Ozone, the bags were left in different trans-Carpathian locations, four of which have been revealed. One is located in Shom village in a school courtyard. In early 2005, local engineer Sofroniy Gumeliuk sent the powder for chemical testing, after which one laboratory worker exclaimed: "After several more years, there will not be a single human left in Bakta!"

Shocked villagers informed newspapers and TV stations. In response, the Prosecutor General's office in Kyiv interfered and ordered the State research institutes to carry out further detailed analyses. Results confirmed that Premix contained high levels of poisonous heavy metals such as lead, chrome, copper and nickel. Although Ukrainian law requires compounds such as Premix to undergo special treatment, nothing was done to address the problem.

A Bureau of Environmental Investigation representative Dmytro Skrylnikov remarked that: "Since 2003, we have been applying to the Council of National Defence and Protection, the General Prosecutor and other competent authorities with the notification that Ukraine is becoming the polygon for European wastes of different types and hazard classes." He added that investigations of all cases should be immediate, that there is a need to introduce a moratorium on the import of wastes, and to develop and introduce effective legal mechanisms to prevent and control hazardous waste imports.

An important emerging problem is the illegal or “semi-illegal” import of hazardous waste and toxic chemicals from one Carpathian country to another. For example, from 2003 to 2006, different types of hazardous waste were illegally imported from Hungary into Ukraine’s Lviv region. These included 3,044 tons of maleic anhydride residues and 2,996 tons of acid tar. The acid tars were brought to the Dobrotvir Thermal Power Station for incineration, and the maleic anhydride residues to Drogobych City. Several new locations for waste disposal have been discovered, including one at a school in Shom village (see box above).

In June 2005, Itar-Tass reported that Ukrainian law enforcement agencies had begun searching for 3,500 tonnes of highly dangerous chemical waste imported from Hungary to Ukraine over the last five years. The first 500 tonnes of toxic chemicals were found in ordinary sacks stored in the open air at enterprises in the Beregovsky district of trans-Carpathia. In response, Ukraine’s President requested that the Ministry of Environmental Protection and the Ministry of Health begin a review of contaminated facilities.

## Industrial Waste

At the end of the 1980s, industrial plants in Poland generated about 170 million tonnes of waste, 43% of which was dumped into disposal sites. Industrial waste production declined with the fall in heavy industrial production following the end of communism. However, the decline was reversed during a renewed period of industrial growth. Nearly 50% of industrial waste is now dumped at deposit sites. The same rate applies to waste from coal mines and fly ash from power plants. The situation is even worse for zinc and copper mining, where only one-third of the waste is recycled, in comparison to Western countries where 70-80% of industrial waste finds many other economic applications (Nowicki 1997).

A similar trend was noticed in Hungary. Here, the assertion that the economic recession in the first part of the 1990s was the most important factor behind a declining trend is supported by the obser-

vation that, where the power sector’s output is slightly increasing, waste generation also increases (i.e. waste production is linked to economic production; see more in Lehoczki and Balogh 1997).

The share of industrial waste in the total waste production of Czech Carpathian districts is about 22.6%, with less than 1% recycled. In Slovakia, 79% of agricultural waste and 60% of the waste from hotels and restaurants is being recovered. The percentage of recovered waste from industry in Slovakia is also relatively high (29%).

The main groundwater pollution sources are communal sewage, mostly in rural areas, and the agricultural sector. The main pollutants from agriculture are phosphates and nitrates. One can generalize that the use of industrial fertilizers and pesticides has been high, with serious impacts on soils, underground waters and the entire biosphere, including human health.

## Waste Management

Waste management is a key response, but in general remains poorly developed in the Carpathians, in comparison to the substantial

progress that has been made in air and water protection. The creation of modern, large disposal sites and waste incineration plants often

faces heavy protests from local authorities or municipalities.

However, an increase in proper waste management techniques may be seen among private and public companies and local governments, as evidenced by an increasing number of new municipal waste management investment projects and waste processing plants. New legal and eco-

nomie measures favour and sometimes enforce these trends.

For example, the Act on Waste Management, in force in Hungary since January 2001, introduced general conditions for performing various waste management procedures/activities, special rules for the management of municipal and hazardous wastes, and waste management planning tasks.

### Waste management in Slovakia

Since 1991, when the first Waste Act entered into force, Slovakia achieved many significant results, although the country still faces important challenges. Waste management is now a comprehensive system covering waste prevention, collection and treatment.

Slovak waste legislation has been harmonised with relevant EU directives. While the directives lay down overall frameworks and principles, the organisation of waste management and implementation of the directives is a national task. Slovakia's central legislative instrument, Act No. 223/2001 on their implementation, is regulated by a set of Orders issued by the Ministry of the Environment.

In order to attain the objectives set by legal regulations, waste management plans are developed on a five-year basis. Plans should represent the baseline for measures to minimise waste generation, waste handling and the preparation of territorial planning documents. The Waste Management Plan of the Slovak Republic is prepared by the Ministry of Environment, based on source materials

be recovered for energy production and only 15% to be disposed of in landfills. The obligatory part of the Plan contains particular objectives for a number of priority waste streams.

Waste holders and waste operators are obliged to prepare their own plans and keep records of the waste types and quantities handled, and their recovery and disposal, and report stipulated data from the records to the respective state administration bodies in waste management. These reports are sent to the Regional Waste Information System (RISO) operated by the Slovak Environmental Agency. Data on municipal waste are processed by the Statistical Office of the Slovak Republic. The data are published in the annual 'State of the Environment Reports of the Slovak Republic' ([www.sazp.sk](http://www.sazp.sk)).

In 2004, from the treated amount of waste, 27% was recovered while 27% of hazardous wastes and 47% of other wastes were dumped in landfills. All 165 operational landfills in Slovakia comply with waste legislation requirements.

Table 3.13 Waste generation and treatment in Slovakia in 2004 (t)

Waste	Generation	Treatment by Authorised Companies
Hazardous	1,021,201	432,257
Other	14,885,578	8,974,972
Municipal (included in other waste)	1,475,122	1,475,122
TOTAL	15,906,979	9,407,229

Source: Slovak Environmental Agency, Statistical Office of the Slovak Republic

Note: The difference (6,499,750 t) is the amount treated directly by producers at their utilities.

from the regional and district authorities, and adopted by the Government.

In February 2006, the Government of the Slovak Republic approved the Waste Management Plan for the period 2006 to 2010, the fourth since 1992. The Plan sets down quantitative objectives for 2010 including 70% of the total amount of waste to be recycled, 15% to

According to the Act on waste, municipalities shall introduce separate collection of paper, plastic, metals, glass and biodegradable waste no later than January 1, 2010. To achieve this objective, municipalities can also benefit from the Recycling Fund, a non-state special purpose fund to pool financial means to support the collection, recovery and processing of wastes. (Šimkovicová and Huba 2006)

## Conclusions

It is clear that the annual volume of solid waste generated in Carpathian countries will continue to grow during the next decade, due to the increasing affluence of residents, as well as changing lifestyles and consumption patterns (e.g. more households, rising consumption of single-use goods). Waste management practices need to improve as well. It is probable that a higher share of municipal waste will be recycled, and that the environmental standards for both landfill disposals and incinerators will improve.

The majority of the landfills in the Carpathian EU member states do not comply with the standards elaborated in the EU Landfill Directive. The non-complying landfills will have to be either closed down and the sites rehabilitated, or upgraded to comply with EU standards. Considerable investment is thus needed in this area.

National Waste Management Plans are important strategic documents to reach full compliance with EU standards. These Plans cover aspects such as compliance with National and Community waste policy, in particular reaching the

proposed targets, establishment of sufficient capacities and investment requests.

On the other hand, waste legislation at the EU level is evolving, particularly with the recent revision of the Waste Framework Directive in June 2007, addressing in particular the challenge of establishing a system of efficient and environmentally-friendly incineration of waste, characterised by energy recovery and cross-border trade in waste between EU member states. The Directive also introduces a five-step hierarchical "order of priority" for dealing with wastes as follows:

1. prevention of waste;
2. re-use of products;
3. recycling/composting;
4. recovery of energy by incineration, and;
5. landfill disposal.

This hierarchy is to be applied "flexibly" by member states, whose first priorities in the Carpathian region must still be considered as the needs to reduce landfill disposals, and increase the recycled share of waste.



## 3.8 Environmental Security

**E**nvironmental security issues are related to both natural and technological risks and hazards, which are as well increasingly interconnected. Many environmental security issues are of growing importance in the Carpathians due to the pressures of global climate change, as well as the large number of obsolete technologies and legacy environmental problems existing in the region. This section deals with natural hazards such as floods,

drought, soil degradation, seismic activities and risks, and geomorphological hazards including landslides, karst and mining subsidence and collapse, snow avalanches, water and wind erosion. Technological hazards such as those related to radioactive substances, the chemical industry, accidental pollution from hydrocarbons and other noxious substances, accidents from mining and tailing dam deposits, and damaged river dams and other waterworks are also analysed.

### Floods in the Carpathian Region (1990-2005)

#### Background

Floods, often referred to as extreme hydrological phenomena, are in most cases unavoidable natural threats. In most years an extensive flood with the character of a 10-year extreme high water event occurs somewhere in the region. Floods originate from the Carpathian Mountains, but their consequences are evident in lowlands, particularly in the Danube River Basin, and thus

the issue of floods is addressed in the context of the wider Carpathian region.

Several risk factors contribute to increased flood hazards in the Carpathians (Hanušín 2006, Wyžga 2006). One of the most important is the shape of the hydrographical network. The high concentration of several lower river reaches in a relatively small area in the Carpathian Mountains, closing three sides of the central Danube

lowland, determines high flood risks. The hydrographical network of the Bodrog River in Eastern Slovakia and the Crisul/Körös system in Western Romania/Eastern Hungary have similar shapes. The geological substratum consisting of rocks with low permeability, and the character of the relief caused by the young tectonics of the Carpathian range, are additional natural factors that contribute to the occurrence of floods in the region.

Human activities in the Carpathians contributed to landscape transformations which may have impacted the hydrological cycle. For example, Dutch engineers built a hydro-technological system in the mid-19th century in the Tisza Basin (including the Tisza, Bodrog and Ondava rivers) that led to straightening and shortening of streams, construction of dikes and drainage canals, and draining of wetlands. These appeared to be positive measures at the time, and similar approaches were gradually applied to other parts of the region. In the 1950s and 1970s, numerous dams and water reservoirs were built to control flood discharges, and drainage systems were

developed to remove surplus water from the land.

The collectivisation of agriculture led to significant changes in land use and contributed to accelerated runoff. Technocratic procedures, relying on efforts to achieve the fastest possible draining of runoff from the basin and to capture surplus flood discharge in artificial reservoirs, were applied for flood control. In spite of the suggestions and warnings of hydrologists, it long appeared that this approach was correct and sustainable due to the absence of extensive or intensive floods over several decades. However, this technocratic vision gave rise to construction activities in territories within the immediate reach of potential floods.

### Impacts

As a result, the Danube alone, the main water receiving body in the Carpathian region, lost 80% of its original floodplains by area. In Hungary, 4,200 km of dikes were built to protect 23% of the country against floods, but they also

**Table 3.14 Overview of largest flood events in the Carpathian region (Hanušín 2006)**

Year, Month	River basin /Country	Number of victims	Flooded territory (km <sup>2</sup> )	Number of directly impacted inhabitants
1991, July	Siret/RO	71		10000 evacuated
1993, December	Upper Tisza/UA	5		25000 evacuated
1996, January	Cris, Somes, Siret/RO	2		19000 evacuated
1997, July	Morava/CZ; Váh/SK; Odra/PL	about 10-15 in Carpathian region	240 (only on the Slovak side)	20 000 (only on the Slovak side)
1998, June	Siret, Mures/RO	23	1000	more than 10 000
1998, July (flash flood)	Svinka/SK	47	several tens km <sup>2</sup>	10 000
1998, November	Upper Tisza with tributaries/UA,RO,HU,SK	16	3500	25000 evacuated
1999, June	RO	16	230	About 7000
1999, November	Upper Tisza /UA, HU, SK		several hundreds km <sup>2</sup>	150-170 000
2000, February	HU	0	3250	?
2000, March, April	Upper Tisza, Crisul/Körös, Muresul/Maros/HU,RO; Olt, Timis, Siret/RO	9	3500	about 45 000
2001, July, August	Upper Vistula/PL	30	290	16 000 evacuated
2001, March	Upper Tisza, Somes, Mures, Siret/RO	8	450	91 000
2001, June	Mures, Olt/RO	7	500	About 10000
2005, April, May	Tisza, Crisul, Mures,Olt/RO	40	2000	About 100 000
2005, July	Siret/RO	23	1500	13000 evacuated

limited the natural spread of floodwaters. Slovakia has more than 38,000 km of streams administered by water authorities, and 21% of them are secured by more than 2,800 km of dikes.

These protective measures are concentrated in lowlands that are outside the Carpathians. The 150 years of transformations to the river landscape and basins in the Carpathian region resulted in major changes to the original river network and shape of river channels, mostly in lowlands, that are now associated with diminishing natural floodplains. Population increase, expanding urbanization and inadequate agricultural and forestry management in river basins have also heightened flood threats in the region. These threats became evident in the 1990s when the frequency of disastrous floods increased. Fluctuating climate parameters, particularly mean temperature rise and higher incidence of extreme rainfall events, are the evident causes of the observed increase in flood frequency.

Table 3.14 identifies the largest floods in the Carpathian region during the 1991-2005 period. High flood incidence areas are located in the Romanian river basins, particularly the upper and middle reaches of the tributaries Tisza, Cris, Mures and Olt, the Ukrainian and northeastern Slovak Carpathians and their rivers such as the Laborec, Uh and Latorica, and the middle reach of the Tisza in Hungary.

Floods cause both damage to and complete destruction of dwellings, buildings and infrastructure. One major flood impact was the contribution to the collapse of walls of a mine tailings reservoir in Baia Mare, Romania, in January 2000, which led to a huge cyanide spill and contamination with other pollutants in local water bodies and the Tisza River (and Danube). Increased heavy metal concentrations were detected in the drainage basins of Lăpuş/Someş and Vişeu/Tisza, in the vicinity of mining and industrial centres (Macklin et al. 2003).

High flood waves and overflows also have severe effects on settlements, communication routes and terrains. The deforestation of various Carpathian areas has increased the risk of overflows through higher discharge velocity, erosion processes, sediment transport and deposition, as well

as over-elevation of channel beds in the plains. One typical example is the last flood events that affected more than 50% of Romanian territory in July-August 2002 (Stănescu and Drobot 2002).

## Solutions

Flood control strategies are slowly being modified in response to many extensive flood events at the end of the last century. Under the pressure of newly-gained experiences, many hydrologists from the region have now agreed that an exclusively technocratic approach is unsustainable. Alternative and more sustainable measures are slowly being reintroduced, such as widening the area between dikes, creating accumulation polders for capturing flood waves instead of permanent reservoirs, revitalizing streams and increasing natural retention capacities. Unfortunately, in most cases, these efforts remain at the 'conceptual' and 'visionary' stage. In addition, the EU's most important water-related legislation the Water Framework Directive (EU Directive 2000/60), does not explicitly address the issue of floods.

Early warning systems, based on meteorological and hydrological data, are also important for minimizing flood hazards. Flood warning systems are being established both at national and regional levels. The European Flood Alert System (EFAS) is the most important flood man-

### The early warning system in Slovakia

Slovakia's Comprehensive Monitoring and Information System for the Environment, adopted in 2000, consists of partial monitoring systems dealing with individual components of the environment (e.g. water, air, biota, forests, soil, wastes). The system is comparable with similar monitoring systems in the EU and OECD countries. The overview of data related to the environment is enabled by a meta-information system 'Catalogue of environmental data sources' operated by the Slovak Environment Agency, and compatible with those implemented in other EU countries. The catalogue is interconnected with a multilingual environmental thesaurus published by the European Environment Agency. The Information System on Monitoring (ISM) is defined as a subsystem of the Information System on the Environment. Its task is to maintain integrated whole-area monitoring. The ISM is an interdepartmental information system operated by the Ministry of the Environment.



agement tool in the Carpathian region. Some countries are simultaneously preparing their own alarm systems compatible with the EFAS. In addition, the Action Programme of Sustainable Protection against Floods in the Danube Basin should be implemented by 2009.

Flood control financing is problematic in most parts of the region. Flood damages are estimated at tens of millions of euros (see Table 3.14) and represent large burdens for most national budgetary systems. For example, during the period 1998 to 2002, floods produced damage equalling 0.19% of the Romanian GDP, 0.13% of the Hungarian GDP and 0.76% of the GDP in the Czech Republic. In the Polish Carpathians, significant

impacts were also observed within hydro-technical structures such as dikes and dams.

Unexpected floods also expose governments to calls for reclamation from victims. Among possible solutions, practical approaches including financing for immediate counter-measures are a necessity. At times, the issue becomes a political tool, bypassing the need for realistic and preventive flood-control. For example, Slovakia's ambitious flood control plan approved by the Government in 2000 failed; from the proposed budget of 21 billion Slovak Crowns, only 15% was actually allocated for measures that immediately followed floods.

#### State of knowledge of flood causes and effects in different parts of the Carpathians

Several natural and human-related factors determining the degree of flood hazards in the Polish Carpathians over the past century are specified below. The expertise from Poland can be generalised for the majority of the Carpathians territory (Wyzga 2006).

**Low retentiveness of flysch bedrock:** Steep slopes, typical of mountain areas, induce rapid runoff over the entire Carpathian area. In the Polish Carpathians, the rapidity of the runoff is further increased due to the bedrock character, as the vast majority of the area is constituted by flysch rocks with a very low potential for groundwater retention.

**Erosional character of floods in mountain areas:** Flood hazards connected with high-energy mountain rivers mainly result from rapid erosional and sedimentary processes, with less danger caused by the inundation of valley floor areas.

**Reduction in peak discharges of flood waves from mountainous areas in the Polish Carpathian river basins:** A comparison of mean annual floods calculated for the periods 1921 to 1955 and 1956 to 2000 indicate some reduction in peak discharges of flood waves generated by the mountainous areas of the Polish Carpathian river basins in the second period. In the eastern part of the Polish Carpathians, the reduction was approximately -30%, reflecting both the change in the precipitation pattern and the regulatory effect of reforestation (this part of the Polish Carpathians was rapidly depopulated in the 1940s, with a subsequent considerable increase in forest cover) (Lach and Wyzga 2002).

**Loss of floodplain retention due to deep channel incisions in Polish Carpathian rivers:** During the 20th

century, the rivers draining the Polish Carpathians became deeply incised (up to 3.8 m), mostly in their foothill and foreland reaches. One effect of this process was a loss of floodplain retention and a temporal increase in peak discharges recorded at the downstream end of the Vistula tributaries.

#### **Negative consequences of floods in Polish Carpathians, common for all Carpathians and Sub-Carpathian regions**

**Economic losses:** In the 20th century, 46% of the flood-related economic losses within the upper Vistula drainage basin were caused by floods of low and moderate magnitude, up to 10-year flood events (Roszkowski and Hennig 1991). Damage to hydro-technical infrastructure such as bank-protection structures, weirs and flood embankments constituted a considerable part of the total economic damage. This means that a significant proportion of losses resulted from positive feedback of the hydro-technical infrastructure. In other words, increasing the number of hydro-technical structures led to increased destruction and damage during flood events.

**Negative effects on the natural environment:** Generally, floods have been a natural component of the environment for millions of years. Furthermore, affected ecosystems adapt to repeated flood disturbances. As a consequence, the impact of large floods on ecosystems is only minor and ephemeral (Denisiuk 2002). It is actually the lack of flood disturbance that considerably reduces the rejuvenation of habitats.

Source: Wyzga 2006

## Drought, Desertification and other Forms of Soil Degradation

According to the European Soil Bureau, the Carpathians belong to the “dry” areas of Europe. The recent climate evolution is the main factor behind drought episodes, with adverse impacts on the outflow of surface water, groundwater and soil humidity (Bujnovský et al. 2005).

The degree of soil and land degradation is influenced by particular soil and land uses. Agricultural soil degradation often results from improper agricultural practices related to soil, fertiliser and crop management. Soils were considered to be a tool of production that served to satisfy increasing consumer needs. In urban and industrial areas, the main threats to soil are pollution and compaction. While building new infrastructure requires the conversion of agricultural land, the restoration of brownfields is considered less attractive for investors.

Drought episodes last more than 20 days in some Carpathian regions. Several periods of severe drought have occurred over the last century, causing large economic losses and rural poverty. For example, the drought period of 2000 to 2003 proved to be disastrous for the Romanian economy, and led to enhanced desertification processes in areas already subject to intense human pressures (Bălteanu et al. 2006). In the Romanian Carpathians, highly eroded soils cover 20.6% of agricultural lands, moderately eroded soils represent 19% and slightly eroded soils 3% of the agricultural area.

The consequences of soil degradation have a gradual and long-term character, with negative impacts on the provision of environmental functions and biomass production. Improper soil use and management also affects the health of people through its contamination with toxic elements.

At the global level, the UN Convention to Combat Desertification (CCD), to which Carpathian countries are signatories, addresses the issue of drought and its consequences. According to the

CCD, Carpathian countries are both developed and, at the same time, affected countries. They are therefore obliged to address their own desertification, degradation and drought problems, and engage in organizing expert (or other forms of) aid to countries that are intensively impacted by desertification, soil degradation and drought (mainly developing countries).

According to the CCD, the term “drought” is defined as the ratio between annual precipitation volumes and evapotranspiration. The majority of the Carpathians is not significantly endangered by drought; the problem is more relevant to Southeastern Europe, and therefore to southern Carpathian slopes, as well as foothills in the Western, Eastern and mostly Southern Carpathians. Annex V of the CCD deals with Central and Eastern European (CEE) countries, including the Carpathians. CEE countries are obliged to adopt national action programmes as an integral part of their policy framework for sustainable development, and address in an appropriate manner various forms of land degradation and desertification.

### Windstorms in the Slovakian Carpathians

The number of registered windstorms with negative impacts on the environment in the Slovakian Carpathians increased during the period 1996 to 2005. The largest number (15) occurred in the Brezno District in 2005, followed by the Poprad District (10) in the years 2002 and 2005. These districts cover the territory of the highest mountains in Slovakia as well as the Tatras. 2000 and 2005 had the highest number of windstorms (152), followed by the year 2003 (123).

In 2004, there were “only” 111 windstorms, but the largest one on 19 November destroyed large forest areas in the High Tatras, Low Tatras, Orava Beskyds and Muránska planina plateau. It swept through the transboundary Tatras National Park and Tatra Biosphere Reserve (BR) shared by Slovakia and Poland, seriously damaging 14% of the total area of the Tatra BR in Slovakia (approximately 12,500 ha or 2.7 mil m<sup>3</sup>) and affecting 7.1% of small-scale strictly protected areas in the BR.

## Geomorphological Hazards

In the Carpathians, the contact zone between the Eastern and Western Carpathians, and the south-western margin of the Southern Carpathians, are most relevant from the seismic point of view and associated risks. The southern and western parts of the Western Carpathians and the southeastern part of the Eastern Carpathians between Hungary, Ukraine and Romania have moderate seismic activity and lower risks (Giordiny, Jimenez and Grundthall 2003).

Romania is a high seismic risk country, with the epicentre of many events located in the Vrancea region. On 4 March 1977, an earthquake led to 1,570 deaths, 33,000 buildings being destroyed and 763 factories damaged, with estimated losses of over two billion US\$ (Bălan, Cristescu and Cornea 1982). In the epicentral area, the earthquake reactivated fault lines with the formation of mud volcanoes, landslides, rockfalls and variously sized fissures (Bălțeanu 1983).

Although the territory of Slovakia is not ranked among the most hazardous regions of the world, geomorphological hazards represent a serious problem for the economy and development of the country. The morpho-structural effect of tectonic movements, natural conditions, and human inter-

ventions in the Slovak part of the Carpathians has led to a relatively high degree of geomorphological hazards such as earthquakes, landslides and related phenomena, karst and mining subsidence and collapse, snow avalanches, water and wind erosion and floods, many of which are interlinked (Minár et al. 2006).

The risk of **landslides and related phenomena** is relatively high due to the predominantly mountainous character of the region. The regional extent of slope failures depends on the geological structure and rock type, as well as geomorphologic, hydro-geologic and climatic conditions. The most affected areas are flysch uplands, intra-mountain basins and the marginal parts of young volcanic mountains.

**Karst and mining subsidence and collapse** constitute another geomorphological hazard in the Carpathians. According to Jakál (2000), the high degree of near-surface karstification induces high risks, particularly in areas where carbonate massifs are strongly affected by tectonics, and cave levels are located close to the surface. Subsidence and collapse are also typical phenomena for mining areas, and occur frequently in geological contact zones.

### Floods, accidents and natural disasters in Slovakia

Water-related accidents	1995	1996	1997	1998	1999	2000
	129	117	109	117	88	82

**Largest loss of human life** (July 1998): Eastern Slovakia – 46 victims, 4 persons missing. The peak discharge was of a 1000-year extreme water event. In 1999, damage costs represented 4,528.6 Slovak Crowns, in 2000 – 1,298.6 mil. Slovak Crowns

**Largest flood in 20<sup>th</sup> century:** 16 June 1965 in Čičov near the Danube River (flow rate 9,000 cubic meters per second, height 9 m)

**Largest landslide:** Handlová (1960-1961) 1,630 m long, 1,200 m wide, maximum thickness 30 m, 20 million cubic meters

**Highest measured speed of wind:** Hurricane (10 Beaufort scale), Skalnaté Mountain Lake – 78.6 meters per second

**Fire accidents in Slovakia** (2000): Agriculture 2,346; habitation 1,940; transport 1,230; forestry 937

**Highest percentage of fires** (2000): agriculture (20 percent of all fire accidents)

**Highest number of fire accidents** (2000): nature (3,949 fire accidents)

Source: *Environment of the Slovak Republic, Ministry of the Environment, Bratislava, 2001*

**Snow avalanches** are a significant geomorphological hazard in the Western Carpathians' high mountains. Up to 300 avalanches are registered in each winter season in the Slovak Carpathians

alone (Midriak 2002). From 2000 to 2005, avalanches killed 24 people and injured 33. Skiers, mountain climbers and hikers are among the most vulnerable groups.

## Technological Hazards and Risks

Technological hazards and risks in the Carpathians are varied. As the population has been concentrated in urban agglomerations, buildings have been constructed in flood- and/or landslide-prone areas. Interactions between humans and the environment have become increasingly complex, and the damage incurred by extreme events is ever-greater. The lack of legislation in this field during the first part of the transition period contributed to further deterioration in environmental conditions through deforestation, destruction of protected forest belts and development of irrigation systems, enhancing the impact of both technological and natural hazards on society.

### Technological hazards in the Romanian Carpathians

Technological hazards are the result of errors in designing industrial installations and/or poor management of enterprises. Following Romania's accession to the EU, the 96/82 CE Seveso II Directive concerning the management of major accidents caused by dangerous substances became the main instrument in managing technological hazards. 333 locations are listed under this Directive (245 of major risk and 88 of low risk), the majority belonging to the chemical and petrochemical industry (Balteanu et al. 2006).

Hazards related to radioactive substances can pose great risks for humans. Romania has one nuclear station at Cernavodă, operated with advanced Candu-type technology. Among other nuclear hazard sources, the reactors used at the Institute of Nuclear Physics Bucharest-Măgurele, Pitești-Mioveni and the Heavy Water Works at Drobeta Turnu-Severin are the most important. The major risk for the western part of the Romanian Plain comes from the Bulgarian nuclear

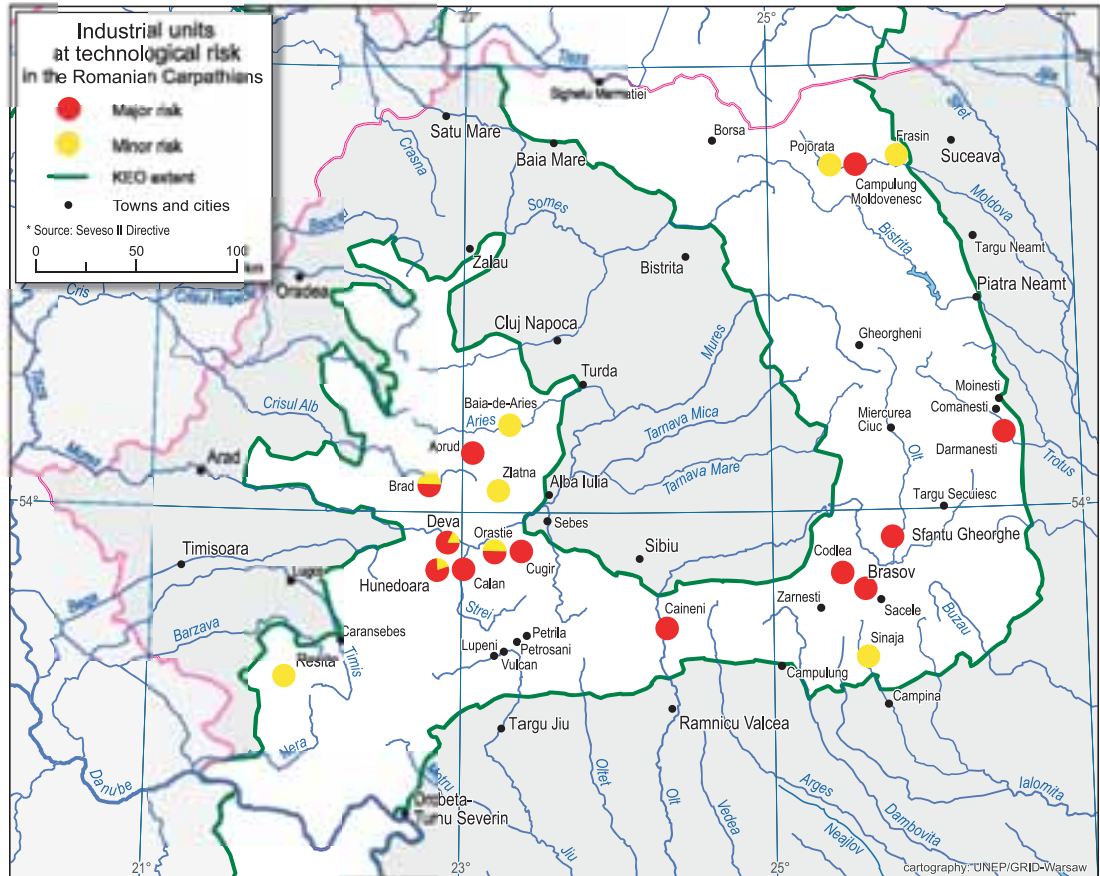
electrical generation plant located at Kozlodui, which is based on outdated technology. The Chernobyl (Ukraine) nuclear accident in April 1986 affected northeastern Romania, where the incidence of thyroid cancers and malformed newborns increased significantly.

Nearly 140 enterprises in Romania use noxious substances in their production processes (e.g. highly toxic substances, substances with specific toxic properties, inflammables and explosives). These enterprises operate under the provisions of national legislation. They also observe ISO 14000 norms, EU regulations regarding the management of the environment, and the IPPC 61 EC Directive authorizing industrial installations under the Seveso II Directive on the management of major accidents triggered by dangerous substances (Ozunu 2000) (see Map 3.16).

Accidental pollution with hydrocarbons and other noxious substances is due to advanced wear and flawed design of installations in the power industry, hydrocarbon transport and distribution network. Accidents occurring in oil extraction and processing areas entail heavy pollution of soil, surface waters and underground sheets. Pipes may be broken by floods or quake-induced fissures, leading to massive leaks of fluid fuels. In 2002, the Prahova River was heavily polluted over a distance of eight kilometres near the junction with Ialomița.

Hazards related to damaged hydro-technical constructions may affect approximately 1,600 embankment works (8,700 km) and 1,353 dams (total volume 13.8 billion m<sup>3</sup>). The partial failure or collapse of dams is caused by high flood-waves followed by catastrophic overflows. Outdated technologies are among high risk factors.

**Map 3.16 Industrial units at technological risk in the Romanian Carpathians (2003) according to Seveso II Directive**



The high flood-waves on the Tazlău River (July 29-29, 1991) that destroyed the Belci dam, followed by the sudden flooding of the valley downstream, produced 25 deaths (Stănescu 1995). In 1991, flood-waves destroyed 47 km of dams and nearly 117 km of maintained river

banks, killing 110 people. The collapse of dams may also have cross-border effects. For example, in April 2000, the dam across the Crişul Alb river near the Hungarian border failed and flooded the Ineu-Chişineu Criş sector.

**Forest fires in the Czech Republic and Slovakia**

In the period 1995 to 2005, the Carpathian district of the Czech Republic most affected by forest fires was Brevclav, in the southern part of the Moravian Carpathians. Other frequently affected districts are Prerov and Pros-

tejev. In Slovakia, during the same period, the number of people affected or killed by fires fluctuated between 37 in 1997 to 68 in 1992, with an average of 53 victims per year.

**Table 3.15 Fires in the Carpathian districts of the Czech Republic (1995-2005)**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number	24	39	9	21	14	28	7	13	34	27	20
Territory (ha)	15.19	46.27	4.67	14.46	8.32	7.91	5.28	7.06	11.81	8.13	16.98
Damages in mil. Czech crowns	1.022	2.773	0.331	0.986	0.814	0.702	0.680	1.367	1.595	1.342	1.636

## Conclusions

In the field of environmental security, the greatest set of problems is related to global climate change and its regional/local manifestations such as floods and drought. A special category of negative climate change impacts in the Carpathians is strong windstorms, with growing catastrophic impacts on settlements and forests.

Natural and technological risks and hazards are increasingly interlinked. Their diversity and importance is very high in the Carpathians. For example, some accidents involving casualties and environmental pollution are produced by

obsolete technologies, waste deposits or the transport of noxious substances. In certain situations, technological accidents, such as dam failure or explosions at installations may occur due to natural causes (e.g. earthquakes, floods), triggering a chain reaction of events. Certain technological disasters happening in one country may have impacts of a trans-border, regional or even macro-regional character. Research and monitoring, as well as adequate policy measures and their application in this field, should play an increasingly important role in the Carpathians.



## 3.9 Urban Environment and Cultural Heritage

### Urban Development

The urban environment and related issues are gaining in importance in the Carpathians. Rapid urbanization within the region is having the effect of putting additional pressure on the surrounding rural and natural environment, including biodiversity and traditional landscapes.

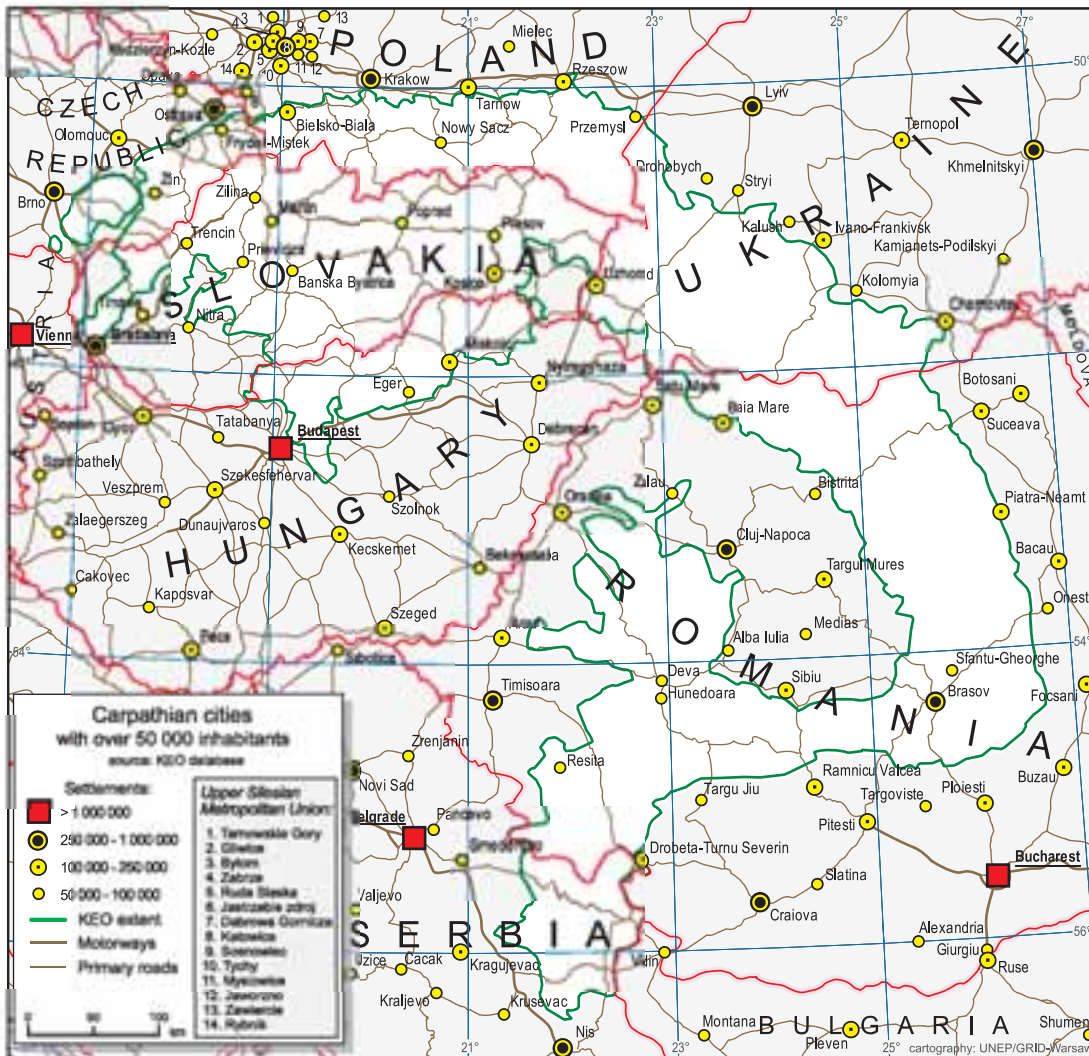
The legacy that past communist regimes left to Carpathian urban areas is still discernable. The growth and actual state of most urban areas during the communist era had little in common with today's concept of "sustainable" cities or towns. In fact, urban development during this period typically ignored inhabitants' requirements for a sound and healthy environment, as well as economic and social needs of future generations (Huba et al. 2000a).

The main aim of post-war industrialisation and urbanisation policy in the Carpathian region was largely attained through a gradual transition from prevailing traditional rural-agrarian struc-

tures to an urban-industrial society. This process was accelerated during the second part of the 20<sup>th</sup> century, significantly influencing the regional urban and suburban environment (Balteanu et al. 2006). As a consequence, most Carpathian countries today have large urban populations. For example, national statistics show that approximately 65 per cent of the population in the Czech Republic, Poland and Hungary, and 60 per cent in Slovakia, currently live in an urban setting.

In the period from 1950 to 1970, the Carpathians observed high rates of rural-to-urban migration. Between 1970 and 1990, industries were commonly located within or near residential areas. Air and water pollution, solid waste, noise, odours and soil contamination represented typical externalities (Vaishar et al. 2006). Furthermore, public and private transportation and related infrastructure depreciated the residential environment through noise, emission, vibrations and accidents.

Map 3.17 Carpathian cities with over 50,000 inhabitants (Hanusin and Huba 2007)



In terms of housing, a typical approach in the Carpathians during communism was Soviet-style urbanization based on large concentrated urban settlements, consisting mainly of concrete panel block buildings. These were common features of Carpathians' cities and towns, characterized by a lack of green space, proximity of polluting central heating plants, inadequate maintenance (e.g. low energy efficiency) and insufficient wastewater and solid waste management facilities.

In the Carpathians and their environs, one finds a single metropolitan city with more than one million inhabitants (Budapest), 13 cities with between 200,000 and one million inhabitants (e.g. Brasov, Bratislava, Kosice) and 22 towns and cities with between 50,000 and 200,000 inhabitants (see Map 3.17). Some other cities and towns are closely linked to the Carpathian region, while being geographically beyond its boundary. These large cities and towns, together with several industrial 'hot spots' in smaller settlements, are major driving forces behind environmental pollution and hazards within the Carpathians.



## Threats to and Impacts on the Urban Environment

Since the fall of communism and over the last 18 years of transition, changes to the urban environment and its forms and structures have been significant. Carpathian cities and towns have continued to face various negative effects from urban development. Changes were most spectacular in larger cities, but similar tendencies also emerged in other municipalities. Transport became the main cause of both air and noise pollution (Vaishar et al. 2006).

The transformation of the urban environment was influenced by political changes occurring since 1989 and the subsequent economic, social, environmental and institutional transition from a centrally-planned system to a market economy. Globalisation and its effects also contributed to urban change in large post-communist cities. As a consequence, a profound reorganization of urban management approaches has taken place, impacting the lives of millions of urban residents in the Carpathians. Post-communist towns and cities in the Carpathians are now characterised by a gradual development of new lifestyles, changes in demographic structure and behaviour, and social, economic and environmental changes.

Environmental transformations in urban areas in post-communist Carpathian countries combine the restructuring of the built environment with underlying processes and forces of socio-economic reforms. The liberalization of the property market, growing disparity of income levels and formation of a well-paid upper/upper-middle class due to economic changes are having major influences on the urban environment. The problem of the creation of economic "ghettos" in larger cities is also connected with social differentiation.

During the past 18 years, important demographic changes occurred in many towns and cities.

Reduced population growth caused by low birth rates has important implications for urban change. The rise of consumerism and the propagation of more materialistic values is a dominant cultural trend. These recent trends result in an emphasis on private property as an expression of wealth and status, especially by the new middle and upper classes. This includes the growing importance of private cars and living in suburban homes and apartment complexes.

Since the 1990s, the Carpathian economy entered a substantially different phase in terms of "production". Many industrial facilities were closed down and/or transformed, leading to lower industrial air pollution levels. The dominant trend has been the shift from manufacturing industries toward the development of a service sector, especially in city centres, where specialised shops, financial and business services have become concentrated. Another major outcome of the recent urban changes has been the re-industrialisation of some urban centres and adjacent areas. Green space is generally limited in inner-city areas, while extensive green areas in their surroundings sometimes compensates for this lack.

Technological advances that have transformed the means of interacting, living and working also had implications for urban reorganisation. The widespread commercial development of new technologies that have emerged during the 1990s (e.g. high-speed computing, advanced telecommunications) impacted the development of service systems and new forms and standards of residential environments (Ira 2003). Many post-communist cities changed their focus from industrial activities to services with high ambitions in the commercial, financial, cultural and educational spheres. Tourism has become an additional specific problem for the urban environment, due to its often intensive nature.

## Urban Sprawl and Suburbanization

Today, all Carpathians countries are undergoing a trend, often strongly manifested, towards suburbanization, particularly on the outskirts of capitals and other large cities (Gremlica 2002). The migration of urban populations into surrounding open spaces accelerated during the 1990s, causing mostly negative effects. Building in greenbelts is accompanied by ecosystem destruction and deterioration of living conditions due to more frequent car use, new roads, urban sprawl and fragmentation of natural areas. Inefficient and unregulated land-use patterns are thus formed, threatening sustainable urban development in the longer term (Gremlica 2002). Conversely, mainly from the perspective of quality of life and reduction of pressures experienced in the inner city, suburbanization can also be positive.

“Urban sprawl” is by definition uncontrolled and unorganised growth, which can indeed be seen in all Carpathian major cities. The situation is further complicated by the fact that land use and spatial planning have declined over the last 15 years due to several reasons; for example, corruption in decision-making at the local level

with respect to land use contracts and permits, governmental policies stimulating new investments in “greenfields”, while leaving extensive “brownfields”<sup>7</sup> all but untouched. In the Czech Republic, the agency Czechinvest offered investors 2,130 hectares of greenfields compared to only 320 hectares of brownfields. As a result, built-up areas are rapidly increasing with serious effects for local water cycles, traditional landscapes, local climates, and biological and cultural diversity.

Typical Carpathian suburbanization, except in some marginal cases, does not create new complete satellite settlements. Rather, new fragments, differing in the size of space and plots, are linked with existing village formations, infrastructure and amenities. There is little integration with the previously existing settlements, and the new patterns do not match the historic ones, leading to unattractive aesthetic results.

<sup>7</sup> Land previously used for industrial purposes or other commercial uses, that may be contaminated by low concentrations of hazardous waste or pollution.

## Urban Transportation

The transport sector in large urban areas is a major factor leading to negative environmental impacts. Since 1990, cities and towns in the Carpathians have experienced several common features and trends related to city transport (Hanušín 2006):

- Substantial growth of individual/private car transport and a decline in the public transport systems in most cities and towns in the region;
- New construction and improved transport infrastructure (e.g. parking, roads, highways);
- Increase in the number and gravity of accidents;

- Improvement in the technical parameters and thus performance of cars.

The growth in the share of bus transport in public transport is nevertheless a reality in most Carpathian countries: the increase ranges from 69% in 1993 to 82% in 2004 in the Czech Republic; 52% in 1993 to 71% in 2004 in the Slovak Republic; and 65% in 1995 to 79% in 2004 in Poland. Only in Hungary has the share of bus transport slightly decreased since the early 1990s.

Table 3.16 Changes in the number of passenger cars in selected Carpathian cities/districts in Slovakia after 1989

NUTS 4	1990	1991	1992	1993	1994	1995	1996
Prievidza	21708	22403	23537	24471	24268	24721	26323
Čadca	10618	10958	11761	12488	12727	13273	14632
Martin	18186	18768	18807	19755	19052	18995	20217
Žilina	24620	25408	27113	29148	28813	29676	30933
B.Bystrica	31825	32844	35663	39330	41845	44958	50368
Lučenec	16628	17160	18608	18766	18789	19152	20118
Rim.Sobota	16723	17259	18114	18632	18540	18821	16981
Veľký Krtíš	9183	9477	9696	9724	9490	9360	9671
Zvolen	23857	24621	25875	25967	25740	26002	27408
Bardejov	11448	11815	12224	12620	12675	12717	12301
Humenné	17582	18142	16233	16519	16488	16900	18593
Poprad	22701	23428	24476	23964	24080	24663	26478
Prešov	29266	30203	32711	31788	31835	32236	34864
Košice	45129	46573	50711	52842	52837	52277	57929
Rožňava	13394	13823	14455	14693	14700	14812	17548

Source: Slovak Environment Agency, 2006, adopted by Huba 2007

The main negative impacts from city transport are emissions, noise, congestion and land use changes for new transport infrastructure, as well as accidents. These impacts are more intensive, socially complicated and problematic than similar impacts outside urban areas due to the greater concentration of people and their activities within a relatively limited space.

The main pollutants produced by the transport sector are volatile organic compounds (VOCs), carbon monoxide, nitrogen oxides, sulphur dioxide, particulates, heavy metals and greenhouse gases. Increased pollution from more intense traffic levels in Carpathian cities and towns was partially compensated for by improvements made to technical parameters of cars and the use of unleaded petrol, resulting in an relative reduction of pollutants emitted, with the exception of carbon dioxide.

Figure 3.17 Two transport modes in Romanian Carpathians



Nevertheless, cities contribute to increased concentrations of air pollutants from road transport, particularly when located in a basin with weak natural ventilation. This situation is typical for the Carpathians; for example in Brasov, Romania and to some extent in Kosice, Slovakia. Streets and squares suffer from similar effects, with concentration of emissions from car transport reaching high values. In addition, maximum noise limits in residential areas (as established by WHO) are frequently exceeded in Carpathian cities.

Intensive car transport and expanding road networks are in conflict with the historical design of many Carpathian cities. The result is traffic congestion, with many negative impacts such as

increased emissions and noise, often at the cost of disturbing historical city centres, or sometimes even their partial destruction to make way for new infrastructure.

The increase in the number of private cars in cities induces new demands and considerations for transport, such as the necessity for new parking spaces and new and/or wider roads and crossroads. Urban development trends are generally driven by car transport requirements. For example, new shopping centres located on the margins of cities are only designed for urban dwellers having cars. Furthermore, transport construction may disturb the integrity of cities; for example, the motorway crossing the historical centre of old Bratislava now separates the town into two distinct parts.

In addition, the intensive development of car transport in the Carpathians does not correspond to what is often the inappropriate nature of

Figure 3.18 Local train in Romanian Carpathians



current road infrastructure. This has led to a rapid growth in the number of car accidents in the Carpathians and consequent injuries/deaths.

## Policy Measures and Responses

The concept of the “sustainable city” (Prodanovic 2006) opens the way to a new vision of Carpathian urban development. The aim is to provide theoretical, sociological and urban inter-

pretations of the city concept through formulation of models, assessment of public views and opinions, the media’s role and impact, sustainable production and consumption patterns, as

### Proposed instruments for the implementation of a sustainable development transportation policy in Poland

In the area of landscape management (utilization of land):

- restrict the expansion of towns/cities, maintain an adequate urban intensity and preserve open landscapes;
- locate office and trade activities in urban centres or in other places that have good access to public transport;
- restrict car traffic by determining the lowest acceptable number of parking spaces;
- increase housing intensity in centres and internal urban area;
- re-locate parking spaces from the inner urban area to outside urban areas (i.e. park & ride);
- set aside areas close to existing transport networks for the purpose of constructing facilities for the distribution of goods;
- create incentives for urban development around existing public transport routes and stations;

- construct networks of bicycle and pedestrian routes;
- establish car-free areas.

In the area of environmental protection:

- tighten standards to reduce emissions and the noise level from new vehicles;
- promote incentives to lower fuel consumption by new vehicles;
- promote the use of low-emission buses and ban/limit truck traffic at night in sensitive areas;
- apply fiscal instruments in order to promote environmentally friendly fuels and less polluting cars, trucks and buses;
- use sign-posting and traffic engineering in order to keep traffic flow at levels of ecological acceptance.

Source: Kassenberg (2002)

### The perception of their environment by the inhabitants of Bratislava

Bratislava is one of the smallest capitals in Europe with a population of 430,000 people, situated on the edge of the Carpathian region. It is Slovakia's largest city as well as its administrative, economic, financial and cultural centre.

In 2000, a survey focusing on the perception of negative and positive developmental aspects of urban environmental change was conducted in Bratislava (Ira 2003). Information from individuals was collected via a formal questionnaire.

Major positive features relating to the city's development over ten years of transition were identified, including the development and improvement of infrastructure, renewal and reconstruction of historical town, better-quality services including tourism and recreation facilities, improved quality of greenery, higher aesthetic quality and tidiness. Some negative features were also identified:

environmental pollution and overall deterioration of the environmental quality, degradation of public transport, higher incidence of drugs, crime and vandalism, higher unemployment, and lower aesthetic quality of the urban environment in some marginalized areas/districts.

The questionnaire also focused on opinions concerning sustainable development trends related to functional zones and municipal areas. A positive development trend towards a more sustainable situation was perceived by 76.1 per cent of respondents. The Old Town was estimated as the most sustainable city zone by 74 per cent of participants (this despite its near-separation into two parts by a new major cross-city route). In contrast, the development of the large-scale housing estate Petržalka (one of the largest in the region) was estimated as unsustainable by 46 per cent of respondents.

Source: Ira (2006)

well as the relevance of Local Agenda 21 strategic documents.

The ecological attributes of Carpathian cities and their hinterland is not unilaterally related to their natural resources and values, but also to indigenous knowledge and practices, based on cultural codes, which are relatively well-preserved in Carpathians cities and settlements. On the other hand, the quality of the environment in Carpathian cities and settlements needs to be improved as well. One sustainable solution to achieve this ecological target is the promotion of

bio-climatic architecture based on the sustainable use of natural resources, protection of biodiversity, landscape identity and related "artefacts".

Last but not least, urban management can be understood as a function of the municipal authority, governing the development of the urban land, marketing the city as a public good, controlling housing policy, rent and maintenance of housing stocks, as well as micro-credit schemes, the organization of the building industry, and to a certain extent acting to moderate pure market forces.

## Cultural Heritage

The Carpathian region has always been a cross-roads for business routes, human migrations and military expeditions. It was a territory where raids from many directions and empires (the Roman Empire, Germans, Swedes, Soviet forces, Tatars and Turks) were frequently halted or neutralized (see Chapter 1). For ages, it was an area where different tribes and ethnic and religious groups and nations – including the Austrians, Bohemians, Boykos, Czechs, Hungarians, Lemkos, Poles, Romanians, Ruthenians,

Slovaks, Ukrainians and Wallachians – met, fought, colonized and finally assimilated with each other, as in a melting pot. These clashes and inter-minglings explain the region's richness, diversity and cultural significance.

Today as in the past, nature, culture and a shared history bind the many Carpathian peoples together with a common spirit and to a cultural/historical area. This common heritage serves to unite peoples who from birth share the same

### UNESCO cultural heritage sites in the Carpathians and/or Carpathian foothills

#### Czech Republic

1. Lednice-Valtice Cultural Landscape
2. Gardens and Castle at Kroměříž

#### Hungary

3. Tokaj Wine Region Historical Cultural Landscape
4. Old Village of Hollókő and its Surroundings
5. Budapest, including the Banks of the Danube, the Buda Castle Quarter and Andrásy Avenue

#### Poland

6. Kalwaria Zebrzydowska: the Mannerist Architectural and Park Landscape Complex
7. Wieliczka Salt Mine
8. Wooden Churches of Southern Little Poland
9. Krakow: old town

#### Romania

10. Churches in Moldavia
11. Hurezi Monastery
12. Villages with Fortified Churches in Transylvania
13. Dacian Fortresses of the Orăştie Mountains
14. Wooden Churches of Maramureş Serbia (under preparation)

#### Slovakia

15. Banská Štiavnica
16. Spišský Hrad and its Associated Cultural Monuments
17. Vikolínec
18. Bardejov Town Historical Monument Reserve

hardships and joys of mountain life. Many practices and traditions survive, including Carpathian music and dance, harvest festivals, traditional agricultural products such as sheep cheese and plum brandy, magnificent wooden architecture, and local costumes and folklore.

Many historical and cultural monuments and structures also survive. They represent important evidence of historical development and lifestyles as manifestations of human creativity and work in all fields of activity with revolutionary, historical, artistic, scientific or technical value. They also have a direct relationship to important personalities and historical events. Some of the historical patrimony has received official protection, particularly sites designated as UNESCO World Heritage Sites (see Box above and Map 3.18). There are thousands of others that are not part of any official lists but which remain valuable for other reasons (e.g. contribution to the identity, amenity and quality of life). Cultural heritage is socially relevant because it attaches individuals to their past personally and collectively through its physical, cultural, emotional, intellectual and spiritual aspects. The stories and events, people and aspirations that communities associate with their heritage give meaning to their past, present and future.

This common Carpathian heritage survives in spite of national boundaries and major transformations in the region's economy, political structure and ideology, legal system and stratification of society. The post-war period of intensive industrialisation and collectivisation caused a rapid disappearance of historical structures. In par-

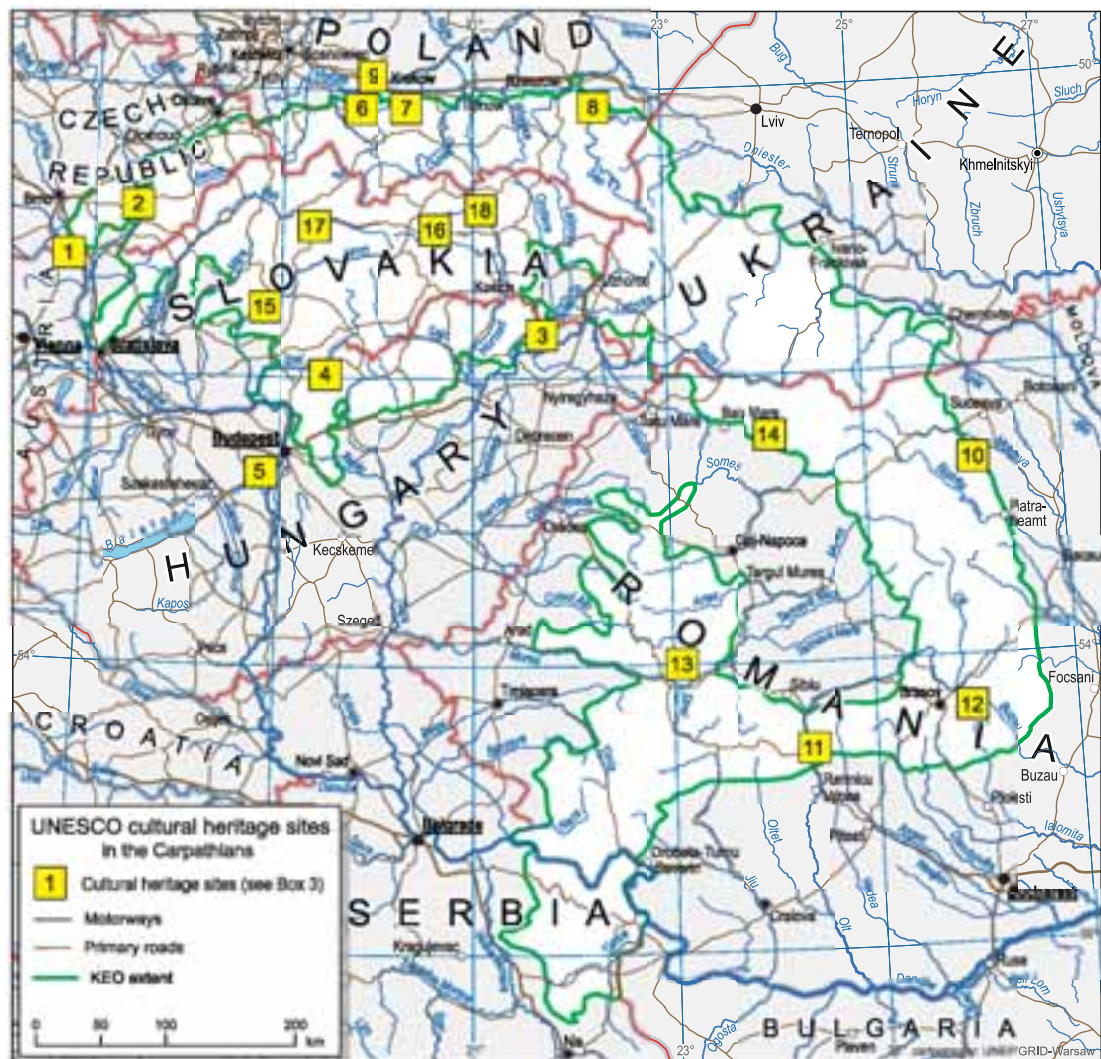
ticular, technological advances sustaining a high-technology society place emphasis on engineering and science rather than religion or culture, thus altering the fundamental societal values. The result is that a deterioration of both natural and historical-cultural patrimony may occur.

There is a need to preserve relatively untouched ecosystems and revitalise transformed and/or

Figure 3.19 Banská Štiavnica, World Heritage site (Lacika)



Map 3.18 UNESCO cultural heritage sites in the Carpathians (Huba 2007)



denaturalised contemporary landscapes and environments. The protection and revitalisation of landscapes modified during centuries by predecessors of the contemporary society is a prerequisite for sustainable development in the region. These landscapes were and still are typical for the Carpathian mountains and sub-mountain systems: traditional environments of the countryside (e.g. villages, fields, meadows, vineyards, ancient towns, historical mining regions and technical monuments, historical parks, gardens, cemeteries, etc.), and give the region its unique character and appearance (Huba 2000b).

'Nature' and 'culture' represent two interconnected elements of the Carpathian landscape in the Central/South-Eastern European space, which is rich in cultural and historical transformations of nature and equally profuse in both natural and cultural diversity (and authenticity) in comparison to much of Western Europe. On the other hand, a substantial part of the cultural heritage is non-material, in the form of literature and folk traditions.

## Preservation of cultural heritage in the Slovak Carpathians

In the Slovak Carpathians, there is a high density and large diversity of valuable cultural heritage sites. Examples include: archaeological sites in Biňa, Nižná Myšľa, Spišský Štvrtok and Nitra; wooden folk architecture in Vlkolínec, Podbiel, Podšíp, Osturňa and Ždiar; wooden churches in Eastern Slovakia, castles such as Spišský hrad, Strečno, Trenčín, Devín and Krásna Hôrka; technical monuments in Banská Štiavnica and preserved areas in the towns and cities of Banská Bystrica, Banská Štiavnica, Bardejov, Bratislava, Kežmarok, Kremnica, Levoča, Nitra, Podlínec, Poprad, Spišská Kapitula, Štiavnické Bane, Trenčín, Prešov, Košice, Spišská Sobota, Žilina and others. Overall, there are nearly 13,000 officially designated immovable cultural monuments (historical buildings and monuments, archaeological sites, architectural ensembles and complexes, historical town centres and other populated areas, streets, squares, cemeteries, etc.) together with more than 30,000 movable ones (individual objects – archaeological findings, antiquities, historical relics, works of art, manuscripts, etc.), mostly concentrated in museums and galleries.

During the communist period, the process of urbanisation, collectivisation and industrialisation of rural areas had adverse impacts on traditional social structures and forms of settlements, for example through uniform housing development. However, there are signals of a possible revival of rural areas through the return of former inhabitants.

Numerous threats to these sites and cultural heritage remain, including new construction, the abandonment of traditional agriculture and non-traditional renovation of

old buildings (e.g. not using thatch roofs or wooden windows). It is difficult to find qualified craftsmen with traditional skills for maintaining and restoring cultural monuments; therefore, alternative technological solutions are often applied. Furthermore, the depopulation of rural areas, where much cultural heritage and traditional knowledge is concentrated, continues with adverse impacts on the protection and maintenance of cultural heritage.

Other problems include insufficient historical and national awareness, evanescence of traditional cultural values, and often a preference for imported items.

On the positive side, achievements include the growing involvement of NGOs and local authorities in the protection of monuments and their use for sustainable tourism, a system of protection for historical monuments, and the inclusion of several monuments in the UNESCO list of World Cultural Heritage sites (see above).

Selected tools supporting the preservation of monuments in the Slovak Carpathians include:

- General obligations in the Constitution
- Slovak Act No. 49/2002 on the protection of monuments and historic sites.
- Act 237/2000 on land-use planning.
- The National Plan for Rural Development, adopted by the Slovak Government and the European Commission in 2000 (adoption of this plan was a pre-condition for access to EU funds); and
- National Programme of Restoration and Renewal of Cultural Monuments (Belčáková 2006).

## Conclusions

The urban system (including its environment) acquires new characteristics and dimensions in the Carpathians. As part of the economic and socio-political development targets set for the beginning of the third millennium, and with a view to integration in the European urban system, the industrial city – representative of typical Carpathian urban settlement types – is being gradually replaced by the multi-functional and service type of urban area.

The protection of cultural and historical monuments can be seen as a form of environmental protection, requiring a common base of classification of the urban heritage in the Carpathians, thorough analyses of ways and means of restoration, consideration of ethnological aspects of

conservation of archaeological sites, protection of cultural scenery, and management of monuments. New problems and challenges are related to the protection of “genus loci”, a location’s distinctive cultural essence and heritage.

Important questions arise with respect to stakeholders’ responsibility vis-à-vis the cultural and historical heritage, such as who is responsible and which sectors of society should care: governments, citizens, NGOs, market forces; some or all of the preceding? Challenges include issues such as new information and communication technologies, information management and knowledge about the historical heritage, the expansion of tourism, and environment and sustainability. The temporal aspect is very important in



the Carpathians, due to the extremely high speed of modernisation and globalisation trends, threatening sensitive historical structures and traditional behavioural patterns. The very definition of cultural and historical heritage needs to be reconsidered due to these recent developments.

The Carpathian region represents certain values, both environmental and cultural, which may serve as guides towards a more sustainable way of living and can potentially trigger successful

development in the region. The desired development pattern for the region needs to be collectively pursued in a strong partnership, and based on regional and international cooperation involving all elements of the society, in the Carpathian countries and the world. The unique life experience and natural and cultural heritage of the Carpathians are meaningful to local populations, but they could also become a positive example for people living elsewhere in marginalized and/or threatened environments.

## References

- \*\*\* National Ore Deposits Maps, scale 1/2.000.000, 1/1.000.000 and 1/500.000 of Czechoslovakia (1975), Hungary (1993), Poland (1984), Romania (1984)
- Ackermann, R. (1994). *Environmental Action Programme for Central and Eastern Europe: Setting Priorities*. Abridged Version of the Document Endorsed by the Ministerial Conference, Lucerne, Switzerland, 28-30 April, 1993, Environmental Action Programme for Central and Eastern Europe, Ministerial Conference Environment for Europe, and World Bank
- Alexandrescu, A., Geicu, A., Cuculeanu, V., Marica, A., Patrascu N. (2003). Climate change impact on forestry ecosystems. Vulnerability and adaptation measures. In *Potential impact of Climate change in Romania* (ed: V. Cuculeanu), Ars. Docendi, p. 101-128
- Anderson, S., Kuslik, T., Radford, E. (eds) (2005). *Important plant areas in Central and Eastern Europe*. PlantLife International
- Baciu, M., Busuioc, A., Breza, T. (2004) Spatial and temporal variability of meteorological phenomena frequency in the cold season. *Romanian Journal of Meteorology* 6(1-2), 27-39
- Bălan, S., Cristescu, V., Cornea, I. (eds.) (1982). *Cutremurul de pământ din România de la 4 martie 1977*. Editura Academiei, București
- Bălțeanu, D. (1983). *Experimentul de teren în geomorfologie*. Editura Academiei, București
- Bălțeanu, D. (1997). Geomorphological hazards of Romania. In *Geomorphological hazards of Europe* (eds: C. Embleton, Ch. Embleton-Hamann), Elsevier
- Bălțeanu, D. (2003). Environmental change and sustainable development in the Romanian Carpathians. *The Journal of the Geographical Society of Hosei University* 35
- Bălțeanu, D., Badea, L., Buza, M., Niculescu, G., Popescu, C., Dumitrașcu, M. (eds.) (2006). *Romania. Space-Society-Environment*. The Publishing House of the Romanian Academy, Bucharest
- Baše, M. (2002). Countryside Transformation and Sub-urbanisation in the Czech Republic. In *Visegrad Agenda 21 – Transition from a Centrally Planned Economy to a Sustainable Society?* (eds: V. Třebický, J. Novák), Confer. Proceed. IEP, Prague, p. 147-148.
- Belčáková, I. (2006). *The Assessment of the National Policy, Legal and Institutional Frameworks related to the Carpathian Convention*. Slovak Republic. Bratislava
- Beniston, M. (1997) Variations of snow depth and duration in the Swiss Alps over the last 50 years: links to changes in large-scale climatic forcings. *Climatic Change* 36, 281-300
- Beniston, M. (2003) Climatic change in mountain regions: A review of possible impacts. *Climatic Change* 59, 5-31
- Berndes, G., Hansson, J. *Cost-effective bioenergy use for climate change mitigation – a model based analysis for Europe*. *Proceedings of the 15th European Biomass Conference – From research to market Deployment, Berlin, Germany, 7-11 May 2007*
- Bird, G., Brewer, P.A., Macklin, M.G., Bălțeanu, D., Driga, B., Serban, M., Zaharia, S. (2003). The solid state partitioning of contaminant metals and As in river channel sediments of the mining affected Tisa drainage basin, northwestern Romania and eastern Hungary. *Applied Geochemistry* 18, 1583-1595
- Bird, G., Brewer, P.A., Macklin, M.G. Serban, M., Bălțeanu, D., Driga, B. (2005), Heavy metal contamination in the Arieș river catchment, western

- Romania: Implications for development of the Roşia Montană gold deposits. *Journal of Gechemical Exploration* 86(1), 26-48
- Bojariu, R., Giorgi, F. (2005). The North Atlantic Oscillation signal in a regional climate simulation for the European region. *Tellus* 57A, 641-653
- Bojariu, R., Dinu, M. (2007) Snow variability and change in Romania. In *Proceedings of the Alpine Snow Workshop* (eds: U. Strasser, M. Vogel), Munich, October 5-6, 2006, Germany
- Borcoş, M., Vlad, S., Udubaşa, G., Gabudeanu, B. (1998). Qualitative and quantitative metallogenetic analysis of the ore genetic units in Romania. *Rom. J. of Mineral Deposits* 78, 7-107
- Borcoş, M., Udubaşa, G., Săndulescu, M., Lupu, M., Găbudeanu, B. (2007). Map of the mineral deposits of Romania, Geol. Inst. of Romania, Bucharest (in press)
- Boroneant, C., Ionita, M., Dumitrescu A. (2004). *Estimarea tendinţei de variaţie a temperaturii medii sezoniere din România în contextul schimbărilor în circulaţia atmosferică la scara mare din sectorul atlantico-european*. Sesiunea Anuala de Comunicari Stiintifice „Meteorologia în contextul dezvoltării durabile”, Bucureşti
- Bujnovský, R., Antal, J., Balkovič, J., Bielek, P., Bublinec, E., Cebecauer, T., Fulajtár, E., Grgešová, Z., Holúbek, R., Huba, M., Hrnčiarová, T., Juráni, B., Kováč, K., Mindáš, J., Pavlenda, P., Sobocká, J., Šiška, B., Škvarenina, J., Šútor, J., Thalmeinerová, D. (2004). *Desertification. National Capacity Self-Assessment related to environmental management of global conventions*. MoE of the Slovak Republic/UNEP/GEF, Bratislava
- Burdusel, E., Kanianska, R., Maryskevych, O. (2005). *Policy consultation on sustainable agriculture and rural development in the Carpathians*. Policy assessment for sustainable agriculture and rural development in mountain regions (SARD-M). National reports in Romania, Slovakia and Ukraine. UNEP-Vienna ISCC, Vienna
- Busuioc, A., von Storch, H. (1996). Changes in the winter precipitation in Romania and its relation to the large scale circulation. *Tellus* 48A, 538-552
- Busuioc, A., von Storch, H., Schnur, R. (1999). Verification of GCM generated regional seasonal precipitation for current climate and of statistical downscaling estimates under changing climate conditions. *J Climate* 12, 258-272
- Busuioc, A., Giorgi, F., Bi, X., Ionita, M. (2006a). Comparison of regional climate model and statistical downscaling simulations of different winter precipitation change scenarios over Romania. *Theor. and Appl. Climatology* 86(1-4), 101-124
- Busuioc, A., Giorgi, F., Gao, X., Bi, X., Dumitrescu, A. (2006b). *Climate change scenarios for mean extreme temperatures in Romania. Comparison between statistical and dynamical downscaling*. “Third Workshop on the theory and use of regional climate models”, 31 May-9 June 2006, Trieste, Italy
- Carpathian Ecoregion Initiative (2001). *The status of the Carpathians 2001*. An information CD-ROM as a part of the Carpathian Ecoregion Initiative
- Carpathian Ecoregion Initiative (2006). CERi Newsletter 1/2006
- CBD (2007). <http://www.cbd.int/countries/profile.shtml?country=ua#thematic>
- Cheval, S., Baciú, M., Breza, T. (2005). The variability of climatic extreme events in the Romanian Carpathians. *Analele Universităţii de Vest din Timisoara - Geografie* XIV, 59-78
- Cinetti, A. (2002). *Resursele de ape subterane ale României*. Ed. Tehn., Bucureşti
- Csorba, P. (1996). Changes in land use structure due to land privatization in Hungary. In *Ecological and landscape consequences of land use change in Europe* (ed: R.H.G. Jongman) ECNC, ser. Man and Nature 2, 336-349.
- Delbaere, B., Nieto-Serradilla, A. (eds.) (2004). *Environmental risk from agriculture in Europe*. ECNC, Tilburg
- Denisiuk, Z. (ed.) (2002). *Strategia zachowania różnorodności biologicznej i krajobrazowej obszarów przyrodniczo cennych dotkniętych klęską powodzi (A strategy of landscape and biological diversity conservation in valuable nature areas, affected by flood disaster)*. Instytut Ochrony Przyrody PAN, Kraków, 299 pp.
- Dinestein, E., Powell, G., Olson, D., Wikramanayake, E., Abell, R., Loucks, C., Underwood, E., Allnutt, T., Wettengel, W., Ricketts, T., Strand, H., O'Connor, S., Burges, N. (2000). *A workbook for constructing biological assessments and developing biodiversity visions for ecoregion-based conservation*. Part I: Terrestrial Ecoregions. Conservation Science Program WWF.
- Dobre, B. (2004). *Managementul dezastrelor tehnologice în sectorul românesc al Dunării între Bazias şi Turnu Magurele*. Ph.D. thesis, Institutul de Geografie, Academia Romana, Bucureşti
- Dragne, D., Cheval, S., Micu, M. (2005). The snow cover in the Romanian Carpathians and the influencing factors. *Analele Universităţii de Vest din Timisoara - Geografie* XIV, 145-158.
- Dragusin, D., Radescu, M. (2003). Romania. Quality of the shallow groundwater based on the data of the National Hydrogeological Network in 2002. *Hydrogeology* VI, 17-23, Bucharest
- Drewmik, M. (2006). The effect of environmental conditions on the decomposition rate of cellulose in mountain soils. *Geoderma* 132, 116-130
- Dyduch-Falniowska, A. (1990). Mięczaki polan tatrzańskich. *Studia Naturae* 34, 145-161
- Enciu, P. (1999). *International Hydrogeological Map of Europe Scale 1: 1 500 000, sheet D5 Budapest. Explanatory Notes on the Romanian Territory*.

- Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover and UNESCO, Paris
- Enciu, P. (2002). Main Structural Units in Romania and their hydrogeological features. In *Selected Papers on Romanian Hydrogeology*, Volume of Special Meeting of the International Association of Hydrogeologists, 23-28 May, Oradea, p. 5-15
- European Commission (1997). *White Paper: Energy for the future*. COM (97) 599
- European Commission (1996). *Green Paper: Energy for the future*. COM (96) 576
- European Commission (2000). *Safe operation of mining activities: a follow-up to recent mining accidents*. COM/2000/0664
- European Commission (2003). *European Energy and Transport Trends to 2030*
- European Commission (2007). *Natura 2000 Newsletter* (21) February 2007
- European Environment Agency (2003). *Mapping the impacts of recent natural disasters and technological accidents in Europe*. Environmental issues report 35, Copenhagen
- European Environment Agency (2004). *Agriculture and the environment in the EU accession countries*. Environmental issue report 37, Copenhagen
- European Environment Agency (2005). *Environment and health*. EEA Report 10/2005, Copenhagen, [http://reports.eea.europa.eu/eea\\_report\\_2005\\_10/en](http://reports.eea.europa.eu/eea_report_2005_10/en)
- Fabijanowski, J., Jaworski, A. (1998). Gospodarstwo Leśne. In *Karpaty Polski, przyroda, człowiek i jego działalność* (ed: J. Warszyńska), Uniwersytet Jagielloński, Kraków
- Fodor, D., Gavril, B. (2001). *Impact of the mining industry on the environment*. Ed. Techn., Bucharest
- Gašienica-Byrcyn, W. (1996). Dynamika liczebności kozicy tatrzańskiej *Rupicapra rupicapra tatrica* (Blahout 1971). *Chrońmy Przyr. Ojcz.* 62(6), 13-31
- Gellér, Z. (2002). Institutional, Administrative and Financial Conditions of Sustainable Development Implementation in Hungary. In: *Visegrad Agenda 21 – Transition from a Centrally Planned Economy to a Sustainable Society?* (eds: V. Třebický, J. Novák), Confer. Proceed. IEP, Prague, p. 49-56.
- Giardini, D., Jimenez, J.M., Grunthal, G. (eds.) (2003). *European-Mediterranean Seismic Hazard Map*. ESC
- Gillard, O. (1996). *Flood risk management: risk cartography for objective negotiations*. Third IHP/IAHS George Kovacs Colloquium, UNESCO, Paris
- Gilbrich, W., Winter, P., Enciu, P. (2000). *Report on Regional Meeting for the Implementation of Sheet E5 – Bucharest*. Bundesanstalt für Geowissenschaften und Rohstoffe and UNESCO, Paris
- Giorgi, F., Whetton, P.W., Jones, R.G., Christensen, J.H., Mearns, L.O., Hewitson, B., von Storch, H., Francisco, R., Jack, C. (2001). Emerging patterns of simulated regional climatic changes for the 21st century due to anthropogenic forcings. *Geophys Res Letters* 28, 3317-3320
- Giorgi, F., Xunqiang, B., Pal, J. (2004a). Mean, inter-annual variability and trends in a regional climate change experiment over Europe. I: Present day climate (1961-1990). *Clim Dyn* 22, 733-756
- Giorgi, F., Xunqiang, B., Pal, J. (2004b). Mean, inter-annual variability and trends in a regional climate change experiment over Europe. II: Climate change scenarios (2071-2100). *Clim Dyn* 23(7-8), 839-858
- Glassl, H. (1993). *P. apollo seine unterarten*. R. Hessler, Beiersdorf
- Głowaciński, Z. (1996). Znajomość i ogólna charakterystyka fauny. In *Przyroda Tatrzańskiego Parku Narodowego* (ed: Z. Mirek), Tatrzański Park Narodowy, Kraków-Zakopane
- Government of the Slovak Republic (1993). *National Environmental Action Program I*. Bratislava
- Government of the Slovak Republic (1996). *National Environmental Action Program II*. Bratislava
- Government of the Slovak Republic (2001). *National Sustainable Development Strategy*. Bratislava
- Gremlica, T. (2002). Dissipative, uncontrolled, and from the long perspective unsustainable growth of city agglomerations. In *Sub-urbanisation and its social, economic and ecological consequences* (ed: L. Sykora), IEP, Prague, p. 21-38
- Guzik, C. (1995). Rolnicze użytkowanie ziemi. In *Karpaty Polskie* (ed: J. Warszyńska), Uniwersytet Jagielloński, Kraków
- Hakai, A., Biroz, P. (2007). New pattern in Danubian distribution of Ponto-Caspian gobies – a result of global climatic change and/or canalization? *Electronic Journal of Ichthyology* 1, 1-14
- Hanušín, J. (2006). *City transport as a growing urban environmental and development problem of the Carpathian region*. Mscr., Bratislava
- Hanušín, J., Wyžga, B. (2006). *Floods in the Carpathian region (1990-2005)*. Mscr., Bratislava, Krakow
- Hassan, R. Scholes, R., Ash, N. (eds.) (2005). *Millennium Ecosystem Assessment*. Island Press, Washington
- Heath, M.F., Evans, M.I. (eds.) (2000). *Important Bird Areas in Europe: priority sites for conservation, Northern Europe*. BirdLife Conservation Series 8, Birdlife International, Cambridge
- Heltai, M., Biro, Z., Szemethy, L. (2006). The changes of distribution and population density of wildcats *Felis silvestris* (Schreber 1775) in Hungary between 1987-2001. *Nature Conservation* 62, 37-42
- Huba, M. et al. (1990). *Slovak forests – a question of existential character*. SZOPK, Bratislava
- Huba, M. (1996). Environment and Sustainable Development in Slovakia 1989-1995. *Südosteuropa. Zeitschrift für Gegenwartforschung* 3, 282-294

- Huba, M. (1997). Slovak Republic. In *The Environmental Challenge for Central European Economies in Transition* (eds: J. Klärer, B. Moldan), John Wiley and Sons, p. 231-270.
- Huba, M. (2000a.) Central Europe – a Victim, Culprit or Both (The Quest for the Central-European Dimension of Sustainable Life). In *The World Perceived by the Heart of Europe* (eds: M. Huba, P. Novacek), SSL, PU Olomouc, Bratislava
- Huba, M. (2000b). The Challenge of Historical Landscapes in Slovakia. In *Landscape – Our Home* (ed: B. Pedroli), Freies Geistesleben, Stuttgart, p. 109-117
- Huba, M., Ira, V., Mačáková, S., Švihlová, D., Záborská, Z. (2000). *Indicators of Sustainable Development of Cities*. ETP-STUŽ, Košice
- Hurrell, J.W. (1996). Influence of variations in extratropical wintertime teleconnections on Northern Hemisphere temperature. *Geophys. Res. Lett.* 23, 665–668
- Huth, R. (2001). Statistical downscaling of daily temperature in Central Europe. *J Climate* 15, 1731-1742
- Institute of Health Information and Statistics (1999). *Health statistics yearbook of the Slovak Republic 1997*, Bratislava, [http://www.uzis.sk/publikacie/pdf/rocn\\_97.pdf](http://www.uzis.sk/publikacie/pdf/rocn_97.pdf)
- Institute of Health Information and Statistics (2005). *Health statistics yearbook of the Slovak Republic 2004*, Bratislava, [http://www.uzis.sk/publikacie/pdf/rocn\\_04.pdf](http://www.uzis.sk/publikacie/pdf/rocn_04.pdf)
- IPCC (2001). *Climate Change 2001*. IPCC Third Assessment Report. Cambridge University Press
- IPCC (2005a). *Safeguarding the Ozone Layer and the Global Climate System. Issues Related to Hydrofluorocarbons and Perfluorocarbons*. Cambridge University Press
- IPCC (2005b). *Carbon Dioxide Capture and Storage* (eds: B. Metz, O. Davidson, H. de Coninck, M. Loos, L. Meyer), Cambridge University Press
- IPCC (2007a). Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Summary for Policymakers *Climate Change 2007: The Physical Science Basis*, [www.ipcc.ch](http://www.ipcc.ch)
- IPCC (2007b) Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Summary for Policymakers *Climate Change 2007: Impacts, Adaptation and Vulnerability*, [www.ipcc.ch](http://www.ipcc.ch)
- IPCC (2007c). Contribution of Working Group III to the Intergovernmental Panel on Climate Change Fourth Assessment Report. Summary for Policymakers. *Climate Change 2007: Mitigation of Climate Change*, [www.ipcc.ch](http://www.ipcc.ch)
- Ira, V., Kollár, D. (1993). Behavioral aspects of the technological hazards and risks investigation. *Životné prostredie* 27, 83-85
- Ira, V. (2003). The changing intra-urban structure of the Bratislava city and its perception. *Geografický časopis* 55, 91-107
- Ira, V. (2006). Perception of the environment by inhabitants of Bratislava. Mscr. IG SAS, Bratislava
- IUCN (2005). *Implementation of Natura 2000 in new EU member states of Central Europe*. IUCN Programme Office for Central Europe, Warsaw
- Jakál, J. (1998). Antropická transformácia reliéfu a jej odraz v krajine Hornej Nitry (Anthropogenic relief transformation). *Geografický časopis* 50(1), 4-20
- Jakál, J. (2000). Extrémne geomorfologické procesy v krase (Extreme geomorphological processes in karst regions). *Geografický časopis* 52(3), 211-219
- Jakubiec, Z. (2001). The brown bear *Ursus arctos* L. in the Polish part of the Carpathians. *Studia Naturae* 47, 1-108
- Janiga, M.M., Marencak, A., Soltesova, R., Kyselova, Z. (1993). A study on the preservation of the Tatras region and the plans to hold the 2002 Winter Olympics in northern Slovakia. *Oecol. Montana* 2, 31-45
- Jankovský, L., Cudlín, P. (2002). Dopad klimatické zmeny na zdravotní stav smrkových porastů středohor. *Lesnická práce* 81(3), 106-107
- Kalmar, J., Kuti, L., Szurkos, G. (2005). Geological conditions of the natural rehabilitations of the mining and other industrial tailings and dumps. *Environment & Progress* 4, 213-224
- Kassenberg, A. (2002). Transport Policy – The case of Poland. In *Visegrad Agenda 21 – Transition from a Centrally Planned Economy to a Sustainable Society?* (eds: V. Třebický, J. Novák), Confer. Proceed. IEP, Prague, p. 72 – 81.
- Kaszewski, B.M., Filipiuk, E. (2003). Variability of atmospheric circulation in Central Europe in the summer season 1881-1998 (on the basis of the Hess-Brezowski classification). *Meteorologische Zeitschrift* 12(3), 123-130
- Klärer, J., Moldan, B. (1997). Regional Overview. In: *The Environmental Challenge for Central European Economies in Transition* (eds: J. Klärer, B. Moldan), John Wiley and Sons, p. 231-270.
- Kotarba, A., Kaszowski, L., Krzemień, K. (1987). High mountain denudational system of the Polish Tatra Mountains. *Geographical Studies Spec. Issue* 3, 1-106
- Kozak, J., Estreguil, C., Vogt, P. (2007). Forest cover changes in the Carpathians over the last decades. *European Journal of Forest Research* 126(1), 77-90
- Krásný, J. (2002). Quantitative hardrock hydrogeology in a regional scale. *Norges geologiske undersøkelse* 439, 7-14
- Kurzyński, J., Łajczak, A., Michalik, S., Mielnicka, B., Witkowski, Z. (1996). Outline of the history of

- exploitation of the Pilsko Mountain. In *Wpływ narciarstwa i turystyki pieszej na przyrodę masywu Pilska* (eds: A. Łajczak, S. Michalik, Z. Witkowski). *Studia Naturae* 41, 33-59
- Lach, J., Wyżga, B. (2002). Channel incision and flow increase of the upper Wisłoka River, southern Poland, subsequent to the reafforestation of its catchment. *Earth Surface Processes and Landforms* 27, 445-462
- Lapin, M., Melo, M., Damborská, I., Gera, M., Faško, P. (2000). Nové scenáre klimatickej zmeny pre Slovensko na báze výstupov prepojených modelov všeobecnej cirkulácie atmosféry. *Národný klimatický program SR* 8, 5-34
- Lasy Państwowe (2004). *Raport o stanie lasów w Polsce 2003*. Centrum Informacyjne Lasów Państwowych, Warszawa
- Lăzărescu, I. (1983). *The environment protection and the mining industry*. Ed. Techn., Bucharest
- Lehoczki, Z., Balogh, Z. (1997). Hungary. In: *The Environmental Challenge for Central European Economies in Transition* (eds: J. Klärer, B. Moldan), John Wiley and Sons, p. 231-270.
- Lipsky, Z. (1996). Land use changes and their environmental consequences in the Czech landscape. In *Ecological and landscape consequences of land use change in Europe* (ed: R.H.G. Jongman), ECNC, ser. Man and Nature 2, 350-360
- Lupescu, Gh. (2004). Aspecte privind starea de sănătate a unor ape din România. *Hidrogeologia* 6, 60-67
- Macklin, M., Brewer, P., Bălteanu, D., Coulthard, T., Driga, B., Howard, A., Zaharia, S. (2003). The long-term fate and environmental significance of contaminant metals released by the January and March 2000 mining tailings dam failures in Maramureş county, upper Tisa Basin, Romania. *Applied Geochemistry* 18, 241-247
- Mahel, M. (ed.) (1974). *Tectonics of the Carpathian Balkan Regions*. Geol. Inst "D. Stur", Bratislava
- Manea, L., Rada, C. (2002). *Monitoring of the total ozone in Romania. Short review*. International Workshop "Global Atmosphere Watch", May 27-30 2002, Riga, Letonia
- Mertens, A., Anghel, C. (2001). Livestock depredation. In *Carpathian large carnivore project, Annual Report 2000*. HACO International Publ, www.clcp.ro
- Meusel, H., Jager, E., Weinert, E. (1965). *Vergleichende Chorologie der Zentraleuropaeischen Flora*. Fischer Verl, Jena
- Mezřický, V. (2002). Globalisation, Protection of the Soil and Sustainable Development. In *Visegrad Agenda 21 – Transition from a Centrally Planned Economy to a Sustainable Society?* (eds: V. Třebický, J. Novák), Confer. Proceed. IEP, Prague, p. 36-38
- Michalczuk, S. (1992). Cultural landscape of the Pieniny National Park. *Pieniny – Przyroda i człowiek* 1, 17-26
- Midriak, R. (2002). Potential water erosion (according to R.K. Frewert, K. Zdražil and O. Stehlík) 1:1 000 000. In *Atlas krajiny Slovenskej republiky* (Landscape Atlas of the Slovak Republic), MoE of the Slovak Republic, Bratislava / Slovak Environment Agency, Banská Bystrica
- Minár, J., Barka, I., Jakál, J., Stankoviansky, M., Trizna, M., Urbánek, J. (2006). *Geomorphological hazards in Slovakia*. Mscr., Bratislava
- Mindáš, J., Lapin, M., Škvarenina, J. (1996). Klimatické zmeny a lesy Slovenska. *Národný klimatický program SR* 5, 96
- Ministry of Environment and Water Management of Romania (2005). *Romania's Third National Communication on Climate change*. Bucharest
- Ministry of the Environment of the Slovak Republic (1997). *Druhá národná správa o zmene klímy*, Bratislava
- Ministry of the Environment of the Slovak Republic (2001a). *The Third National Communication of the Slovak Republic on Climate Change*. Bratislava, [http://www.lifeenv.gov.sk/minis/ovzdušie/tns/3rd\\_national\\_comm.pdf](http://www.lifeenv.gov.sk/minis/ovzdušie/tns/3rd_national_comm.pdf)
- Ministry of the Environment of the Slovak Republic (2001b). *Environment of the Slovak Republic*. Bratislava
- Ministry of the Environment of the Slovak Republic, Slovak Environmental Agency (2002). *Atlas krajiny Slovenskej republiky* (Landscape Atlas of the Slovak Republic). Banská Bystrica
- Ministry of the Environment of the Slovak Republic, Slovak Environmental Agency (2003). *State of the Environment Report of the Slovak Republic 2003*, Banská Bystrica, <http://enviroportal.sk/spravy-zp/sprava-detail.php?stav=34>
- Ministry of the Environment of the Slovak Republic, Slovak Environmental Agency (2005). *Správa o stave životného prostredia Slovenskej republiky v roku 2005*. Banská Bystrica, [http://enviroportal.sk/pdf/spravy\\_zp/05/svk05\\_havarie.pdf](http://enviroportal.sk/pdf/spravy_zp/05/svk05_havarie.pdf)
- Ministry of the Environment of the Slovak Republic, Slovak Hydrometeorological Institute (2005). *The Fourth National Communication of the Slovak Republic on Climate Change*. Bratislava, <http://unfccc.int/resource/docs/natc/slknc4.pdf>
- Ministry of Health of the Slovak Republic, Public Health Authority (2005). *Detailed Plan of measures in case of an influenza pandemic in the Slovak Republic*, Bratislava
- Mírek, Z. (1996). Antropogeniczne zagrożenia i przekształcenia środowiska przyrodniczego. In *Przyroda Tatrzańskiego Parku Narodowego* (ed: Z. Mírek), Tatrzański Park Narodowy, Kraków-Zakopane
- Mírek, Z., Piękoś-Mirkowa, H. (1992). Plant cover of the Polish Carpathians. *Veroff. Geobot. Inst. ETH* 107(2), 116-150

- Muzika, R.M., Guyette, R.P., Zielonka, T., Liebhold, A.M. (2004). The influence of O<sub>3</sub>, NO<sub>2</sub>, and SO<sub>2</sub> on growth of *Picea abies* and *Fagus sylvatica* in the Carpathian Mountains. *Environmental Pollution* 130, 65-71
- Nowicki, M. (1997). Poland. In: *The Environmental Challenge for Central European Economies in Transition* (eds: J. Klärer, B. Moldan), John Wiley and Sons, p. 231-270.
- OECD (2001). *Environmental Outlook*. OECD, Paris
- Orășeanu, I. (1998). *Hydrogeological researches for still waters in Bihor Vlădeasa Mountains (Apuseni Mountains, Romania)*. Proceed. of the Internat. Symposium A.H.R. "Mineral and thermal groundwater", p. 213-222, Miercurea Ciuc
- Orășeanu, I. (1998). *Hydrogeological researches for still waters in Codru Moma and Pădurea Craiului Mountains (Apuseni Mountains, Romania)*. Proceed. of the Internat. Symposium A.H.R. "Mineral and thermal groundwater", p. 223-232, Miercurea Ciuc
- Orzeł, S. (1993). Ocena dynamiki przyrostu grubości górskich drzewostanów świerkowych na przykładzie wybranych obiektów w lasach Beskidu Śląskiego. *Acta Agr. Silv.* 31, 3-15
- Ozunu, A. (2000). *Elemente de hazard și risc în industriei poluante*. Editura Accent, Cluj-Napoca
- Panigaj, L. (ed.) (2002). *Pieniny, Priroda a clovek I: Fauna a flora Pienin*. Tatraprint, Poprad
- Panizza, M. (1996). *Environmental geomorphology*. Elsevier, 284 pp.
- Paraschiv, D. (1979). *Romanian Oil and Gas Fields*. Institute of Geology and Geophysics, Technical and Economical Studies A13, Bucharest
- Parusel, J. (2001). Laserpitiom archangelica Wulfen Okrzyn jeleni. In *Polska czerwona księga roślin* (eds: R. Kaźmierczakowa, K. Zarzycki), Inst. Botaniki PAN and Inst. Ochrony Przyrody PAN, Kraków
- Pasoi, I. (2004). *Inventory of the Main Hydraulic Structures in the Danube Basin*. Follow-up volume No. VIII/2 to *The Danube and its Catchment. A Hydrological Monograph*. Regional Cooperation of the Danube Countries in the Frame of the International Programme of UNESCO
- Petraschek, W. (1982). *Map of the Mineral Deposits of the Danubian Countries*, Vienna
- Public Health Authority of the Slovak Republic (2004). *Annual Report of Environmental and Health Indicators Information System assessment*. Bulletin 4/2004
- Prodanovic, M. (2006). *Urban Environment: Selected problems of the urban environment in Carpathian countries*. Mscr. Novi Sad
- Rada, C., Manea, L., Caian, M. (2004). *Temperature sensitivity to ozone variability in the presence of inhomogenous surface*. Proceedings of the International Workshop "The Black Sea Coastal Air-Sea Interaction/Phenomena and Related Impacts and Applications", Constanta, Romania
- Razowski, J. (ed.) (2000). *Flora i fauna Pienin. Monografie Pienińskie I. Pieniński Park Narodowy, Krościenko nad Dunajcem*
- Roszkowski, A., Hennig, J. (1991). Ochrona przed powodzią. In *Dorzecze górnej Wisły* (eds: I. Dynowska, M. Maciejewski) Part II, p. 147-153
- Ruffini, F.V., Streifeneder, T., Eiselt, B. (2006). *Implementing an international mountain convention – an approach for the delimitation of the Carpathian Convention area*. European Academy, Bolzano
- Ruzicka, T. (2006). A Regional Brand from the White Carpathians, CERI Newsletter No. 1
- Rybacki, M. (1995). Threat to amphibians on roads of the Pieniny National Park. *Pieniny – Przyroda i Człowiek* 4, 85-97
- Săndulescu, M. (1984). *Geotectonica României*. Ed. Tehnică, București
- Săndulescu, M. (1994). *Outlines of Romanian Carpathians*. 2nd Covasna ALCAPA Sess., Bucharest
- Serban, M., Macklin, M.G., Brewer, P.A., Bălțeanu, D., Bird, G. (2004). The impact of metal mining activities on the Upper Tisa River Basin, Romania and Transboundary river pollution. *Studia Geomorphologica Carpatho-Balcanica*, Krakow
- Serban, P., Galie, A. (2006) *Managementul Apelor*. Editura Tipored, Bucuresti
- Sidło, P.O., Błaszowska, B., Chylarecki, P. (eds) (2004). *Important Bird Areas of European Union importance in Poland*. OTOP, Warsaw
- Skiba, S. (2006). Characteristic properties of the Alpine type mountain soils. In *Pochva kak swizujshce zweno funkcinowanija prirodnych i antropogenno- preobrazowanich ekosistem* (ed: N.I. Granina) p. 17-19, Irkutsk
- Skiba, S., Drewnik, M., Drozd, J. (1997). Characteristics of the organic matter of ectohumus horizons in the soils of different mountain regions in Poland. In *The role of humic substances in the ecosystems and in environmental protection* (eds: J. Drozd, S. Gonet, N. Senesi, J. Weber) p. 497-505, IHSS
- Slăvoacă, D.C., Slăvoacă, R. (1998). *Information concerning the genesis of the thermomineral water reservoir of the spa Complex Călimănești-Căciulata-Cozia*. International Symposium A.H.R. "Mineral and thermal groundwater", p. 97-103, Miercurea Ciuc
- Sottnik, P., Dubikova, M., Linterova, O., Rojkovic, I., Sucha, V., Uhlik, P. (2002). *The links between the physico-chemical character of different mining waste in Slovakia and their environmental impact*. Proceed of the XVIIth Geol. Carpath. Balkan Assoc. Congr., p. 227-229, Bratislava
- Stanescu, V., Drobot, R. (2002). *Măsurile nestructurale de combatere a inundațiilor*. Editura HGA, București

- Statistical Office of the Slovak Republic (1990). *Statistical Yearbook*. Bratislava
- Stanova, V. (2003). Plant alliances. In *Carpathian list of endangered species* (eds: Z.J. Witkowski, J. Król, W. Solarz), WWF and Institute of Nature Conservation PAS, Vienna/Kraków
- Starkel, L. (1972). Charakterystyka rzeźby Polskich Karpat i jej znaczenie dla gospodarki ludzkiej. *Problemy Zagospodarowania Ziemi Górskich* 10, 34-56
- Struckmeier, W.F., Margat, J. (1995). Hydrogeological Maps and a Guide and a Standard Legend. *International Contributions to Hydrogeology* 17, Verlag Heinz Heisse
- Suprunenko, O. (2001). *Agriculture in the Carpathian region*. Carpathian Ecoregion Initiative
- Šúri, M., Cebecauer, T., Hofierka, J., Fulajtár, E. (2002). Soil erosion assessment of Slovakia at a regional scale using GIS. *Ekológia* 21(4), 404-422
- Tasenkevich, L. (1998). *Flora of the Carpathians. Checklist of native vascular plant species*. L'viv State Museum of Natural History of NAS of Ukraine, L'viv
- Tasenkevich, L. (2003). Vascular Plants. In *Carpathian List of endangered species* (eds: Z. Witkowski, W. Król, W. Solarz), WWF and Institute of Nature Conservation, Polish Academy of Sciences, Vienna/Kraków
- Třebický, V., Novák, J., Ira, V., Huba, M., Stodulski, W., Eri, V. (2003). *Road to Sustainability – Economic, Social and Environmental Dimension of Sustainability in Visegrad Countries*. Institute for Environmental Policy, Prague
- Trenberth, K.E. (1990). Recent observed interdecadal climate changes in the Northern Hemisphere. *Bull. Amer. Meteor. Soc.* 71, 988–993
- UNEP (2002). *Caucasus Environment Outlook*. New Media, Tbilisi
- UNESCO (1984). *Explanatory memoir of the metallogenetic map of Europe and neighbouring countries*. UNESCO, Paris
- UNESCO (1984). *Metallogenic map of Europe and neighbouring countries, scale 1/2.500.000*. UNESCO, Paris
- Vaishar, A., Cetkovský, S., Kallabová, E., Klusáček, P., Kolibová, B., Lacina, J., Mikulík, O., Zapletalová, J. (2006). Urban Environment in Big European Cities. *Moravian Geographical Reports* 1(14), 46-62
- Voloscuk, I. (ed.) (1992). *Pieninsky Narodny Park*. Akcent press service, Banska Bystrica
- Voloscuk, I. (ed.) (1997). *The nature of the Pieniny in transformation*. Sprava Narodnych Parkov Slovenskej Republiky, Tatranska Lomnica
- Witkowski, Z., Madziara-Borusiewicz, K., Płonka, P., Żurek, Z. (1987). Insect outbreaks in mountain national parks in Poland – their causes, course and effects. *Ekol. Pol.* 35, 465-492
- Witkowski, Z. (1989). The pollinating insects are endangered in the Pieniny National Park by the competition of the bee *Apis mellifera*. *Chrońmy Przyr. Ojcz.* 45(5-6), 48-59
- Witkowski, Z. (1996). Conclusions. In *Wpływ narcyzarstwa i turystyki pieszej na przyrodę masywu Pilska* (eds: A. Łajczak, S. Michalik, Z. Witkowski), *Studia Naturae* 41, 239-253
- Witkowski, Z. (1998). The Carpathian mountain range as an ecological system within the Pan-European Ecological Network. In *The green backbone of Central and Eastern Europe* (ed: P. Nowicki). European Centre for Nature Conservation, Ser. Man and Nature 3, 161-173
- Witkowski, Z., Dyduch-Falniowska, A., Makomaska-Juchiewicz, M., Kaźmierczakowa, R., Kotulski, M., Perzanowska, J., Serafin, R., Skawiński, P., Zajac, K. (1998). Preliminary assessment of the environmental impacts of the Zakopane 2006 Winter Olympic Games proposal. *Oecol. Montana* 7, 32-38
- Witkowski, Z. (2000). *The Carpathian Biodiversity Assessment*. Report of the Biodiversity group of the Carpathian Ecoregion Initiative under auspices of WWF, Kraków
- Witkowski, Z., Król, W., Solarz, W. (eds) (2003). *Carpathian List of endangered species*. WWF and Institute of Nature Conservation, Polish Academy of Sciences, Vienna/Krakow
- Wołoszyn, B.W., Bashta, A-T.V. (2001). *Nietoperze Karpat. Polowy klucz do oznaczania gatunków*. Chiropterological Information Center, Institute of Animal Systematics and Evolution PAS, Kraków/Lvov
- Wyżga, B. (1997). Methods for studying the response of flood flows to channel change. *Journal of Hydrology* 198, 271-288
- Wyżga, B. (2006). *A review on channel incision in the Polish Carpathian rivers during the 20th century*. Msc. Warsaw
- Zarzycki, K. (ed.) (1980). The nature of the Pieniny Mountains (West Carpathians) in face of the coming changes. *Studia Naturae* ser. B 30, 1-578

### Internet Sites

- whc.unesco.org  
 www.dartmouth.edu/floods  
 www.government.gov.sk  
 www.sazp.sk  
 www.mirror-weekly.com/nn/show/549/50244/ "Hungarian Transit"  
 www.ce-review.org

**Chapter Four**

**Outlook 2020:  
Three Scenarios for  
the Carpathian Region's  
Future Development**





The purpose of this Outlook Chapter 4 is to help government policy-makers and other stakeholders identify the key environmental challenges faced by the Carpathian region, and to understand the economic and environmental impacts of the policies that could be used to address those challenges.

Environmental problems are often complex, interlinked and cross-cutting. For example, biodiversity loss is often the result of multiple pressures, such as loss of habitat through land-use change or habitat fragmentation and impacts from pollution. A mix of policy instruments may be needed to tackle the various causes of this loss. Policy packages need to be carefully designed in order to achieve desired environmental benefits at least-cost levels.

Many of the major environmental challenges that Carpathian countries face in the early 21st century are global or trans-boundary in nature, such as climate change, biodiversity loss, management of shared water resources, trans-boundary air pollution, trade in endangered species and waste disposal. As a result, there is an increasing need for countries to work together in partnerships to tackle these challenges.

Futures studies reflect on how today's changes, or lack thereof, become tomorrow's realities. They include attempts to analyse the sources and patterns of change and stability, and with foresight to be able to map alternative futures. The subjects and methods of futures studies

include the possible, probable and desirable variation, or alternative transformations of the present, both from a social and "natural" (i.e. independent of human impact) perspective. A broad field of inquiry, futures studies explore and represent what the present could become from multiple interdisciplinary perspectives (Slaughter 2005).

Chapter 4 introduces three main scenarios of anticipated environmental developments until 2020, and the underlying economic and social factors that drive these developments. The scenarios are based mainly on qualitative analyses of key economic, social and environmental trends and their impacts. In developing different scenarios, an explanatory (narrative) and qualitative approach was followed, consisting mainly of 'informed speculations' based on essential findings and key messages from the previous KEO chapters and the Regional Stakeholders Consultation (Banska Bystrica, Slovakia, October 2006).

The three scenarios of potential future development at the regional level are entitled "Business as Usual" (roughly analogous to "Markets First" in UNEP's GEOs-3/4), "EU policy first" (similar to "Policy First" in GEOs-3/4) and "Carpathian Dream" (which can be linked to "Sustainability First" in GEOs-3/4). The process of developing the three Carpathians scenarios was far more limited in time and scope than the one employed for the global (GEOs-3/4) scenarios (UNEP 2002 and UNEP in press).

© Pavel Meiss



## 4.1 Methodological Approach

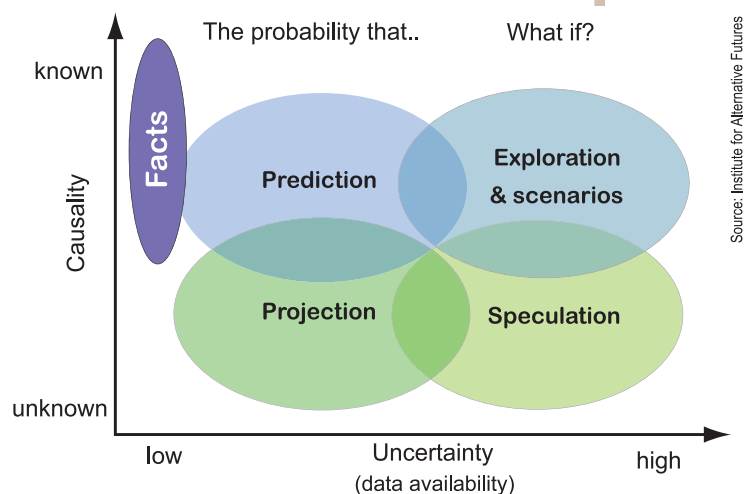
**W**hy develop potential environmental futures? In many cases, the economic, political and/or social choices that are being made today will have effects on the environment far into the future. Full environmental impacts will often not be felt until long after such choices have been taken. This inertia makes policy decisions difficult: the costs of policy actions to change development paths will impact societies today, but the benefits in terms of improved environmental quality and/or negative effects avoided may only be realised and obtained in the future. However, decision-makers and politicians tend to reflect on the immediate needs of society today, not on future generations. This situation is exacerbated by uncertainty about the future; often the exact environmental impacts may be poorly understood or disputed, or both.

Futures studies take as one of their key points of departure the ongoing effort to analyse images of the future and distinguish possible, probable and preferred (normative) pathways. This includes collecting quantitative and qualitative data and information about the possibility, probability and desirability of change towards the emergence of alternative futures. Just as histori-

cal studies try to explain what happened in the past and why, the efforts of futures studies try to understand the 'latent potential of the present'. This requires the development of theories of present conditions and how conditions might change, and what their impacts may be.

Two factors usually distinguish futures studies from pure academic research. Firstly, futures studies often examine not only probable but also possible and preferable futures. Furthermore,

Figure 4.1 Futures development process



futures studies typically attempt to gain a holistic or systemic view based on insights from a range of different disciplines (see Figure 4.1).

The future cannot be predicted. The word “futures” in futures studies is plural because there is no one pre-ordained future that is fated to occur. Rather, there are many different possible alternative futures. Instead of predicting what the future will be, futurists use a wide range of meth-

odologies to engage in structured and thoughtful speculation about possible developments. This helps people prepare for whatever future comes, and positions them to be more able to create the kind of future they would actually prefer.

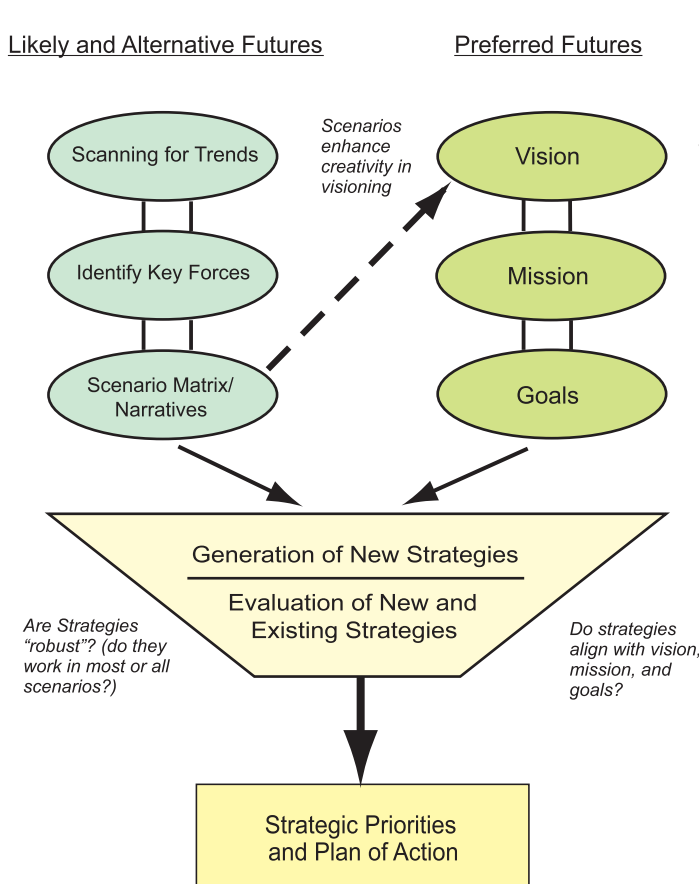
Scenario-building and storylines in this chapter are based on three main driver categories: economic driving forces, societal drivers and the environmental itself (see section 4.2 below).

## Scenarios for the Carpathian Region

The timeframe covered by the three scenarios is from the current time to 2020. It was chosen because it is short enough for readers to imagine this near-future, and simultaneously long enough for changes to become apparent and for different policy responses on various issues to take effect.

In developing different scenarios, an explanatory and qualitative (narrative) approach was followed which mainly consists of ‘informed speculations’, based on essential findings and key messages from the previous chapters of KEO. Due to the lack of historically and regionally comparable data sets and time series across the Carpathians, quantitative modelling could not yet be carried out, but should be possible at a later stage.

Figure 4.2 Scenarios, predictions and projections



Scenarios are defined in this chapter as ‘plausible descriptions of how the future may develop, based on a coherent and internally consistent set of assumptions about key relationships and driving forces’ (see Leemans 2006, and below).

UNEP’s third GEO report (and the fourth to be published in 2007; GEOs-3/4) includes a description of four outlooks for the future at the global and broad (e.g. pan-European) regional levels. These four scenarios were given the following designations: “Markets First”, “Policy First”, “Security First” and “Sustainability First”. While it was not deemed either reasonable or possible to re-create all four of these scenarios for the Carpathians, due to factors explained below, three of them have been used as inspiration for potential futures of development and possible environmental impacts: “Business as usual” (roughly analogous to “Markets First” in GEOs-3/4), “EU policy first” (similar to “Policy First” in GEOs-3/4) and “Carpathian dream” (which can be linked to “Sustainability First” in GEOs-3/4) (UNEP 2002 and UNEP in press).



## 4.2 Driving Forces, Critical Uncertainties, Fundamental Assumptions and Challenges

This section explores the driving forces and fundamental assumptions that lie behind and distinguish the three KEO scenarios. It places the remainder of the chapter, including the scenarios themselves and the lessons drawn from them, in the context of the overall Conceptual Framework of KEO, which applies the well-known and widely accepted Driving Forces–Pressure–State–Impact–Response (DPSIR) model. **The driving forces** taken into consideration in KEO include governance and power (i.e. institutional and socio-political frameworks), demography, economic activity, human development and culture.

**Three aspects** of how driving forces manifest themselves were used for developing the Carpathian scenarios. The first provides the basic premises underlying and defining the three scenarios. For the KEO scenarios, these relate primarily to questions of governance and power (See Table 1). In effect, the scenarios explore different combinations of assumptions about **who** holds most of the power (i.e. public, private or civil sector); **how** governance is generally handled (i.e. top-down vs. bottom-up; focusing

on sub-national, national or supra-national scales); and **why** particular decisions are made, reflecting what is given primacy in defining and achieving human well-being (i.e. economic gain, social equity, environmental welfare or the security of particular sub-groups).

Scenario-building, and “storylines”, in this chapter are based on the differentiation of **three main driver categories**. These categories were described and assessed in Chapters 2 and 3 of this KEO report. Economic driving forces across the three scenarios include economic activities in the agriculture, energy and industry, transport, tourism and traditional livelihoods sectors. Social driving forces cover demographic processes, employment, household consumption and environmental democracy. Chapter 4 describes environment also as a driving force including biodiversity, forest resources, land resources, mineral resources, water resources, atmospheric processes, waste and hazardous chemicals, environment and security issues and the complex urban environment, because the environment itself influences future social and economic development.

### Uncertainties across and within scenarios

With respect to scenarios, uncertainties deserve particular attention as they involve the use of multiple approaches. Having a set of scenarios intrinsically addresses certain aspects of uncertainty by varying specific assumptions, but there is also uncertainty within individual scenarios.

#### *Uncertainty across the scenarios*

In the development of each scenario, certain decisions were made for the sake of internal consistency over time and within the whole region. The basic premises were assumed to endure throughout the entire scenario period. Questions arose about the validity of holding these assumptions static across time and space. Developments in the scenarios could make one or more of the basic premises untenable at a certain point in time. For example, if there was to occur a backlash against the EU among the new Carpathian country members,

Source: UNEP, 2006a

adoption and application of the *acquis communautaire* would be invalidated or at least endangered in those countries affected.

#### *Uncertainty within the scenarios*

There are, obviously, other areas where our understanding of socio-ecological systems is incomplete, including the nature and strength of relationships between certain components. The individual scenarios reflect a particular representation of this understanding. Changes to specific assumptions could have dramatic effects on how a particular scenario unfolds. For example, using a different assumption about the sensitivity of the climate to anthropogenic emissions could lead to very different outcomes for agriculture, biodiversity and human well-being within the same scenario. These would not indicate a 'shift' to another scenario, but rather reveal the sensitivity of the scenario to particular assumptions.

Table 4.1 Basic assumptions made during the KEO scenario-building process

<u>3 SCENARIOS:</u>	<u>Business as usual</u>	<u>EU policy first</u>	<u>Carpathian dream</u>
Governance and Power Aspects			
Division of power	Dominance of multinational enterprises with active government support	Governments and EU machine; NGOs/public	Partnership relations between government, civil society and private sector
Governance patterns	Trans-national focus Weak or no government influence	Supra-national and national focus Strong governance Harmonisation with EU Acquis National Development Plans	Participatory activities at all levels Strong regional and local governance
Priorities and targets	Sustained economic growth Profit maximisation	Economic and social welfare Social cohesion Stability and prosperity Convergence	Social justice Regional equity Environmental sustainability Resource efficiency Social values and cultural diversity

Source: Pomázi, Szabó, 2007 (after UNEP 2006a)



## 4.3 Three Scenarios for the Carpathian Region

### Setting the Scene: Recent Key Trends

The previous chapters of KEO have highlighted historical and recent trends, and key economic and social driving forces with regard to environmental changes and policy actions. Looking back over the years since 1975, it is clear that many dramatic changes have occurred in the Carpathian region. These developments and trends of the last three decades are explored herein, as they relate to and are used to help derive the future scenarios.

Recent policy reforms at the regional level have also seen a greater integration of policies, sectors and standards across groups of countries, for example with respect to water management and agricultural practices in the enlarged European Union. These developments suggest that government-led approaches have made some headway in tackling certain challenges.

Many citizens, governments and other stakeholders are encouraged by what they see as a continued shift in favour of a stronger social and envi-

ronmental agenda among both governments and citizenry. Concerted efforts to promote universal primary and secondary education and mainstreaming environmental and social adjustments into economic growth represent two steps in this direction. At the local level, growing grassroots and civil society engagement has directed attention towards livelihood issues with both local and regional relevance (UNEP 2006a).

Some stakeholders see the market economy as the dominant paradigm for fostering growth and well-being, with diverging opinions about its success. Proponents see the continued rise in oil consumption and prices as a basis for considerable growth, while sceptics focus on their negative societal and environmental consequences. The increasingly globalised nature of enterprises has created a more interlinked economic world. Some argue that the role of governments is tilted in favour of economic objectives, even while it may be shrinking overall in the face of increasing corporate influence in policy decisions and trade agreements.

These varied aspects of the recent situation exert very different pressures on human decisions and actions, with implications for human and environmental well-being. A continuation or change in any of these patterns could have a pivotal influence on major issues at local, regional and global levels. Government leadership, market incentives, protectionist motives or unconventional approaches could produce either marked improvement or steady declines for such pre-

vailing environmental concerns as freshwater quality and availability, land degradation, conservation of biodiversity and energy use with its associated climate and pollution effects. Socially, these different approaches could translate into radically different situations regarding equity and the distribution of wealth, peace and conflict, access to resources and health services and opportunities for political and economic engagement. (UNEP 2006a)

## Business as Usual

“Business as usual” describes a future development/state in which no new policies or measures are implemented apart from those already adopted or agreed upon. ‘Normal’ socio-economic development continues without any particular constraints. The scenario below provides: an overview and storylines, potential development trends and policy implications within and across the sectors; a political, economic, social and environmental interface; and the most important regional highlights and future status images.

Under this scenario, most of the world’s development continues to be primarily driven by the global demand for goods and services. Privatisation, the production of specialised products and competition on the world market become key strategies for maximising economic growth. The world adopts the values and expectations prevailing in today’s industrialized societies. The exploitation of cheap natural resources, mass production and manufacturing efficiency are seen as the formula for lowering prices and competing in a global market where few inter-regional trade conditions exist. Economic development through better technology and management is given a high priority, as it is believed that this will lead to equity and social improvement in the shortest time. Governments are confident that the self-correcting market will yield a technological fix or solution of some kind to any problem that may arise, be it environmental or otherwise (UNEP 2006a).

Across the Carpathians, globalisation and liberalisation forces are also strong and widespread. Multi-national enterprises with active government support dominate the division of power, and GDP growth rates are high. Governance patterns focus on trans-national cooperation, but the actual capability and levels of government intervention are very weak. Government policies are driven by the promotion of steady economic growth, with profit maximisation as the only measurement tool.

Small businesses and local economies are threatened by trans-national corporations. Income inequalities are growing, and the so-called social security systems (“safety nets”) are greatly weakened. Regional disparities increase, and the depopulation of rural areas, especially of the most remote ones, accelerates. There is rapid migration from mountainous and rural areas toward cities and abroad. In general, quality of life as measured by the Human Development Index (HDI; UNDP 2006) stagnates or slowly improves at best.

Due to rapid globalisation, traditional values gradually disappear. Cultural, ethnic and linguistic diversity, and the integration of minorities such as the Roma population of the Carpathian region, are not acknowledged as important, and manifestations of unique local cultural differences diminish, due to cultural homogenisation.

The health care and education systems are underfunded, and the population rapidly ages, threatening inter-generational solidarity. Social cohesion weakens, and the unemployment rate, particularly among young people, may increase due to structural changes. Society as a whole ignores vulnerable groups. Increased immigration fills gaps in the workforce while creating social and ethnic tensions. The European integration process focuses only on the extension of the internal market, and the regulatory and watchdog functions of the European Commission are cut back. There is only limited and *ad hoc* dialogue and cooperation among different stakeholders, governments, business and civil society. This applies as well to the implementation of the recently approved Carpathian Framework Convention.

The share of agriculture both as a contribution to GDP and employment rapidly decreases, endangering food security and the viability of rural areas in the Carpathians. The concentration of land ownership continues in parallel with the collapse of small holdings.

In the forest sector, unsustainable practices of forest management prevail, for example clear-cutting and the introduction of non-indigenous species. Wood production exceeds the annual increment of forested areas. Reforestation and afforestation programmes are under-financed and thus languish. Due to weakened enforcement and inspection capacities, as well as increasing rural poverty, illegal logging and poaching reach high rates, and in some cases organised crime is involved. The most valuable tree species are cut at an accelerating pace.

The size of the total forested area decreases, and the structure and composition of tree species worsens. Unsustainable logging dominates overall forest management. Available land is rapidly exploited, built-up areas increase and developers favour green field investments. The private sector dominates the land ownership structure, followed by some state ownership.

Energy policies are guided by supply-side management and energy demand increases, while there is only a limited focus on energy efficiency and savings. The energy structure is still domi-

nated by fossil fuels, dependency on oil continues, the use of natural gas increases and renewable energy sources and nuclear energy become more important in the energy balance. The overall energy dependency on Russian sources and transit fees in the Carpathian region increases. The mining sector in the Carpathians creates local and trans-boundary conflicts.

Greenhouse gas emissions continue to rise, climate change impacts (e.g. storms, heavy rains, heat waves) become more apparent and weather extremes more frequent, causing huge economic and health damages. Flood risks and average temperatures increase. Winters become warmer and drier with less or no snow at all, with a strong impact on winter tourism. Epidemic events and vector and water-borne diseases occur more frequently.

Nearly all European regions are negatively affected by some future impacts of climate change and these pose challenges to many economic sectors. Climate change magnifies regional differences in Europe's natural resources and assets. Negative impacts include an increased risk of inland flash floods and increased erosion. The great majority of organisms and ecosystems have difficulties adapting to climate change. Mountainous areas face reduced snow cover and winter tourism, along with extensive species losses (in some areas up to 60 per cent under high emission scenarios by 2080).

In Central and Eastern Europe, summer precipitation decreases causing higher water stress. Health risks due to heat waves increase. Forest productivity declines and the frequency of peat land fires increases.

Adaptation to climate change benefits from past experiences gained in reaction to extreme climate events, specifically through the implementation of proactive climate change risk management adaptation plans.

Transport policies and infrastructural developments concentrate on highway construction with a limited focus on environmentally-sustainable transport modes. Public transport deteriorates further, mainly because of rising prices. Both traffic volumes and passenger cars per capita



strongly increase. Nature protection aspects are not integrated into transport development programmes, while freight transport also grows significantly.

Tourism is promoted with the development of large-scale investments (e.g. wellness centres, aquaparks). Mass tourism becomes a very common feature in the Carpathians. In contrast, rural and ecological activities are supported to a very limited extent. The management of tourist facilities does not consider environmental issues such as energy efficiency, water savings, the use of renewable energy and healthy food.

Uncontrolled and illegal movements of different kinds of waste, including hazardous and municipal, occur more frequently. The illegal trade of endangered species and transport of second-hand products (e.g. old cars, refrigerators, electronic equipment) becomes widespread. Control and enforcement capacities to stop illegal activities remain very weak, as does the related transboundary co-operation among regional and local governments.

Environmental democracy principles as enshrined in such multi-lateral environmental agreements as the UNECE Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters (Aarhus Convention) are adopted, but their implementation is accompanied by many conflicts and a lack of any real competency. Public participation in decision-making is only formal, and access to environmental information is limited. Ecological awareness throughout society does not improve, since environmental education is incorporated into formal and informal education curricula only on a limited basis.

Overall household consumption increases, and there are no incentives to change social and individual behaviour. Some social groups regularly over-consume, while others have no access even to basic needs.

Consumption-driven waste generation increases and the share of final disposal dominates waste management. The use of hazardous chemicals

remains common. The occurrence of natural and man-made disasters becomes more frequent and, at the same time, more irregular.

Overall, urban environmental quality worsens. Generated wastewater is not, or only partially, treated. In most settlements, air quality endangers human health while respiratory diseases spread. The size of green areas decreases and they are poorly managed or untended. Unhealthy fast-food restaurants continue to spread, and obesity becomes the norm for many. There is no strict urban planning or regulation. Public transport systems deteriorate, as passenger cars eventually occupy all space. Households fail to follow environmentally-friendly behaviour; they do not save water and energy, nor collect waste separately.

Both habitat fragmentation and biodiversity loss continue. Landscape destruction increases, while invasive species spread and threaten biodiversity. The territory of protected areas decreases while the management of existing protected areas weakens. Nature conservation activities are under-funded when compared with their needs.

The over-exploitation of water resources continues, as does the discharge of pollutants into waters. Drinking water quality worsens as water prices increase without taking into account social consequences and affordability. Governments tend toward privatisation of the entire water sector. Drinking water pollution events and water use conflicts occur more frequently.

Air pollution increases mainly due to the large fleet of motor vehicles and transport volume. Air quality conditions worsen both in cities and in the countryside. The use of obsolete pesticides is not banned, while toxic substances are neither regulated nor controlled.

All in all, globalisation, liberalisation, privatisation and deregulation are the prevailing driving forces. The profit motive is everywhere dominant, while simultaneously, social and cultural homogenisation and the marginalisation of environmental values are widely spread.

## EU Policy First

“EU policy first” is based on the GEO “Policy First” scenario which presumes the regional implementation of sustainable policy measures and strong collaboration between countries and citizens. It considers the successful implementation of EU environmental regulation procedures in the entire Carpathian region. Furthermore, the European Commission joins the Carpathian Framework Convention and its protocols.

### Relevant EU-Wide Policies

Recently, there has been a wide range of policy developments that provide, to different degrees, relevant contexts for the assessments presented in this section. A few important developments merit particular consideration. These are: the Lisbon Strategy adopted in March 2000; EU Sustainable Development Strategy adopted in Göteborg in June 2001 and renewed in 2006; 6th Environment Action Programme (EAP) adopted in July 2002; and the enlargement of the EU to 25 Member States in May 2004 (including the Czech Republic, Hungary, Poland and Slovakia) and to 27 in January 2007 (including Romania and Bulgaria).

The previous EU enlargements added unique environmental assets to the EU, including rich biodiversity and landscapes and vast areas of relative wilderness. However, this positive development also represents an important challenge for EU environmental policy given the capacity building and financing needs required to support implementation of the *acquis communautaire*. The progressive adoption by the EU-12 Member States of the environmental “acquis” has already contributed to improving environmental quality in many areas, and there are opportunities for mutual learning about better policy design and implementation.

The 6th EAP sets out the EU’s environmental roadmap until 2012. It is the main vehicle to achieve the environmental goals of the EU’s Sustainable Development Strategy. It sets ambitious, long-term goals for environmental protection, and provides a stable framework within

which both the public and private sector actors in Europe and the rest of the world can take action. The programme focuses on four priority areas: 1) climate change, nature and biodiversity; 2) environment; 3) health and quality of life; and 4) natural resources and waste.

This updated EU Sustainable Development Strategy requires environmental objectives to be considered alongside their economic and social impacts (and vice-versa), so that integrated policies can be implemented for the benefit of the economy, employment and the environment. This strategy provides a longer-term perspective than either the 6th EAP or the Lisbon Strategy.

The Lisbon Strategy seeks to make the EU “the most dynamic and competitive knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion, and respect for the environment by 2010”. The strategy was reviewed in 2004 and re-launched in 2005 with a strengthened focus on economic growth, employment and “win-win environmental economic strategies through the development and use of eco-efficient technologies”. This new policy direction also offers new opportunities to take forward the development of cleaner environmental technologies. (EEA 2005)

### Impacts on Carpathian Region

The above-mentioned recent EU policies and strategies have a great impact on the formulation and implementation of relevant policies and actions in the Carpathian region. In general, the application of these EU policies leads to short-term difficulties in adjustment, but longer-term benefits for the future development of the region.

Carpathian governments recognise the need for stronger coordination of policy efforts and structural reforms. The European currency (Euro) is adopted across the region. Most policies become harmonised with EU regulations and standards. All countries attempt to take serious efforts in

## Policy-Guiding Principles in the Renewed EU Sustainable Development Strategy

### *Promotion and protection of fundamental rights*

Place human beings at the centre of the European Union's policies, by promoting fundamental rights, combating all forms of discrimination and contributing to the reduction of poverty and the elimination of social exclusion worldwide.

### *Solidarity within and between generations*

Address the needs of current generations without compromising the ability of future generations to meet their needs in the European Union and elsewhere.

### *Open and democratic society*

Guarantee citizens' rights of access to information and ensure access to justice. Develop adequate consultation and participatory channels for all interested parties and associations.

### *Involvement of citizens*

Enhance the participation of citizens in decision-making. Promote education and public awareness of sustainable development. Inform citizens about their impact on the environment and their options for making more sustainable choices.

### *Involvement of businesses and social partners*

Enhance social dialogue, corporate social responsibility and private-public partnerships to foster cooperation and common responsibilities to achieve sustainable consumption and production.

Source: European Council, 2006

### *Policy coherence and governance*

Promote coherence between all European Union policies and coherence between local, regional, national and global actions in order to enhance their contribution to sustainable development.

### *Policy integration*

Promote the integration of economic, social and environmental considerations so that they are coherent and mutually reinforce each other by making full use of instruments for better regulation, such as balanced impact assessment and stakeholder consultations.

### *Use best available knowledge*

Ensure that policies are developed, assessed and implemented on the basis of the best available knowledge and that they are economically sound and cost-effective.

### *Precautionary principle*

Where there is scientific uncertainty, implement evaluation procedures and take appropriate preventive action in order to avoid damage to human health or to the environment.

### *Make polluters pay*

Ensure that prices reflect the real costs to society of consumption and production activities and that polluters pay for the damage they cause to human health and the environment.

reforming their social security systems by reducing their financing. In the short run, this results in some political protests, and even social conflict, and a temporary decline in economic growth. Deepening social and regional inequality become major challenges. The five Carpathian EU member states experience post-accession political, economic, social and environmental challenges, culminating in a crisis of confidence in, and a sense of frustration with, the fact of EU membership.

There are strong governmental interventions in the marketplace. The political commitments and policy-guiding principles formulated in the renewed EU Sustainable Development Strategy in 2006 serve as an overarching document to enhance sustainable development in the Carpathian countries (See Box 2). These policy principles are taken into consideration while Carpathian countries, regions and local governments formulate their own sustainable development strategies and plans.

The overall aim of the renewed EU Sustainable Development Strategy is to identify and develop actions to enable the EU to achieve continuous improvements to the quality of life, both for current and future generations. This is done through the creation of sustainable communities that are able to efficiently manage and use resources, and to tap the ecological and social innovation potential of the economy, ensuring prosperity, environmental protection and social cohesion. However, there is a risk that these commitments are overwritten by economic and competitiveness fears and deepening social problems. Governance failures increase due to an inefficient coordination mechanism which threatens the implementation of common policies including environmental policy. At the same time, trans-regional and trans-local co-operation strengthen to compensate for supra-national and national failures and incompetencies. Carpathian members of the European Parliament are directly elected by their constituencies and become more accountable.

National development plans define overall economic and social development in the region. In the Carpathian countries there is a strong desire to enhance stability and prosperity, strengthen social cohesion and catch up with the quality of life existing in the former and richer EU Member States.

The share of agricultural output to GDP slightly decreases while the EU Common Agricultural Policy (CAP) guides the whole process of agricultural restructuring, moving it toward more environmentally-friendly practices. Agricultural subsidies are reduced and strictly tied to environmental standards which enhance extensive and labour-intensive agricultural methods. The share of ecologically-produced (bio-friendly) agricultural goods increases. The production of genetically modified organisms is encouraged by the European Commission and under negotiation within the Cartagena Protocol and WTO.

Forest cover stabilises or slightly increases as the share of unsustainable logging decreases. Most illegal logging is stopped due to serious inspection measures. The area of land withdrawn from agricultural cultivation increases because of the impacts from the CAP and decreasing subsidies.

Certification systems such as the Forest Stewardship Council for sustainable forest management are widely introduced and implemented throughout the Carpathians. Sustainable forest management is strengthened through the EU Forest Action Plan.

The energy intensity of the economy declines and converges towards the EU-15 average. Energy security is at the top of the agenda, making diversification of energy sources a key issue. The use of renewable energy sources is continuously supported by both EU and national government funds and through the taxation system. Energy security goes hand-in-hand with climate security, but this could easily be negatively affected from outside the region. Intelligent energy systems supported by the EU spread across the region. Trans-national corporations prevail in the productive and service sector; however, small and medium-size enterprises enjoy positive discrimination support.

Environmental management systems in enterprises become commonplace, while corporate social and environmental responsibility becomes stronger.

Energy diversification and energy mix are a great concern, and particular attention is given to renewables and biofuels. By 2020, greenhouse gas emissions are reduced by 30 per cent compared with the 1990 level. Climate-friendly economic activities and consumer behaviour are strongly supported through national governments' and EU budgets and other sources. Traditional air pollutant emissions are further reduced while some improvements occur in urban air quality.

A more balanced approach is followed among different transport modes than in the "Business as usual" scenario. However, the main focus still remains on road construction. The share of public transport is maintained or slightly increases. There are incentives to increase the use of biofuels in vehicles but these changes are outpaced by volume effects, as individual passenger transport continues to grow.

The Carpathian countries need to guarantee a balance between ensuring the satisfaction of tourist demands and the protection of the environment. The EU identifies best practices in sustainable tourism to be promoted for the benefit of Carpathian tourism. The Carpathian sustainable tourism network is supported by the European Commission.

An old connection, 'harmony between nature and man', continues to gradually disappear from everyday life. These links need to be reconstructed on a new level by applying new tools. The EU supports the preservation of language and cultural diversity in minority groups including the integration of Roma people. This provides a greater chance for the survival of traditional cultures and livelihoods.

EU policy aims at maintaining and strengthening regional and social cohesion for the budget period 2013 to 2020. Huge funds are made available for sustainable, rural and agricultural development in the Carpathians, helping to decrease the social divide between rich and poor people as well as regional disparities.

Taking into account the ageing of populations in all Carpathian countries, the sustainability and adequacy of pension systems remain an important issue for the coming decades. The EU continues to support the efforts of Carpathian states to modernise their social protection systems. Carpathian countries reduce their public debt to meet “Maastricht criteria”, raise employment rates and productivity and reform health care systems. Human populations stabilise or slightly increase while migration to cities weakens.

A moderate convergence occurs towards the EU-15's quality of life, with an increase in salaries and social benefits, while child poverty decreases due to strong social policies.

While current consumption levels continue, at the same time environmental awareness is on the rise. The demand for environmentally-friendly products and services increases, but most people cannot afford to buy them. Consumer consciousness increases, fair trade rules are better implemented and eco-labelling schemes for goods and services are provided with robust consumer protection efforts.

There are few border controls in the internal (or common) market of the EU. The movement of waste and illegal trade of endangered species thus takes place with greater ease and frequency. Inspection and enforcement capacities weaken due to a lack of consideration in public sector reforms.

However, trans-regional cooperation in environmental protection and nature conservation improves at all levels. There is a strong intention followed by actions to implement Aarhus Convention principles: participation in decision-making is ensured, environmental and sustainable development issues are incorporated into the education curricula and free access to information on the environment is facilitated. “State of the Environment (SoE) reports” are regularly prepared at many levels of government. Governance is a mixture of top-down and bottom-up methods, and the principle of subsidiarity gains its share in decision-making.

The Natura 2000 network and other protected areas grow in size. By 2020, biodiversity loss in

the Carpathians is fully halted, thanks to the application of the Birds Directive and Habitats Directive. People in the countryside are recognised as guardians of cultural and natural landscapes, and they receive the necessary moral and financial support to pursue their activities.

Huge infrastructure developments financed through the EU Cohesion Fund and Structural Fund threaten the conservation-rich natural values of the Carpathians, but their negative effects are minimised through careful planning, and by the application of strategic and project-based environmental assessments. Full compliance with the EU mining waste directive diminishes negative environmental effects of the mining sector in the Carpathians.

The Carpathian countries work toward improving their integrated water resources management. The rational use of water spreads among all users including households, businesses and farmers. There are tangible results in reaching the good ecological status of all water resources required by the EU Water Framework Directive's provisions.

The generation of municipal waste slightly increases. The efficient use of natural resources is enhanced by applying the concept of life-cycle thinking and promoting reuse and recycling. By applying strong economic incentives, recycling rates for paper, plastic and metals increase. A waste ‘prevention’ philosophy prevails over waste ‘management’ policy. In the management of chemicals, the EU's relatively new regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) is strictly enforced, diminishing health risks for the general population.

Regarding climate change and related natural hazards, average precipitation and temperatures, and flood events increase. Winters become warmer and drier with less snow. Epidemic events and vector-borne diseases occur more and more frequently. The EU Solidarity Fund compensates for only a small part of economic and health impacts.

Man-made and technological accidents are prevented or efficiently managed by the implemen-

tation of the EU's Seveso 2 Directive. Citizens are well-informed and prepared to confront the effects of potentially harmful events.

Urban environmental quality improves overall. Most generated wastewater is treated by applying best available technologies with reference to the EU Urban Waste Water Directive. Clean air prevails in most settlements while respiratory diseases caused by air pollution decline. The share of green areas increases. The 'sustainable city' concept is applied by municipalities, with politicians, the public, scientists and

green NGOs working together to increase public transport, pedestrian zones, car-free streets, cycling routes and sustainable housing. The use of obsolete pesticides is totally banned, and highly toxic substances are strictly regulated and controlled.

In conclusion, the "EU policy first" scenario provides great opportunities and, at the same time, uncertain challenges in the future development of the Carpathian region. Most of the future policies and development are determined by EU integration and extension by 2020.

## Carpathian Dream

The "Carpathian Dream" scenario focuses on key regional issues and policy differentiation and derives from the GEO "Sustainability First" scenario, assuming the implementation of pro-environment and anti-poverty policies having highest priority, at nearly unlimited cost.

Conducting futures workshops, where participants brainstorm about the future, is a means widely used as a participatory approach in formulating future scenarios. Box 3 represents the final result of "brainstorming" activities conducted among various Carpathian stakeholders during the KEO Regional Stakeholders Consultation (Banská Bystrica, Slovakia, Oct. 2006).

In this scenario, it is broadly agreed that the concept of environmental sustainability put forward by the Brundtland Commission is necessary and beneficial to humans, even though there are disagreements among decision-makers about how it should be implemented. In any event, policy-makers recognize that achieving environmental sustainability relies on a multitude of potential interventions undertaken by individuals, groups, organizations and institutions across different levels and sectors of society. Three broad categories of approaches to environmental sustainability are widely pursued: the implementation of technological innovations; changing the structure of government,

laws and/or the education system; and changing consumer behaviour.

The change of paradigm produces other benefits such as simplicity, tranquillity and community gradually displacing consumerism, competition and individualism as dominant values. Tolerance becomes a key aspect of culture. A new "environment for development" paradigm emerges in response to the challenge of sustainability, supported by new, more equitable values and institutions. A more visionary state of affairs prevails, where radical shifts in the way people interact with one another and with the world around them stimulates and supports sustainable policy measures and corporate responsibility. There is much fuller collaboration between governments, citizens and other stakeholder groups in decision-making on issues of close common concern. At the same time, this scenario runs the risk that lower human consumption may lead to a reduction of trade and overall economic growth with uncertain consequences (UNEP 2006a).

By 2020, the two Carpathian countries (Serbia and Ukraine) not yet in the EU, become full members of both the EU and North Atlantic Treaty Organisation (NATO). This development determines the overall geo-political framework in the Carpathians. The Carpathian region is defined by increased partnership among different

### Participatory futures workshop – main findings

*Carpathian Dream (Living countryside), process approach*  
Now we see problems such as nature protection and depopulation. The aim of international conventions will have to focus on raising environmental awareness. Policy-makers realise that they have to contribute to making people aware of their responsibilities, as the Carpathian region cannot be managed without people.

Actions are taken to: revitalise traditional cultures (with EU policy support and funding); support eco-tourism (e.g. local authority support, protocol on sustainable tourism); improve site-specific management and nature conservancy plans; enhance administrative capacity to protect ecologically valuable places; support small ecological planning and regional products (e.g. through CAP and LIFE funds); and to better regulate the waste disposal system. Spatial planning visions are designed for the region as a whole. High quality education services attract young people in the region.

The Carpathians become a 'living countryside' where traditional ways of life are preserved and transmitted through generations. Policy interests favour nature protection, a clean environment and a high quality of life.

*Carpathian Dream, sectoral approach*

Demography and households: immigration into the Carpathians.

- development of zero-energy houses and energy-efficient villages

Source: KEO Regional Stakeholders' Consultation meeting report; UNEP 2006.

Industry: no mining but the development of brownfield activities, handicrafts and forestry continues.

Energy: 20% increase in renewable energy use mainly through the development of small hydro, biomass and biofuels.

- no nuclear energy
- increased gas consumption, decreased coal and oil use
- market-driven energy savings

Agriculture: promotion of organic farming and small-scale ecological farming.

- traditional species, old varieties and products
- advanced marketing system

Transport: shift from road to rail transportation.

- promote public transportation vs. private cars
- promote soft mobility and hybrid cars

Tourism: strong development of summer tourism (e.g. cycling, hiking, horse riding, water tourism, speleology, cultural and agro-tourism, paragliding, fishing, hunting).

- winter tourism diversification (e.g. spas)

Protected areas and biodiversity: increase in the total area of protected areas.

- protection of green/migration corridors
- gene banks to preserve endangered species
- measures to decrease habitat fragmentation

stakeholders. There is a permanent dialogue between governments and civil society and continuous consensus building, which allows for the establishment of efficient mechanisms and tools to achieve a more sustainable path of development. The direct participation of citizens at all levels further strengthens regional and local governance based on the subsidiarity principle. There is a very strong and decisive decentralisation in parallel with central government interventions and redistribution. Local taxation is dominated by the revenue side of the budget, while the implementation of locally-determined priorities, plans and programmes receives only supplemental support from central government budgets.

Decisive central and local government initiatives attempt to achieve commonly agreed environmental and social goals. In general, environmental sustainability, social justice and strong anti-poverty policies are formulated as basic premises of development, taking into account

the main objectives and principles of the Carpathian Framework Convention.

The economy of the region is characterised by qualitative growth accompanied with regional convergence. The contribution of the service sector to GDP is dominant, meaning that environmental policies are mostly directed by sustainable consumption patterns. The share of health and education as well as research and development in GDP are significantly higher, which contributes to human and social capital and changing behaviours among the population. Resource efficiency gradually increases, and social values and cultural diversity override economic interest and profit maximisation.

Population also increases, with young people immigrating to the Carpathians from other regions, due to high-quality educational services. The region in general is characterised by full employment, equal opportunities for both genders

and minorities (e.g., the Roma population), vulnerable groups and disabled people. Poverty and homelessness diminish, while life expectancy increases especially for men. All in all, the quality of life in general converges towards average standards within the rest of the EU.

In the agricultural sector, organic farming and small-scale ecological and traditional agricultural methods are promoted, along with traditional/domesticated animal and plant species, old varieties and local products, and local branding and advanced marketing systems. The use of genetically modified organisms (GMOs) is excluded in the Carpathian region, despite the existence of the Cartagena Protocol.

In the forestry sector, the multi-functionality of forests is pursued in a balanced manner, especially through the use of biodiversity, recreation and carbon sequestration. The process of deforestation is gradually reversed thanks to effective and extensive reforestation and afforestation programs and funding. Sustainable forest management practices become common across the Carpathians and among owners and users. Illegal logging and clear-cutting become practically non-existent.

Under this scenario, to address climate change impacts in the post-Kyoto period, it is necessary to ensure a dominant use of renewable energy sources of up to 30 per cent in electricity generation. Maximum but careful use of local energy carriers is required. The overall aim of mitigating climate change requires the attainment of a carbon-neutral or carbon-free economy. Regional and local climate change strategies are fully implemented including mitigation and adaptation. Climate-friendly behaviour is followed by local governments, the private sector and citizens. Nuclear power use is limited to current reactor capacity, while small-scale hydropower, biomass and biofuel energy sources are promoted. Natural gas consumption increases while coal and oil use both decrease.

Behavioural changes lead to changed production and consumption patterns. The number of zero-energy houses and energy-efficient villages increases widely, as does the use of renewable energy sources (e.g. solar, heat pumps, wind, biomass).

The frequency and magnitude of floods decrease as a consequence of comprehensive flood protection policies including water management, forestry, land-use planning, climate change and innovative financing. Economic damage and human losses from floods are minimised. Man-made and technological accidents approach zero, while public participation and access to information in hazard prevention and disaster management are fully ensured.

No mining activities are developed in the Carpathians, but there is a strong incentive to develop activities in restored brownfield areas, such as local industries and handicrafts.

In the transport sector, support is given to public transportation versus the use of private cars and non-motorised modes of transport (e.g. walking, cycling and climbing). There is a strong shift in freight transport from road to rail and in some cases to inland waterways.

Summer tourism activities are strongly supported such as cycling, hiking, horse riding, canoeing/rafting, speleology, cultural and agro-tourism, para-gliding, fishing and hunting. Enhanced support is also given to the development of eco-tourism, especially through local authorities. The Protocol to the Carpathian Convention on Sustainable Tourism is fully implemented. To preserve and revitalize traditional livelihoods and cultural activities, various actions are taken with EU policy support and financial sources.

Trans-regional co-operation is enhanced among regional and local governments. The illegal movement of waste and illegal trade in endangered species is greatly reduced due to the strengthened enforcement and inspection capacities of regional and local authorities. The subsidiarity and partnership principles also prove to be a basis for strong cooperation.

Environmental democracy is characterised by strong local and cooperative initiatives and actions. Public participation is enhanced and embedded in day-to-day decision-making and implementation. Environmental education is practiced in curricula at all levels of formal and informal education, while life-long learning becomes widespread. Ecological awareness



among the population is high and determines everyday lifestyle choices. There are few limits in accessing environmental information, and knowledge about the local state of the environment is freely accessible from home computers.

Nature conservation is deeply integrated into agricultural sectoral policies. Formerly indigenous species are resettled or reintroduced with support from local NGOs and governments. The total extent of protected areas increases, with green/migration corridors being established and strongly protected. Gene banks are established and operate to preserve endangered species. Effective measures are taken to decrease habitat fragmentation. Habitat revitalisation and reconstruction programs are supported by local and EU sources. Maintaining landscape diversity is an important priority of nature conservation policies. Site-specific management and nature conservancy plans are in place, while the administrative and management capacity for nature conservation is enhanced to protect ecologically valuable places. The eventual goal is towards an overall concept that no protected areas are required, thus aiming for a fully sustainable society.

Spatial planning visions are designed for the region as a whole. Sustainable practices drive land-use management including spatial planning and strong control over different types of functions. Soil contamination originating from agrochemicals and industrial activities is eliminated, and soil erosion is strictly controlled. Large-scale traditional mosaics of landscapes are entirely recovered while mining sites are fully recultivated and rehabilitated. Rehabilitated areas are used for different purposes such as afforestation, vineyards, recreation, local industries and handicrafts.

The good-quality ecological status of surface waters and groundwater aquifers is achieved in the entire Carpathian region. Sustainable water management practices are widely employed by all users of water resources. There are no industrial and municipal discharges into rivers and lakes. Healthy drinking water is available across the Carpathians, including free access to, and the affordability of, water. All watercourses are suitable for bathing and fishing. Major dams are decommissioned to ensure the free movement of water animals, including the migration of fish in parallel with the renaturalisation of some watercourses.

### The vision of the Carpathian Ecoregion Initiative

Based on information gathered through this process, the partners of the Carpathian Ecoregion Initiative (CERI) agreed on a short statement, representing their shared vision for the region as follows: "Our vision is to achieve the long-term conservation of the unique nature in the globally important Carpathian Mountains and, at the same time, support the economy and culture for the lasting benefit of people through international partnership."

This statement was expanded into a longer sign-up vision statement to which more than 100 organisations have committed themselves. As a result of the CERI's data-gathering process, a range of maps displaying biodiversity and socio-economic data were also developed. Most important are the two maps identifying the CERI 'Priority Areas' for conservation.

To achieve the vision, the CERI mission was split into three overarching themes, or medium-term aims:

#### 1) *Strengthen institutional development*

The structures and organisations conserving Carpathian nature need to maintain or increase 'their capacity to act'. To achieve this, legislation protecting Car-

pathian nature must be harmonised and strengthened, programmes need to be adequately financed and stakeholders at all levels need to be co-operatively involved in the processes of nature conservation.

#### 2) *Develop a Carpathian ecological network*

The protective area network should be strengthened to ensure that the biodiversity of the Carpathians is effectively conserved and restored where appropriate. The network should support viable populations of species and maintain natural processes and evolutionary phenomena; perhaps most importantly, management of the network should be enhanced and integrated with the conservation of the region as a whole.

#### 3) *Generate sustainable economic benefits for the people in the region*

As the Carpathian countries adapt to a more market-oriented system, it is vital that sustainable use of the region's rich natural resources is promoted in a way that will benefit the people of the region. Initiatives such as eco-tourism programmes, renewable energy use and the marketing of local products should be developed to provide a truly sustainable future for the region.

Source: WWF, 2001

Overall, urban environmental quality is very good. All generated wastewater is fully treated through the application of advanced technologies. Households use recycled water for washing, gardening and street cleaning. Clean air in most settlements is achieved, and thus respiratory diseases caused by air pollution disappear. The percentage of green areas is very high, and they are well-managed and tended. Over-consumption and hedonism shrink to minimal levels in society. Biologically-grown foods and healthy eating habits become widespread, while heart disease and obesity practically disappear. The sustainable city concept is followed by politicians and citizens, including the very high use of public transport, pedestrian zones, car-free streets, cycling routes and sustainable housing.

'No waste is good waste' waste prevention practices are implemented as a daily practice. Sustainable materials management and material flow analyses are incorporated into decision-making and planning. Illegal waste dumping is stopped, waste disposal does not exist and the 'recycling society' concept is practiced. The use of obsolete pesticides is totally banned, and highly toxic substances are strictly regulated and controlled.

In summary, the "Carpathian Dream" scenario is based on and embedded in the concept of sustainability. The implementation of this well-known concept includes economic prosperity, social justice and gender equality, decreasing regional disparities and a cleaner and healthier environment for the whole Carpathian region by 2020.

## Conclusions

Each of the three scenarios presents a possible future including environmental, economic and social trends. The "Business as usual" scenario highlights globalisation, liberalisation, privatisation and deregulation as the prevailing driving forces. The "EU policy first" scenario provides great opportunities and uncertain challenges as well. The "Carpathian dream" scenario follows the sustainability concept and the full implementation of the Carpathian Convention and its protocols, including economic prosperity, social justice, gender equality, decreasing regional disparities and a cleaner and healthier environment for the people of the Carpathian region.

The three scenarios intentionally paint highly distinct storylines about the future, in order to present clear views for the audience. While such "black-and-white pictures" can at times be contradictory and uncertain, they can also stimulate, and serve as a basis for further thought and discussion among different stakeholders. Consequently, these scenarios can and should be further discussed, revisited and refined in the future, because the entire process is a dynamic exercise, while each presentation of the storylines can only be static. Further development of the outlooks would benefit from a more quantitative approach and analysis, and possibly modelling work.

Summary Table of Selected Issues Across Three Scenarios

	Business as Usual	EU Policy First	Carpathian Dream
<b>Economic Driving Forces/ Pressures</b>			
Agriculture	Share of GDP decreases	Share of GDP slightly decreases Common Agricultural Policy	Promotion of organic farming and small-scale ecological farming Traditional species, old varieties and products, advanced marketing system
Forestry	Unsustainable use of forests Illegal logging continues	Forest Stewardship Council certification for sustainable forest management	Pursuing multi-functionality of forests (e.g. biodiversity, recreation, carbon sink)
Tourism (sport and recreation)	Support of mass tourism	Support of rural and eco-tourism	Strong development of summer tourism Support eco-tourism (by local authorities; protocol on sustainable tourism)
Traditional Livelihoods (e.g. hunting, fishing)	Rapid elimination of traditional values	Support to cultural and language diversity Greater chances for survival of traditional livelihoods	Actions are taken to revitalise traditional cultures (with EU policy support & funding)
<b>Societal Driving Forces/ Pressures</b>			
Population and demographic development (e.g. structure of population, migration)	Population is decreasing and ageing; rapid migration from mountainous and rural areas	Stabilisation of population, weaker migration to cities	Immigration into Carpathians
Household consumption	Consumption increases in general	Consumption increases but environmental awareness also increases Consumer consciousness Fair trade, eco-labelling	Development of zero-energy houses and energy-efficient villages Use of renewable energy sources
Transboundary Issues/ disputes	Uncontrolled and illegal movement of waste (hazardous and other) Illegal trade of endangered species Legal and illegal transport of second-hand products No control and enforcement capacity Weak transboundary co-operation	No border control for the movement of waste (hazardous and other) Illegal trade of endangered species Legal and illegal transport of second-hand products No or minimal control and enforcement capacity Stronger transboundary co-operation at all levels	Strong enforcement and control capacity Very strong and borderless co-operation Subsidiarity works
<b>Atmospheric Processes</b>			
Climate Change	GHG emissions continue Weather extremities are more frequent	By 2020, GHG emissions reduced by 30 per cent Climate-friendly activities and behaviours predominate	Dominance of renewable energy source up to 30 per cent share of total energy Maximum but careful use of local energy carriers Carbon-neutral economy
Atmospheric Emissions, Acidification	Increasing release of air pollutants	Reduced air pollutant emissions	Air emissions are kept at minimal levels possible
Air Quality	Worsening air quality condition in cities	Some improvements in air quality	Clean air in most settlements
<b>Waste and Hazardous Chemicals</b>			
Municipal and Industrial Wastes	Consumption-driven waste generation increases Share of waste disposal increases	Consumption-driven waste generation slightly increasing Recycling rate to be achieved is regulated Waste prevention	No over-consumption Sustainable materials management Improved regulation of the waste disposal system
Hazardous Chemicals and Obsolete Pesticides	Continuing use of hazardous chemicals	REACH regulation is enforced	Strong restrictions for using or banning of highly toxic substances

## References

- EEA (2005). *The European Environment. State and outlook 2005*. Copenhagen
- European Council (2006). *Renewed EU Sustainable Development Strategy*. Annex (adopted by the European Council meeting, 15–16 June 2006, Brussels)
- IPCC (2007). *Climate Change 2007: Climate Change Impacts, Adaptation and Vulnerability*. Summary for Policymakers. Brussels, 6 April 2007
- Leemans, R. (2006) *Scenarios of a Sustainable and Desirable Future: Lessons From the Millennium Ecosystem Assessment*. Power point presentation, February 2, Burlington, VE, USA
- Pomázi, I., Szabó E. (2007). Környezeti jövőképek nemzetközi tapasztalatainak áttekintése (Overview of international experiences in developing environmental outlooks). *Hungarian Statistical Review*, in press
- Slaughter, R. (2005). *The Knowledge Base of Future Studies*. Foresight International, Indooroopilly, Australia
- UNDP (2006). *Human Development Report 2006*. UNDP, New York
- UNEP (2002). *Global Environment Outlook 3*. Earthscan Publications Ltd. London.
- UNEP (2006a). *Global Environment Outlook 4*. Draft (November 2006).
- UNEP (2006b). *Report on Carpathians Environmental Outlook Regional Stakeholders Consultation*. Banská Bystrica, 18–20 October 2006
- WWF (2001). *The Status of the Carpathians*, Bratislava

### Internet sources:

[cordis.europa.eu](http://cordis.europa.eu)  
[eea.europa.eu](http://eea.europa.eu)  
[www.altfutures.com](http://www.altfutures.com)



Chapter Five

Conclusions and  
Options for Action





© Pavel Meisl

## 5.1 Overall Conclusions

The Carpathian Mountains region represents a unique and dynamic common living space (natural, cultural, political and socio-economic), both ecologically valuable and important in terms of its human heritage. The region has enormous ecological and economic potential and currently faces rapid environmental, social and political changes. The challenge is to preserve and fulfill the region's potential and specificity, while increasing its sustainability. This will require adapted, responsible actions, taking into account global, regional and trans-boundary contexts and linkages, in order to enhance both the Carpathian environment and human livelihoods.

The current development pattern in the Carpathian region is leading to loss of traditional knowledge, livelihoods, practices and values. Since the fall of communism and over the last 18 years of transition, changes to the urban and natural environments and their forms and structures have been significant; for example, rural de-population menaces the traditional character of the Carpathians countryside. It is therefore critically important that culturally sustainable and coherent policies be formulated and implemented for the Carpathians, in order to slow down and even reverse this trend. Policy meas-

ures must be implemented, and incentives developed, so that people remain in their villages as guardians of the landscape, traditional knowledge and livelihoods. Education, communication and public participation, together with environmental democracy, could form the basis for creating a sustainable environment in and development of the Carpathian region.

KEO introduces the concept of an "ideal" Carpathian space, with closer linkages between urban and rural areas and aiming to encourage stronger cohesion between sectoral and cross-cutting policies in the region, and increase public participation in the decision-making process. The Carpathian Framework Convention (CFC) provides a trans-national platform for multi-stakeholder cooperation and constitutes a valid basis for the implementation of the most relevant EU policies across the Carpathian region. Efforts to raise the visibility, significance and hence the political power of the Carpathian Mountains and common Carpathian space at the EU level need to derive from the region's positive externalities and competitive advantages, along with the geo-strategic importance of the Carpathians (in terms of pan-European transport corridors, including oil and gas pipelines traversing most of these countries).

## Uniqueness of the Carpathians (Including Current Major Threats)

The Carpathian Mountains are the largest in area, longest, most twisted and fragmented mountain range in Europe (although having lower average altitude than the Alps). Stretching across seven countries (eight, if the elevated “Hainburger Berge” in Austria is considered the final western terminus), and dominated by middle and low mountains, they are severely affected by human activity. Land use changes, deforestation and extreme climatic events against a background of global environmental change are increasing the vulnerability of these mountains to various phenomena, both natural and anthropogenic. They exhibit great fragility, with some of the major threats including deforestation, over-exploitation of niche resources (wood and certain mineral ores), land use changes (land abandonment) and related land degradation, and elimination of traditional livelihoods.

The Carpathian Mountains include many unique landscapes, and natural and cultural sites, which express both geographical diversity and a distinctive pattern of regional evolution of man-environment relations over time. The Carpathians were put on the WWF ‘Global 2000’ list among the major eco-regions of the world for the conservation of habitats and biodiversity, and since 1999 are featured by the Carpathian Ecoregion Initiative (CERI) for the integrated

conservation of the natural and cultural heritage and sustainable, cross-border development of their mountainous space.

From a bio-geographical point of view, the Carpathian Mountains represent a link between the taiga of Northern Europe and Mediterranean ecosystems to the south, and also are home to the largest pristine forests on the continent. The rich variety of endemic plants and animals characteristic of Carpathian ecosystems is an integral part of European biodiversity.

Being in the heart of Europe, the Carpathians have since centuries ago been at the contact point of empires, ethnic groups and cultures. The population preserves cultural and economic traditions, especially in the mountains. Numerous Carpathian settlements preserve the ethnographic traditions of the Czechs, Hungarians, Poles, Romanians, Ruthenians, Slovaks, Szecklers, Transylvanian Saxons and Ukrainians. The multitude of passes, depressions and valley corridors has long facilitated inter-ethnic contacts and highlighted common ethnographic elements. The Carpathians’ unique cultural heritage includes many castles, monasteries, peasant strongholds, and painted (and often fortified) churches that are listed under UNESCO’s World Heritage Sites programme.

## Socio-Economic Considerations

The Carpathians have been on the periphery of major development axes and remote from most leading/major markets, a situation which has helped to preserve biological resources over the centuries. Thus, the region remains relatively under-developed compared with the rest of the (full seven) countries.

The seven Carpathian countries have been and continue undergoing transition from previous planned economies to a free-market situation, at varying rates and under very different conditions. Differences in socio-economic policies between the five Carpathian EU member states on the one hand, and Serbia and Ukraine on the other, serve to illustrate this regional diversity in



terms of socio-economic development, which has important implications for the Carpathian region itself.

The geo-strategic importance of the Carpathian region lies largely in the oil and natural gas pipelines (infrastructure) traversing most of the countries from the east on their way to Western Europe. This infrastructure has implications in terms of potential impacts on the unique nature, landscape(s) and biodiversity of the region, as well as in the economic and political realms.

Agriculture, forestry and mining have been the traditional major economic activities in the region. While they remain so in Serbia, Ukraine and parts of Romania, the service sector is developing rapidly in most of the Carpathian EU member states (CZ/HU/PL/SK). Tourism plays

a major role in the service sector, though sustainable tourism is still under-developed.

The issues of poverty and under-employment are key development-related challenges. Inter-linkages between poverty and environment are important issues for how human well-being is influenced by the natural environment, and vice-versa. Certain communities in particular are vulnerable and, at the same time, victims of poverty, social exclusion and discrimination (e.g., the Roma minority).

Migration has increased in recent years due to the scarcity of work opportunities in the poorest areas of the region, and proliferation of offers in other parts that are more economically developed, along with out-migration from the Carpathians in general.

## Environmental Issues

The Carpathians as a whole are considered to be a biodiversity-rich region, with an estimated minimum of 60,000 wild species. The number of flora species represents about 30% of the European plant variety, while the proportion of the Carpathians' area in Europe is only 1:46. The wild fauna species include over 500 taxa of vertebrates and at least 35,000 invertebrate taxa. Also, the greatest populations of large carnivores in Europe are found in the Carpathians, and the region is also relatively rich in endemic species.

Efforts to maintain the diverse landscape and native flora and fauna have resulted in a well-developed network of protected areas (national and natural parks) that currently cover up to 13% of the Carpathian region. Implementation of the Natura 2000 Network in the five EU member states should ultimately lead to the protection of at least 15% of the Carpathians' total land area.

The Carpathians are famous for their relatively high percentage of natural and semi-natural forests, occurring either in higher elevations or in areas of rugged topography with very limited

access. The largest share of virgin forest in Europe is found in the Carpathians, and the average forest cover is nearly 60%. Currently the forests are no longer perceived from a purely economic viewpoint, with their ecological functions and services increasingly being recognised, and nearly 40% of all forests are included in various types of protected areas.

Logging and the wood-processing industry are a main source of income in many areas of the Carpathians. Current trends show that in Europe, the process of deforestation is being reversed and overall forest cover is increasing, a trend that can also be seen in the Western Carpathians. After forestry, the second largest form of land use is agriculture (27.5%), while other activities and land use types, mainly urbanised and industrial areas, cover 13.4%. The intensification of conventional agriculture is taking place in some fertile areas, while traditional small farming is also on the rise in others. Conversely, the abandonment of agricultural land and village depopulation are common phenomena in high-altitude mountain zones.

A characteristic feature is the scale of land use. With the exception of large areas of forest, patches of arable land, grasslands/pastures and urban use are small and form a unique landscape 'grain pattern', with 'coarse' forest areas and 'fine' areas for other uses.

Current threats to biological and landscape diversity include climate change and anthropogenic impacts such as pollution, infrastructure development (especially hydroelectric investments, trans-Carpathian motorways/roads, and large tourist centres particularly ski resorts), the above-mentioned changes in agriculture, unsustainable use of natural resources, loss of traditional livelihoods and poaching.

According to the latest predictive scenarios, climate change will strongly affect hydrological and terrestrial biological systems through increased run-off and earlier spring peak discharge in many glacier- and snow-fed rivers; warming of lakes and rivers in many regions, with effects on thermal structure and water quality; and earlier timing of spring events, such as leaf unfolding, bird migration and egg-laying. In the Carpathian region, increasing air temperatures and decreasing total precipitation in the warm period will lead to a decrease of relative air humidity. This will result in less favorable conditions for high forests and the expansion of xerophytic shrubs and steppe vegetation.

Changes to the living conditions of plants and animals will also result in biodiversity changes. The dendroclimatic model (see section 3.6) for the region of upper Orava (in the Slovak Republic) showed that 11.5% of individual trees will be negatively impacted by climate change, 34.6% will be unaffected and 53.9% will react positively. The research also showed that climate change would mostly affect forest cover in higher zones (Lapin et al. 2000). Jankovsky and Cudlín (2002) showed that high mountain forests would be impacted by a precipitation deficit that will result in weakened spruce communities, making them vulnerable to windstorms and intensive rains.

Furthermore, climate change would induce the migration of species and current life zones towards higher altitudes. The present sub-polar

tundra zone (according to the Holdridge classification) is projected to disappear from the Romanian Carpathians, while other zones, typical for the current climate on the plains and in hilly areas (e.g. cool temperate steppe and cool temperate moist forest), are projected to expand in higher mountain areas (Alexandrescu et al. 2003).

Climate change will also impact human health, either directly through the physiological effects of heat and cold, or indirectly, through the spread of vector-borne pathogens. An increase in such impacts has already been observed during recent decades.

Environmental problems related to inefficient and unsustainable consumption of natural resources and accumulation of waste are also a major issue in the region. The amounts of industry-generated wastes in the Carpathians decreased from 1990 to 1996 due to the economic recession. Since the recent recovery, amounts of waste generated are increasing again, accentuating environmental impacts such as water and soil pollution, and the destruction of aesthetic and landscape values.

Hazardous wastes are mostly produced by manufacturing, so their management is a substantial problem for the industrialized parts of the Carpathians (particularly in Hungary). The total production of municipal waste in Carpathian countries is constantly growing due to higher consumption patterns.

Waste management is being harmonised with the relevant EU Directives in five of the Carpathian countries. The most important emerging problem is the export of hazardous wastes and toxic chemicals from the five EU to the two non-EU Carpathian countries, and in some cases export from other EU countries to the five Carpathian EU members.

An increase in proper waste management techniques may be seen among both private and public companies and local governments, as evidenced by an increasing number of new municipal waste management investment projects and waste processing plants. New legal and economic measures favor (and sometimes enforce) these trends.

Natural and technological risks and hazards are both diverse and important in terms of impacts in the Carpathians, and seem to become as well increasingly inter-related. Some accidents involving casualties and environmental pollution are produced by obsolete technology and waste deposits, or are due to the transport of noxious substances. In certain situations, technological accidents (e.g. dam failure or explosions at some installations) may occur due to natural causes (floods, earthquakes).

Floods are the most challenging phenomenon for environmental security in the region. Several natural and human-related factors determine the degree of flood hazards. The negative impacts of floods (economic and environmental) have a trans-boundary, regional or even macro-regional character.

Despite rural culture being representative for the Carpathians, a dense network of small and medium-size urban settlements was formed over the centuries. The cities and towns and industrial “hot

spots” in smaller settlements are a major factor in environmental pollution, as well as environmental hazards and risks. At the same time, they are the most vulnerable to natural/technological accidents from a socio-economic point of view.

The processes of suburbanisation and gentrification are typical of major cities today in development of the Carpathians region, including in the transitional countries. The extremely high speed of modernisation and globalisation tendencies is threatening the sensitive historical fabric/structures and traditional patterns of life in the Carpathians.

Many of the major environmental challenges Carpathian countries face in the early 21st century are of global or trans-boundary nature, including climate change, biodiversity loss, management of shared water resources, trans-boundary air pollution, trade in endangered species and waste disposal. As a result, there is an increasing need for countries to work together in partnership to tackle these challenges.



## 5.2 Current Policy Approaches

### Current Policies in the Carpathian Region

All of the Carpathian countries have in place as a minimum the following environmental policies, which can be categorized as:

- **National Biodiversity Strategies**, which set actions needed to ensure that natural values are protected for future generations and for sustainable development. The main objectives of these strategies are to protect and restore the proper functioning of natural ecosystems and to halt the loss of biodiversity.
- **Environmental Strategies**, which are complex strategies dealing with ecosystem protection. Basic obligations for other environmental sectors (water, waste, pollution, climate change, natural resources, quality of life) are in line with the nature conservation legislation. The main purpose of these strategies is to provide a framework and guidelines for decision-making processes and activities at international, national, regional and local levels, including public participation and awareness. The scope of the policy is to integrate ecological issues with sectoral policies, reinforce

market-based mechanisms focused on environmental protection, modify financial support measures, promote the capacity building of institutions, increase public participation and ecological education, integrate spatial planning with environmental issues, and support research and technological development and international cooperation.

- **Sustainable development strategies** aim to identify the strengths, weaknesses, opportunities and threats related to the environmental, economic and social dimensions of sustainability, and find a means to integrate these in a coherent way.
- **Rural/agricultural strategies** define and address the main problems, threats and opportunities for rural development. The overall goal of these strategies is to improve living and labor conditions in rural areas by means of economic growth, and taking into account the requirements of environmental protection. Operational goals of these strategies include: supporting sustainable rural development, increasing the competitiveness of agriculture, strengthening the manufacturing

of food products, and improving the quality and safety of food. Carpathian EU member states are obligated to set and implement rural/agricultural policies. Ukraine has a law on the basis of State Agricultural Policy for the period until 2015, and there is no such policy in Serbia yet.

- Other sectoral strategies and policies as mentioned in Chapter 3 thematic sections.

In addition, Carpathian countries which are EU Member States have Sustainable Development Plans to accede to the EU Structural and Cohesion Funds (CZ, HU, PL, RO, SK). In Serbia, many documents are still under preparation (e.g. rural/agricultural strategies, a National Environmental Action Plan, and a sustainable development strategy).

## Policy Gaps and Limitations

None of the policies and strategies mentioned above are specifically designed for the Carpathian Mountains region. According to the Regional Environmental Center for Central and Eastern Europe (REC) and the European Academy (EURAC; 2005), there is no mountain policy/strategy in Carpathian countries except for Romania, where the Sustainable Development Strategy on the Mountain Region was developed according to the Law on the Mountain Region (347/2004).

The REC and EURAC (2005) have identified a lack of coordination at the regional level in implementing environmental policies in all Carpathian countries. This situation is aggravated by a lack of specification of responsibilities, leading to difficult implementation at the regional level. Sectoral policies involving several ministries in their implementation require increased cooperation. A lack of capacity (including lack of financing) also leads to weak implementation of such policies. The REC/EURAC National Assessments of policy, legislative and institutional frameworks related to the Carpathian Convention also show some contradictions between current regional policies being implemented in the region, and the goals of the CFC. For instance, national strategies on water management promoting hydro-technical actions/constructions would need to comply with sustainable development and biodiversity conservation requirements. Biodiversity conservation and nature protection are not seen as the main priority in the region; economic development and interests prevail, and more financing is

needed in many Carpathian countries to support biodiversity monitoring and preservation.

Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) processes are in place in many countries, but their findings are not often taken into account, and public participation is often missing in this process as well. The process of transposition of EU legislation into national laws is very complicated due to a lack of dialogue and information-sharing between the state and other stakeholders. Insufficient communication in this area means that some positive aspects of the proposed legislation are misunderstood and the public remains generally uninformed. Even if public awareness strategies are in place, they are often neither very effective nor efficient. Thus, public understanding of environmental policy and environmental issues in general needs much strengthening.

Environmental risks such as floods need more attention from decision-makers, and more research, monitoring and early warning systems, as well as appropriate financing are necessary for countries to adapt to flood impacts and mitigate flood damage. Other environmental risks such as droughts, soil degradation and erosion, landslides and mudflows need to be addressed by proper measures and in the broader context of global and regional climate change.

In order for Carpathian regional development to become sustainable, more environmentally-friendly practices and technologies will need to

be implemented, along with appropriate policies to support sectoral developments such as renewable energy sources, sustainable forest management, sustainable tourism, organic farming and improved public transport. Sustainable development of the mountain space implies the establishment of natural systems of protected areas (national and natural parks, nature reserves and biosphere reserves). Bringing the management of protected areas in line with international regulations, and primarily with the EU *acquis communautaire*, calls for the ecological reconstruction of degraded areas and for permanent efforts to identify and protect valuable landscapes and biodiversity. Regional sustainable tourism strategies should be designed to take into account the specificity of the mountain region and specific threats to which the mountain environment is exposed.

A main thrust should be to develop a high-quality environment by means of sustainable natural resources and heritage management. In particular, this should be carried out by: developing joint incentives and actions for managing natural areas, protected areas and landscapes; developing joint actions for improving environmental quality (e.g. air, soil, water); developing and implementing joint strategies and policies for the sustainable use of natural resources and heritage;

rehabilitation of degraded areas such as former mining sites, contaminated sites and brownfields; and sustainable development strategies, which should put more emphasis on assuring sustainable transport and energy-efficient transportation systems. Incentives to promote the use of biofuels (ethanol and biodiesel) should be designed and implemented in line with EU policies, in order to comply with EU recommendations on biofuels and as a means of mitigating climate change. These should also take into account both the positive and negative effects that the increased production and consumption of biomass can have on biodiversity and human well-being.

Lastly, sustainable development cannot be achieved in the region without proper consideration of cultural values and heritage. Most Carpathian countries have general cultural policies at the national level which do not specifically focus on the Carpathians' rich cultural heritage and traditional knowledge. There is a need for a strategic document defining the concept of cultural policy for the region, and a strategy, programme and action plan for national and regional cultural development. All these policy developments should take into consideration the provisions of the CFC and be based on an intersectoral approach.



© Jilka Krasova

## 5.3 Future Policy Framework – Options for Action

To preserve what is unique about the Carpathians while increasing the region's sustainable development capacity will require a full mix of coherent and complementary policies. Thus, it needs to be considered that future policies influencing the Carpathian region will be conceived and implemented at the following levels:

- Global and regional (conventions)
- European Union (EU legislation)
- (Sub-)regional (e.g., the CFC)
- Bi-/multi-lateral cooperation
- National
- Sub-national
- Local

The CFC constitutes an additional legal framework for implementing global and regional conventions, especially the Convention on Biological Diversity (CBD) and United Nations Framework Convention on Climate Change (UNFCCC), as well as relevant UN Economic Commission for Europe (UNECE) conventions (e.g., the Convention on Long-Range Transboundary Air Pollution (LRTAP) and Aarhus Convention) and the European Landscape Convention. Furthermore, a more concerted and efficient use of existing policy initiatives, funding,

scientific research and information to maintain and enhance biological and landscape diversity in the Carpathians is encouraged by the Pan-European Biological and Landscape Diversity Strategy (PEBDLS).

A useful guideline for future policies related to the Carpathian region could be based on the “Policy Guiding Principles” referred to in the renewed EU Sustainable Development Strategy, as follows:

- Promotion and protection of fundamental rights
- Solidarity within and between generations
- An open and democratic society
- Involvement of citizens
- Involvement of businesses and social partners
- Policy coherence and governance
- Policy integration
- Best available knowledge used
- Precautionary principle applied
- Polluters made to pay

The EU's common policies and legislation will considerably influence national policies of the Carpathian countries. Particular actions and related results will be achieved by implementing sub-national and local plans, programmes and projects.

On the sub-regional level, the CFC unites the seven Carpathian countries in a unique partnership, providing a trans-national framework for cooperation and multi-sectoral policy integration, an open forum for participation by stakeholders and the public, and a platform for developing and implementing trans-national strategies, programmes and projects for environmental protection and sustainable development.

Some of the major environmental issues shaping the region's present and future development are related to the following (in no particular order of priority):

- Continuing fragmentation of habitats, accompanied by destruction of important biological corridors (new infrastructure is one of the causes of habitat loss and fragmentation, and species loss in the Carpathians);
- Changes in land ownership (national to private and implications for resource management and exploitation) and the increasing role of local self-governments in deciding on development decisions/policies in their areas (frequently opting for short-term, quick-profit goals);
- Impacts of mass tourism and recreation, as well as tourism infrastructure (resorts, ski lifts) on protected areas;
- Forest management (timber harvesting and international timber trade);
- Increased flood risk resulting from exploitation of forest resources, degradation of wetlands, reduction of flood areas alongside regulated rivers, and other technocratic and unwise water management practices;
- Air pollution resulting from switching from cleaner to more polluting heating fuels in communal use (oil/gas to cheaper, poor-quality coal);
- Growing amounts of municipal waste resulting from greater urbanization and consumption habits of increasingly consumer-oriented societies;
- Development of water supply, sewage and water treatment infrastructures;
- Emergence of new categories of hazardous chemicals;
- The increasing role of local democracies and citizens' participation in local issues;
- Growing pesticide use (after initial recession in high-intensity farming, there is a "rebound" to chemistry-loaded farming);
- Two-way material flows across the Carpathians and illegal cross-border transport: natural re-

sources, timber, CITES-listed species, second-hand technology (PCs, mobile phones, old refrigerators) and wastes.

Initiatives need to be taken to tackle all these issues of major importance for the Carpathian region, including in the following areas:

- There is an increasing need for countries to work together in partnership to tackle a variety of challenges, implement EU policies in order to create important opportunities for biodiversity conservation through the various EU programmes, strengthen cross-border co-operation including protected areas and coordination of different development plans, integrate specific mountain issues when designing National Development Plans (NDPs) in accordance with the principles of the CFC, and promote integrated cross-sectoral rural planning and implementation of plans.
- The Natura 2000 Network and integrated river basin planning (Water Framework Directive, WFD) should provide a policy structure for truly cross-sectoral land use planning and management policies in order to improve biodiversity conservation, water management and water quality.
- Another challenge is to integrate the different processes and instruments pertaining to land use in the region. This means ensuring that the adoption and especially implementation of policies such as Natura 2000, the Common Agricultural Policy (CAP), WFD, forestry-related, social and other policies are implemented in a way that they reinforce, rather than contradict each other.
- The enhancement of trans-European transport capacities should be accompanied by impact assessments reflecting long-term effects on natural land uptake, and biodiversity, urban development, air pollution and climate change.
- Natural and technological risks and hazards also represent major threats to the people living in the region. Countries would need to focus on reducing risks and impacts of both natural and man-made hazards by coordinating practices of integrated risk management between various fields and sectors (spatial planning, industry, transport, infrastructure, forestry, water supply etc.). This could be achieved by: conducting, improving, integrating and harmonizing risk assessments and risk management standards; developing and elaborating strategies against hazards and for joint risk management plans;



developing tools and approaches for mitigation and management of the impacts of climate change and other risks.

- In order for Carpathian regional development to become sustainable, more environmentally-friendly practices and technologies need to be implemented, and sustainable initiatives in energy should be introduced.
- Energy consumption and energy intensity showed decreasing trends in the Carpathian area in the last ten years (excluding Ukraine); however, final energy demand is growing. Therefore, technological improvements are needed to reduce the adverse impacts on environment linked to activities in the economic sectors of energy production, industry, housing and transport.
- The current development pattern in the Carpathian region is leading to loss of traditional knowledge, livelihoods, practices and values. It is therefore critically important that culturally sustainable and coherent policies be formulated and implemented for the Carpathians, in order first to slow, then halt and gradually reverse this trend. The countries need to promote and maintain Carpathian cultural identity and diversity, and strengthen linkages between urban and rural areas, promoting a wider ‘Carpathian space’ and political power.
- Rural de-population menaces the traditional character of the Carpathians countryside. Policy measures must be implemented, and incentives developed, so that the people remain in their villages as guardians of the landscape, traditional knowledge and livelihoods.
- Rural policies should aim at sustainable farming, food security, biomass utilization, expansion of sustainable tourism and small businesses, support the conservation of traditional breeds and species, and carefully control and monitor any introduction of GMOs into the Carpathians, assuming this occurs at all.
- The CFC and integrated sustainable development policies should stimulate rural diversification activities aimed at providing realistic marketing for the promotion of rural services such as eco-tourism, ecological farming and traditional products in order to produce “quality more than quantity”.
- Public participation should be a prerequisite for most planning processes, helping to assure the proper involvement of stakeholders. Awareness-raising on policy and decision-making

processes for civil society should be promoted and achieved.

- Capacity building for Carpathian institutions and stakeholders should be promoted and developed. It should include an inventory of national institutions that specialize in mountain issues to increase regional networking and information-sharing.
- Improved education, communication and public participation, together with environmental democracy, could be used as underpinning processes leading towards a sustainable environment and development path in the Carpathians.

Biological and landscape diversity remain two of the greatest assets of the Carpathian space, and this Carpathians’ “natural capital” is fundamental to the region’s future sustainable development. However, having a knowledge base and well-designed proposals for the further preservation and enhancement of the unique natural and cultural heritage of the Carpathian Mountains region are only necessary, but not sufficient conditions, to see that these goals are attained. What is additionally required is both political will and eventual action, as well as related resources for implementing beneficial measures, in order that effective and efficient policies might succeed.

Like other “mountain spaces” (the Alps, Caucasus, and Pyrenees Mountains) in or near Europe, the ultimate fate and development path of the Carpathians is in the hands of multi-national stakeholders; in the latter case, a “jurisdiction” that overlaps seven national entities with a similar past but a more varied present. In several Carpathian countries, the national capital is far from the mountains, and other than from an economic perspective (general development, often involving resource extraction and/or tourism, both having infrastructural implications) may not receive much attention. That is, preservation of the “natural” environment may be accorded a lower priority than poverty eradication, land development, energy provision etc. It will remain a major challenge for the Carpathian countries to work together in achieving a more sustainable form of development than has often been accomplished until now, partly through the recognition that “development” and “environment” need not be considered opposing (or exclusive) goods. Rather, by the proper (eco-

nomic) valuation of the natural environment and wise investment in the same, it is likely that a sustainable future path for the Carpathians can be designed and achieved.

Only through international cooperation and maintaining a holistic view of the Carpathian environment, and a common (or at least not contradictory or conflicting) path of development will the governments and peoples of the region

succeed in building a viable future within the “Carpathian space”. This Report has attempted to highlight both this overall perspective and many points of departure within multi-scale policy frameworks (from local to international) to accomplish, if not the “Carpathian dream”, the realization of a future which values and preserves the unique character of this region, while simultaneously fostering enhanced human well-being in a sustainable environment.

## References

- Alexandrescu, A., Geicu, A., Cuculeanu, V., Marica, A., Patrascu N. (2003). Climate change impact on forestry ecosystems. Vulnerability and adaptation measures. In *Potential impact of Climate change in Romania* (ed: V. Cuculeanu), Ars. Docendi, p. 101-128
- Jankovský, L., Cudlín, P. (2002). Dopad klimatické změny na zdravotní stav smrkových porostů středohor. *Lesnická práce* 81(3), 106-107
- Lapin, M., Melo, M., Damborská, I., Gera, M., Faško, P. (2000). Nové scenáre klimatickej zmeny pre Slovensko na báze výstupov prepojených modelov všeobecnej cirkulácie atmosféry. *Národný klimatický program SR* 8, 5-34
- REC/EURAC (2005). *Questionnaire for the assessment of the national policy, legal and institutional frameworks related to the Carpathian convention*



# Annexes



# List of Figures

## Chapter One

- Fig. 1.1 The Eastern Carpathians, Izvorul Muntelui storage-lake (Photo Fl. Andreescu) 24
- Fig. 1.2 The Danube Gorge in the Iron Gate Natural Park (Photo Fl. Andreescu) 27
- Fig. 1.3 The Carpathians seen from space 33
- Fig. 1.4 The bridge built by the Romans downstream of the Iron Gate (Southwestern Carpathians), A.D. 105-107 (Istoria Românilor 2001) 34
- Fig. 1.5 Traditional handicrafts, potters from Horezu town (Photo Fl. Andreescu) 34
- Fig. 1.6 The Bran Castle in the Rucar-Bran Corridor (Photo Fl. Andreescu) 35

## Chapter Two

- Fig. 2.1 GDP growth rate at prices and PPPs of 2000, 1990-2005 46
- Fig. 2.2 Consumer price index, 1990-2004 47
- Fig. 2.3 Poorest quintile's share in national income or consumption 49
- Fig. 2.4 Unemployment rate in the Carpathian countries, 1990-2005 50
- Fig. 2.5 Decoupling of GDP from air emissions 53
- Fig. 2.6 Agricultural production index in Carpathian countries, 1990-2003 56
- Fig. 2.7 Use of fertilisers per hectare of agricultural land, in active ingredients, 1985-1999 59
- Fig. 2.8 Consumption of pesticides, 1980-2002 59
- Fig. 2.9 Organic farming in Carpathian countries, 1989-2004 60
- Fig. 2.10 Share of renewables in electricity generation, 1990-2004 65
- Fig. 2.11 Energy use per \$1,000 (PPP) GDP, 1990-2002 66
- Fig. 2.12 Total population growth rate, 1990-2004 78
- Fig. 2.13 Life expectancy, infant and child mortality, early 2000s 80
- Fig. 2.14 Age structure of population, 2005 80
- Fig. 2.15 Personal computers in use per 100 inhabitants, 1990-2004 84
- Fig. 2.16 Internet users per 100 inhabitants, 1991-2004 85
- Fig. 2.17 Telephone lines and cellular phone subscribers per 100 capita, 1990-2004 86

## Chapter Three

- Fig. 3.1 The number and occurrence of plant alliances in the Carpathian countries (according to Stanova 2003) 92
- Fig. 3.2 Comparison of top alliances ranked according to their richness in endemic species (recalculated according to Stanova 2003) 94

- Fig. 3.3 Number of species and abundance (no of specimen/10 ha) of birds in main habitats of the Tatra National Park (after Glowaciński 1996) 96
- Fig. 3.4 Number of chamois in the Polish (TPN) and Slovak (TANAP) Tatra Mountains National Parks (Gaşienica-Byrcyn 2006) 99
- Fig. 3.5 The share of protected areas and Important Bird Areas (IBAs) in the Carpathian region 104
- Fig. 3.6 Main types of forest formation in the Carpathians (according to Ruffini et al. 2006) 108
- Fig. 3.7 Forest yearly increment and standing crop divided into stand and dead crop (in cubic meter/ha) (Lasy Państwowe 2004) 111
- Fig. 3.8 Percentage presence of wheat, rye and barley (A) and oat, potatoes and grasses/clover (B) in relation to altitude (Guzik 1995) 118
- Fig. 3.9 Percentage presence of livestock, hogs and sheep according to altitude (Guzik 1995). Altitude classes: 1: 300-400 m, 2: 400-500 m, 3: 500-600 m, 4: 600-800 m and 5: 800-1000 m. 119
- Fig. 3.10 Increase/decrease in agricultural land in some Carpathian countries in the second half of the 1990s (data for Czech Republic, Slovakia and Serbia unavailable). (Suprunenko 2001) 120
- Fig. 3.11 Some generalizations on the impact of agriculture on biodiversity (simplified scheme of Delbaere and Nieto-Serradilla 2004) 121
- Fig. 3.12 Spatial averages (country level) of annual mean temperature over the period 1990 to 2005 148
- Fig. 3.13 Spatial averages (country level) of annual precipitation over the period 1990 to 2005 149
- Fig. 3.14 Spatial averages (country level) of the annual number of days with snow cover over the period 1990 to 2005 149
- Fig. 3.15 Changes in winter precipitation over Romania derived from RegCM simulations under IPCC A2 (a) and B2 (b) scenarios. Units are mm/season. Grey areas indicate statistical significance at the 5% level 151
- Fig. 3.16 SO<sub>2</sub> concentrations - annual spatial averages in the Czech Republic (three stations), Slovakia (13 stations) and Poland (10 stations). Local details are also presented 154
- Fig. 3.17 Two transport modes in Romanian Carpathians 176
- Fig. 3.18 Local train in Romanian Carpathians 177
- Fig. 3.19 Banska Štiavnica, World Heritage site (Lacika) 179

## Chapter Four

- Fig. 4.1 Futures development process 191
- Fig. 4.2 Scenarios, predictions and projections 192

# List of Boxes

## Chapter One

Different Delimitations of the Carpathian Mountains Region	21
Sibiu through the ages	35
The Monasteries of Bucovina	36

## Chapter Two

The Informal Economy	52
Traditional Agriculture in the Ukrainian Carpathians	61
Cyanide Spill in Baia Mare	69
Transboundary National Parks and Tourism	74
Traditional Knowledge and Activities: Czech White Carpathians	76
Linking Poverty and Environment	78
From Farming to Tourism in Poland	82

## Chapter Three

Species Richness in the Pieniny Park (Poland/Slovakia)	97
Human impacts on Pilsko Mountain	102
Wallachians and the mosaic of land cover in the Carpathians	119
Typology of mineral resource occurrences in the Carpathians	126
The waste situation in Hungary	158

Foreign waste import to Ukraine	159
Waste management in Slovakia	161
The early warning system in Slovakia	165
State of knowledge of flood causes and effects in different parts of the Carpathians	166
Windstorms in the Slovakian Carpathians	167
Floods, accidents and natural disasters in Slovakia	168
Forest fires in the Czech Republic and Slovakia	170
Proposed instruments for the implementation of a sustainable development transportation policy in Poland	177
The perception of their environment by the inhabitants of Bratislava	178
UNESCO cultural heritage sites in the Carpathians and/or Carpathian foothills	179
Preservation of cultural heritage in the Slovak Carpathians	181

## Chapter Four

Uncertainties across and within scenarios	194
Policy-Guiding Principles in the Renewed EU Sustainable Development Strategy	200
Participatory futures workshop – main findings	204
The vision of the Carpathian Ecoregion Initiative	206

# List of Tables

## Chapter One

**Table 1.1** Area and Population of the Carpathians by Country (EURAC 2006) 18

**Table 1.2** Carpathian River Basins and their characteristics (EURAC 2006) 24

## Chapter Two

**Table 2.1** Structural changes in the Carpathian countries, 1995-2003 51

**Table 2.2** Livestock change in Carpathian countries, 1995-2004 57

**Table 2.3** Removal of non-wood forest products, 2005 64

**Table 2.4** Status of Aarhus Convention in the Carpathian countries 83

## Chapter Three

**Table 3.1** Numbers of known species in the best-surveyed Carpathian national parks in Poland by systematic group 97

**Table 3.2** Threatened species of invertebrates in the Carpathians grouped according to their level of threat (Witkowski et al. 2003) 100

**Table 3.3** Endangered vertebrate species in the Carpathians grouped according to their level of threat (Witkowski et al. 2003) 100

**Table 3.4** Threatened species of vascular plants in the Carpathians grouped according to their level of threat (Tasenkevich 2003) 100

**Table 3.5** Natura 2000 efforts in four EU countries sharing the Carpathian territory (IUCN 2005) 105

**Table 3.6** Establishment of protected areas in non EU Carpathian countries (CBD 2007) 105

**Table 3.7** Main quantitative data on water resources in the Carpathian countries (average annual values 1977-2001) 138

**Table 3.8** Surfaces (km<sup>2</sup>) and percentages for the six main types of aquifer formations 140

**Table 3.9** Weighted (%) main types of formations compared with the total surface area (km<sup>2</sup>) of each country (data derived from Table 3.7) 141

**Table 3.10** Relationship between climatic and hypsometric conditions and groundwater runoff (according to Krásný, 2002) 142

**Table 3.11** River Water Quality – main classes (Serban and Galie 2006) 143

**Table 3.12** Forest ecosystems in Slovakia endangered by climate change 153

**Table 3.13** Waste generation and treatment in Slovakia in 2004 (t) 161

**Table 3.14** Overview of largest flood events in the Carpathian region (Hanušín 2006) 164

**Table 3.15** Fires in the Carpathian districts of the Czech Republic (1995-2005) 170

**Table 3.16** Changes in the number of passenger cars in selected Carpathian cities/districts in Slovakia after 1989 176

## Chapter Four

**Table 4.1** Basic assumptions made during the KEO scenario-building process 194

**Summary Table of Selected Issues Across Three Scenarios** 208

# List of Maps

## Chapter One

Map 1.1 The Carpathian Mountains and their sub-units	19
Map 1.2 The Carpathians in Europe	20
Map 1.3 Hypsography of the Carpathians	23
Map 1.4 Settlements in the Romanian Carpathians	31
Map 1.5 Unique sites in the Carpathians	32

## Chapter Two

Map 2.1 GDP per capita in the Carpathians and its environs, 2002	48
Map 2.2 Unemployment in the Carpathians and its environs, 2004	49
Map 2.3 Livestock units in the Carpathians and its environs, early 2000s	58
Map 2.4 Forested area in the Carpathians and its environs, 2003	63
Map 2.5 Electricity transmission network in Europe	67
Map 2.6 Potential accident risk spots in the Tisza river basin, with zoom in the Maramures mining region	68
Map 2.7 Road network density in the Carpathians and its environs, 2003	70
Map 2.8 Stock of passenger cars in the Carpathians and its environs, 2003	71
Map 2.9 Rail network density in the Carpathians and its environs, 2003	72
Map 2.10 Hotel beds in the Carpathians and its environs, 2001	73
Map 2.11 Population density in the Carpathians its environs, 2001	79
Map 2.12 Urban population in the Carpathians and its environment, 2000	81

## Chapter Three

Map 3.1 Concentration regions of endemic vascular plant species in the Carpathians (according to CERI 2001)	93
---	----

Map 3.2 Richness of fish species in the Carpathian river basins (CERI 2001)	98
Map 3.3 Forest cover of the Carpathians (CORINE Land Cover/ PELCOM)	109
Map 3.4 A vision for large scale protected areas in the Carpathians (CERI 2001)	112
Map 3.5 Diversity of land cover and land use in the Carpathians (according to CORINE Land Cover)	115
Map 3.6 Soil erosion risk in the Carpathians	117
Map 3.7 Geo-tectonic sketch of the Carpathians	125
Map 3.8 Potential Sources of Pollution in the Eastern Carpathians and Transylvanian Basin	127
Map 3.9 Potential Sources of Pollution in the Apuseni Mountains and Pannonian Basin	128
Map 3.10 Potential Sources of Pollution in the Southern Carpathians	129
Map 3.11 Potential Sources of Pollution in the Western Carpathians	130
Map 3.12 Coal Deposits in the Carpathian region	133
Map 3.13 Hydrocarbon Fields in the Carpathian region	134
Map 3.14 Hydrogeology of the Carpathians and main permanent reservoirs (simplified map)	139
Map 3.15 Annual number of snow cover days in the Carpathian region. Local details are presented for the Slovak, Czech and Romanian Carpathian areas.	150
Map 3.16 Industrial units at technological risk in the Romanian Carpathians (2003) according to Seveso II Directive	170
Map 3.17 Carpathian cities with over 50,000 inhabitants (Hanusin and Huba 2007)	173
Map 3.18 UNESCO cultural heritage sites in the Carpathians (Huba 2007)	180



# Acronyms and Abbreviations

CAP	Common Agricultural Policy	LSU	Livestock Unit
CBD	Convention on Biological Diversity	MCPFE	Ministerial Conference on the Protection of Forests in Europe
CCD	United Nations Convention to Combat Desertification	NATO	North Atlantic Treaty Organisation
CCS	Carbon Capture and Storage	NGOs	Non-governmental Organisations
CEE	Central and Eastern Europe	ODS	Ozone Depleting Substances
CEEWEB	Central and Eastern European Working Group for the Enhancement of Biodiversity	OECD	Organisation for Economic Co-operation and Development
CERI	Carpathian Ecoregion Initiative	PEBLDS	Pan-European Biological and Landscape Diversity Strategy
CFC	Carpathian Framework Convention	PEEN	Pan-European Ecological Network
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora	PPP	Purchasing Power Parity
CIUS	Canadian Institute of Ukrainian Studies	REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
COMECON	Council for Mutual Economic Assistance (1949-1991)	REC	Regional Environmental Centre
DYMIMIC	Dynamic Multiple Indicator, Multiple Causes	SAPARD	Special Accession Programme for Agriculture and Rural Development
EAP	Environment Action Programme	SEA	Strategic Environmental Assessment
EEA	European Environment Agency	SoE	State of the Environment
EFAS	European Flood Alert System	TACIS	Technical Assistance to the Commonwealth of Independent States
EIA	Environmental Impact Assessment	TEN	Trans European Network
EU	European Union	UNDP	United Nations Development Programme
EUR	Euro (currency of the European Union)	UNECE	United Nations Economic Commission for Europe
EURAC	European Academy (Bolzano)	UNEP	United Nations Environment Programme
FDI	Foreign Direct Investment	UNEP-ISCC	UNEP Interim Secretariat of the Carpathian Framework Convention (CFC)
GDP	Gross Domestic Product	UNESCO	United Nations Educational, Scientific and Cultural Organization
GEO	Global Environment Outlook (UNEP)	UNFCCC	United Nations Framework Convention on Climate Change
GHG	Greenhouse Gas	USSR	Union of the Soviet Socialist Republics
GMO	Genetically Modified Organism	V4	Visegrád countries (Czech Republic, Hungary, Poland and Slovakia)
GRID	Global Resource Information Database	VOC	Volatile Organic Compound
HDI	Human Development Index	WTO	World Trade Organisation
IBAs	Important Bird Areas	WWF	World Wide Fund for Nature
IFA	International Fertilizer Association		
IPAs	Important Plant Areas		
IPCC	Intergovernmental Panel on Climate Change		
IUCN	World Conservation Union		
LRTAP	Convention on Long-Range Transboundary Air Pollution (UNECE)		

# Acknowledgements

UNEP acknowledges the contributions made by the many individuals and institutions to the preparation and publication of the Carpathians Environment Outlook. Special thanks are extended to:

## **KEO Chapter Lead Authors:**

Dan Balteanu, Prof. Dr., Institute of Geography, Romanian Academy of Sciences, Bucharest, Romania (Chapter One)  
Aristita Busuioc, Dr., Head of the Climatology Division, National Meteorological Administration, Bucharest, Romania (Chapter Three)  
Mikuláš Huba, Prof. RNDr., PhD, Institute of Geography, Slovak Academy of Sciences, Bratislava, Slovakia (Chapter Three)  
István Pomázi, PhD, Chief Advisor, Ministry of Environment and Water, Budapest, Hungary (Chapters Two and Four)  
Mircea Sandulescu, Prof. Dr., Romanian Academy of Sciences, Bucharest, Romania (Chapter Three)  
Zbigniew Witkowski, Prof. Dr., Academy of Physical Education, Krakow, Poland (Chapter Three)

## **Institutional support:**

DAPHNE Institute for Applied Ecology  
European Environment Agency  
EURAC – European Academy  
Institute of Nature Conservation, Polish Academy of Sciences  
Ministry of the Environment of the Czech Republic  
Ministry of Environment and Water of Hungary / GRID-Budapest  
Ministry of Environment of Poland  
Ministry of Environment and Sustainable Development of Romania  
Ministry of Science and Environmental Protection of Serbia  
Ministry of the Environment of the Slovak Republic  
Ministry of Environmental Protection of Ukraine  
Regional Environmental Centre for Central and Eastern Europe (REC)  
Slovak Academy of Sciences  
Slovak Environmental Agency  
UNEP/GRID-Warsaw  
UNEP-Vienna Interim Secretariat of the Carpathian Framework Convention (ISCC)

## **Funding**

UNEP provided funding to support the drafting work, all meetings, publication of the report and development of the KEO Database. Additional funding was provided through the EU's INTERREG III B CADSES "Carpathian Project".

## **KEO Steering Group:**

Marek Baranowski, Jana Brožová, Carmen Damian, Harald Egerer, Radoslava Kanianska, Iurie Maxim, Ján Šeffler, Elemér Szabó, Iryna Vanda, Ronald G. Witt

Adam Kotarba, Ján Lacika, Erich Lippert, Ludmila Marcinátová, Iurie Maxim, Jozef Minár, Zbigniew Niewiadomski, Jerzy Pawłowski, Kajetan Perzanowski, Halina Piękoś-Mirkowa, Milan Prodanovič, Snezana Prokic, Tomáš Ruzička, Ján Šeffler, Stefan Skiba, Dmytro Skylnikov, Miloš Stankoviansky, Elemér Szabó, Bronislav Szczęsny, Jerzy Szwagrzyk, Viera Šimkovicová, Lidia Tasenkevych, Tibor Tiner, Milan Trizna, Ján Urbánek, Ivan Vološčuk, Bartłomiej Wyżga, László Zentai.

## **KEO Secretariat:**

Ana Priceputu

## **Editor:**

Paul Csagoly

## **KEO Contributing Authors:**

Joan Abrudan, Gabor Balint, Ivan Barka, Juraj Beták, Roxana Bojariu, Mircea Borcos, Constanta Boroneant, Jana Brožová, Sorin Cheval, Yuriy Czernobaj, Monica Dumitrascu, Petru Enciu, Tetiana V. Gardashuk, Anton Geicu, Ján Hanušin, Vladimír Ira, Emília Jurášová, Radoslava Kanianska, Peter Kapusta, Karel Kirchner,

## **Assistant Editors:**

Ana Priceputu, Ronald G. Witt

**Cover and page design:**

Jana Hajduchová

**Cartography and other illustrations:**

Marek Baranowski, Maciej Bagiński, Maciej Rutkowski (UNEP/GRID-Warsaw)

**Data Collection:**

Marek Baranowski, Jana Brožová, Carmen Damian, Radoslava Kanianska, Iurie Maxim, Dusan Mijovic, Goran Sekulic, Elemér Szabó, Iryna Vanda

**KEO Lead Data Centre:**

UNEP/GRID-Warsaw for data collection, harmonisation and integration (Marek Baranowski, Piotr Mikołajczyk, Katarzyna Fiedziukiewicz)

**Data Provision:****The Czech Republic**

- Agency for Nature Conservation and Landscape Protection of the Czech Republic
- Central Institute for Supervising and Testing in Agriculture
- Czech Environmental Information Agency CENIA
- Czech Geological Survey – Geofond
- Czech Hydrometeorological Institute
- Czech Statistical Office
- Forest Management Institute
- Research Institute of Ameliorations and Soil Conservation
- T.G. Masaryk Water Research Institute
- Lesy České republiky state enterprise

**Hungary**

- Ministry of Environment and Water of Hungary (GRID-Budapest)
- Hungarian Central Statistical Office
- Institute of Geography of the Hungarian Academy of Sciences
- Eötvös Loránd University of Budapest

**Poland**

- Agricultural and Food Quality Inspection
- Central Statistical Office of the Republic of Poland
- Chief Inspectorate for Environmental Protection
- Institute for Meteorology and Water Management, Regional Branch in Krakow
- Institute for Forestry Research
- Ministry of the Environment of the Republic of Poland (Department of Environmental Policy, Department of

Water Resources, Department of Nature Protection, Bureau of Water Management)

- National Fund for Environmental Protection and Water Management
- Polish Geological Institute
- Voivodeship Fund for Environmental Protection and Water Management in Krakow
- Voivodeship Fund for Environmental Protection and Water Management in Katowice, Local Office in Bielsko-Biala
- Voivodeship Fund for Environmental Protection and Water Management in Rzeszow
- Voivodeship Inspectorate for Environmental Protection in Krakow
- Voivodeship Inspectorate for Environmental Protection in Katowice
- Voivodeship Inspectorate for Environmental Protection in Rzeszow
- Voivodeship Office for Conservation of Historic Monuments in Krakow
- Voivodeship Office for Conservation of Historic Monuments in Katowice
- Voivodeship Office for Conservation of Historic Monuments in Przemysl

**Romania**

- Forest Research and Management Planning Institute
- Institute of Geography, Romanian Academy of Sciences
- Institute of Hydrology
- Institute of Soil Science and Agrochemistry
- Ministry of Environment and Sustainable Development
- National Institute of Statistics
- National Meteorological Administration

**Slovakia**

- Ministry of Interior of the Slovak Republic
- National Forest Centre
- Slovak Environmental Agency
- State Geological Institute of Dionyz Stur
- Slovak Hydrometeorological Institute
- Slovak Inspectorate of the Environment
- State Nature Conservancy of the Slovak Republic
- Statistical Office of the Slovak Republic
- Water Research Institute of the Slovak Republic

UNEP also thanks all individuals who provided photographs at no cost. Their names can be found on individual pages with the photos they provided.



[www.unep.org](http://www.unep.org)

United Nations Environment Programme  
P.O. Box 30552 - 00100 Nairobi, Kenya  
Tel.: +254 20 762 1234  
Fax: +254 20 762 3927  
e-mail: [unepubb@unep.org](mailto:unepubb@unep.org)  
[www.unep.org](http://www.unep.org)



**The Carpathians Environment Outlook** is an integrated assessment report on the state of, and trends related to, the environment of the Carpathian Mountains and wider region, retrospectively over the past 30 years and forward to 2020. This assessment is based on analyses of socio-economic and environmental processes and focuses on sustainable development issues, notably the environmental implications of human and economic activities. The Outlook section of the report presents three scenarios of future development for the Carpathians, exploring the relationship and synergies between policy decisions taken, the human situation and the natural environment.

The contents of this Report are based on information and data supplied by national governments of Carpathian countries, and numerous individuals and specialised institutions from the region. The main chapters are the following:

**Chapter 1: Background/Introduction**

**Chapter 2: Socio-Economic Driving Forces**

**Chapter 3: The State of the Carpathians Environment and Policy Measures**

(detailed treatment of major environmental themes)

**Chapter 4: Outlook 2005 to 2020: three scenarios for the Carpathians region's future development**

**Chapter 5: Conclusions and "Options for Action"**

The Carpathians Environment Outlook provides greater knowledge about the unique ecology and related environmental and human problems of the Carpathians, along with better information for sustainable decision-making in this unique region and, in particular, the implementation of the Carpathian Framework Convention.



© Jana Hajduchová, Pavel Bezděčka, Piotr Krzan, Peter Lengyel, Jan Hajduch, František Šulgan