CENTRAL EUROPEAN UNIVERSITY

Impacts of and Adaptation to Climate Change in the Danube-Carpathian Region

Overview study commissioned by the
WWF Danube-Carpathian Programme

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Central European University
Budapest, Hungary
September 30th 2008

List of abbreviations

CDM – Clean Development Mechanism
CFC – Carpathian Framework Convention
EIA – Environmental Impact Assessment
GEF - Global Environment Facility
IBRD – International Bank for Reconstruction and Development
ICPDR – International Commission for the Protection of the Danube River
IPCC – Intergovernmental Panel on Climate Change
JI – Joint Implementation
NGO – Non-governmental organisation
UNDP – United Nations Development Programme
UNECE – United Nations Economic Commission for Europe
UNFCCC – United Nations Framework Convention on Climate Change
LDGC – Lower Danube Green Corridor Agreement

Central European University, 2008

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The study was commissioned by the WWF Danube-Carpathian Programme (http://www.panda.org/dcpo) with co-financing from the European Commission. The study reflects the opinions of the authors and not of the WWF Danube-Carpathian Programme nor of the European Commission.

Table of contents

1 Introduction

Climate change is one of the most serious problems facing the world today. As expressed by the Nobel Peace Price-winning Intergovernmental Panel on Climate Change[1] the warming of the climate system is unequivocal, as 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 (IPCC, 2007a). According to the United Nations-Sigma XI Scientific Expert Group on Climate Change significant harm from climate change is already occurring, and further damages are a certainty (SEG, 2007). Furthermore, it is likely that anthropogenic activity has been influencing warming on the global scale[2] (IPCC, 2007a).

Since 1750, global-average surface temperature has risen by 0.8ºC, with most of the increase occurring in the 20th century, most rapidly since 1970, and continues to rise in the 21st century, by 0.2-0.4ºC per decade (SEG, 2007). It is uncertain what increase in global-average surface temperature will prove to be unmanageable (meaning the crossing of a climate "tipping point" that leads to intolerable, catastrophic impacts); at the same time, scientists agree that the increase must not exceed 2-2.5ºC compared to the 1750 level, or risk catastrophic consequences (SEG, 2007). In case the tipping point is crossed because of the temperature increase, likely consequences will include increases in sea level and acidity of oceans that will not be reversible for centuries or millennia, large-scale shifts in vegetation that cause major losses of sensitive plant and animal species, significant shifts in the geographic ranges of disease vectors and pathogens, as well as disruptions in ecosystems leading to adverse impacts on food security, fresh water resources, human health and settlements, resulting in increased loss of life and property (SEG, 2007, p. XII). Therefore, urgent and significant steps are needed both in terms of mitigating climate change as well as adapting to its effects.

Climate change will also have substantial economic costs, which can be substantially reduced by early action. The Stern Review on the Economics of Climate Change commissioned by the Government of the United Kingdom has estimated from the results of formal economic models, that in case of non-action "the overall costs and risks of climate change will be the equivalent of loosing at least 5% of global GDP each year, now and forever, while the estimates of damage can rise to 20% of global GDP or more" (Stern, 2006). At the same time the cost of action to tackle climate change can be limited to 1% of global GDP each year.

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[1] The Nobel Peace price in 2007 was awarded jointly to the Intergovernmental Panel on Climate Change (IPCC) and Albert Arnold (Al) Gore Jr. (former Vice President of the United States of America) in two equal parts for their efforts to build up and disseminate knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change (http://nobelpeaceprize.org).

[2] "Anthropogenic warming over the last three decades has likely had a discernible influence at the global scale on observed changes in many physical and biological systems" (IPCC 2007a, p.6), where "likely" means > 66% probability.

Climate change will impact different areas of the world in different ways and to different extents. While we do have a clear understanding of overall trends of warming of the climate system [based on observational evidence of increases in global average air and ocean temperatures, widespread melting of snow and ice and rising global average sea level (IPCC, 2007a)], at the same time precise knowledge at local level is mostly lacking. This study reflects the clear, overall trends that are increasingly certain, and some of the regional expressions, but these may vary at local level.

As for the effects in Europe, it is predicted that more adverse effects will occur in the Mediterranean region and south-eastern Europe in terms of energy demand, agricultural productivity, water availability, health effects, summer tourism and ecosystems (EEA, 2007), while regional differences in natural resources and assets will be magnified (IPCC, 2007b). The area in focus of this study, the Danube-Carpathian region in central and south-eastern Europe (comprising two distinct areas: the Danube River Basin and the Carpathian Mountains) will also be affected. The climate of the Danube-Carpathian region is complex, with significant differences between the Black Sea coastal areas, Transylvania protected by the arch of the Carpathian-mountains and the Pannonian basin. Regional vulnerabilities, impacts and difficulties in adaptation have been acknowledged: in terms of ecological vulnerability to future climate change (changes in ecosystem structure and natural vegetation) the Danube River Basin has been identified as highly vulnerable (SEG, 2007), while adapting to climate change will also be a challenge for the great majority of organisms and ecosystems in mountainous areas (UNEP, 2007).

The impacts of climate change not only influence natural systems, habitats and species, but also human economy and society. Therefore, governments must act in time to adapt to these changes in order to reduce damage in both natural and social systems, and in this way avoid unnecessary costs associated with late action. This study aims to explore the impacts of the warming climate and the state of affairs with respect to adaptation to climate change in the Danube-Carpathian region in central and south-eastern Europe. The specific countries in focus of this study include Slovakia, Hungary, Serbia, Bulgaria, Romania and Ukraine.

After providing brief background information on the countries in focus, the following sections review the most important impacts of climate change on natural ecosystems and species as well as on human economy and society, focusing on selected aspects including water, agriculture, forestry and tourism. This section is followed by an assessment of efforts related to climate change adaptation undertaken by the relevant governments and other actors in the countries of the region. The study concludes by providing recommendations to WWF on what actions it should take to enhance adaptation efforts of the countries in focus.

This is an overview study that in terms of methodological approach represents secondary research. It is based on the assessment of effects and likely impacts of climate change in the Danube-Carpathian region by drawing on selected existing literature to review the current understanding of these issues. The assessment of the adaptation efforts of

governments has been carried out by an analysis of documents and strategies related to adaptation to climate change of the countries forming the focus of this study.

2 Background

The area in the focus of this study is the Danube-Carpathian region in south-eastern Europe, focusing specifically on relevant areas of Slovakia, Hungary, Serbia, Bulgaria, Romania and Ukraine. In some cases, most or all of the area of the specific country is located in the Danube-Carpathian region (in the cases of Slovakia, Hungary, Serbia and Romania), while in other cases (Bulgaria and Ukraine) only part of the country lies in the geographic area comprising the focus of this study. In the latter cases information specifically on the part of the country belonging in the Danube-Carpathian region was often not available; therefore, sources referring to the whole country were used (for example, in the case of climate change strategies).

Climate change is closely connected to sustainable development. Furthermore, the two interact in a circular fashion, whereby "climate change vulnerability, impacts and adaptation will influence prospects for sustainable development, and in turn, alternative development paths will certainly determine emission levels that affect future climate change" (Munashinge *et al.*, 2003, p. 11). Therefore, the level of the economic and social development of a county is a factor that can significantly influence its ability to act effectively against climate change.

In terms of development (here defined by level of Gross National Income, GNI, per capita[3] and Human Development Index[4] ranking), the countries in the focus of this study can be classified in three categories. Hungary and Slovakia represent the highest relative development level, followed by Bulgaria and Romania, while Ukraine and Serbia are the relatively least developed of the six countries (see ***Table 1***).

Countries with a higher development level have a better chance to deal with challenges posed by climate change, such as natural disasters resulting from extreme weather events (a number of which have already occurred in the countries of the Danube-Carpathian region in the beginning of the 21st century, see ***Table 1***). At the same time, a higher development level does not guarantee better reaction to natural disasters (as for example the case of Hurricane Katrina in the United States demonstrated), as the sufficient institutional structure to deal with these events also has to be in place.

[3] GNI = Gross National Income. GNI comprises the total value added produced within a country (GDP = Gross Domestic Product), plus income received from other countries, minus similar payments made to other countries.

[4] The Human Development Index (HDI) is and index regularly assessed and published by the United Nations Development Programme. It is based on the following components: life expectancy at birth; adult literacy rate; combined gross enrollment ratio for primary, secondary and tertiary education; and GDP per capita.

Table 1: Population, development indicators and weather related disasters of countries in the Danube-Carpathian region

	Population (thousand, 2008)[1]	GNI per capita (PPP international dollars, 2006)[2]	Human Development Index rating (2005)[3]	Weather-related disasters (number 2000-2005)[4]
Slovakia	5,444	17,060	0.863	6
Hungary	9,931	16,970	0.874	11
Serbia	10,159	9,320	n.a.	7
Bulgaria	7,263	10,270	0.824	11
Romania	22,247	10,150	0.813	28
Ukraine	45,994	6,110	0.788	7

Sources: 1: CIA The World Factbook; 2: World Bank; 3: UNDP; 4: EM-DAT Emergency Events Database

Four of the six countries in the focus of this study are member states of the European Union and therefore they have transposed the EU *acquis communautaire* into their legislation and have to implement it. This includes environmental and climate change policies as well.

The legal framework and policies of countries that are not member states but have the objective to join the European Union must also converge to and are influenced by EU laws and policies. The Government of Serbia has declared that European integration is a priority for the country, and currently the EU is providing support for reforms in Serbia. Serbia is a potential candidate for EU membership and is part of the EU Stabilisation and Association Process towards accession. Therefore, it can be expected that climate change policy in Serbia will with time (as the date of accession comes nearer) comply with the EU *acquis*.

Ukraine is regarded by the EU as a priority partner. At the same time, it is uncertain how this status might influence the country's climate change policy, as it is currently not a potential candidate country and does not have legal obligations to comply with EU laws and directives. At the same time, in some areas the convergence of policies and laws has started. An example of this is the EU Water Initiative, which Ukraine is a beneficiary of and which aims to provide assistance to countries to incorporate the principles of EU water legislation into their laws (REC, 2004). A deepening of economic integration and political cooperation, however, might also bring with it convergence in climate change and related policy fields.

3 Climate change impacts

Climate change will have different impacts in the Danube River Basin and in the Carpathian Mountains. According to the IPCC, a key vulnerability of the European systems and sectors to climate change during the 21st century in low lying areas of central Europe will include increased frequency and magnitude of floods, increased variability of crop yields, increased health effects and heat waves as well as severe fires in drained peatland (IPCC, 2007b). Droughts are also expected to increase in both scope and frequency, especially impacting those areas that are already experiencing water stress, including many areas of Bulgaria as well as parts of Southern Hungary and the Banat region in Serbia and Romania.

In mountain areas, the main vulnerabilities will include the disappearance of glaciers, reduced periods of snow cover, upward shifts of the tree line, severe loss of biodiversity, reduced ski season and increased rock fall (IPCC, 2007b). In mountain areas a change in high mountain vegetation types has already been observed and alpine vegetation on high summits has occurred as a result of recent temperature and precipitation trends (IPCC, 2007b). Specifically in the Carpathian Mountains, the effects of climate change include enhanced erosion, landslides, floods (resulting from prolonged heavy rainfall, sudden snowmelt or both occurring at the same time), deforestation, and the occurrence of local flash floods (frequent in summer but restricted to small catchments) (UNEP, 2007).

It is important to note that the effects of climate change on the natural environment are coming on top of a wide range of very serious and mostly human-caused stresses, from loss of habitat and habitat fragmentation due to construction of infrastructure to depletion of freshwater and other resources. Some 80% of the Danube's natural floodplains have already been lost, and dams lacerate the upper and middle parts of the river, significantly weakening the resilience of ecosystems and limiting the ability of fish and other species to migrate in response to changing conditions. As the result, populations of beluga sturgeon in the Danube, for example, are teetering on the edge of extinction. In the Carpathian Mountains, construction of roads and other infrastructure is leading to loss and fragmentation of habitats, threatening populations of flora and fauna and limiting their ability to adapt to climate change impacts.

Not only natural environment, but economy and society will be and already is affected by climate change. Human health effects have included heat wave mortality, while the earlier onset and extension of the allergic pollen season have also already occurred, leading to higher health costs. The heat wave that occurred in Europe in 2003 has already shown this, with 35,000 people dead and agricultural losses reaching USD 15 billion (€ 13.1 billion)(Stern, 2006). Vulnerability to climate change will is expected to be highest in already deprived population groups. Poor population groups often live in marginal areas and low-quality housing that is more vulnerable to extreme weather events and they do not have the financial resources to reduce their vulnerability or insurance cover to cope with losses, at the same time also lack sufficient information on how they can cope

with these extreme events (Stern, 2006). Therefore the social aspects of adaptation to climate change also have to be taken into account.

In the following sections the main impacts of climate change on natural ecosystems and species as well as on human economy and society in the Danube-Carpathian region will be reviewed. In terms of natural environment, the impacts of climate change on freshwater, forest and grassland habitats and species will be reviewed in detail, while in terms of production systems and economic sectors, the focus will be on impacts on freshwater resources, agricultural and forest production, and the tourism sector.

3.1 Impacts on natural habitats and species

3.1.1 Impacts on freshwater habitats and species

Impacts of climate change on freshwater habitats and species in the Danube-Carpathian region are expected to differ between mountain and lowland areas, due to different climatic conditions. The Danube River Basin itself is characterized by large differences in climate due to its large geographic area and diverse relief (WWF, 2008). In the following the general effects of climate change on freshwater habitats will be summarized.

Freshwater ecosystems have been identified as the ones being most severely impacted by climate change, with having the highest proportion of species threatened (IPCC, 2008). Species richness in freshwater systems is currently highest in central Europe however this is likely to change as a result of climate change. In the Danube River Basin the most likely impacts related to surface water resources will include more frequent flooding, longer periods of drought, an increase in water temperature, which will in turn indirectly contribute to deteriorating water quality, limitation of ground water recharge, spread of invasive species, disconnection of functional habitats, as well as harming natural biodiversity and overall river integrity (WWF, 2008). Other impacts of climate change affecting surface level waters include earlier ice melt and longer growing seasons in lakes and rivers that freeze, higher risk of algal bloom in lakes, salinisation, species loss and lowering of the water table (IPCC, 2007b; IPCC, 2008). Enhanced nutrient loss from cultivated fields may lead to higher concentrations of dissolved organic matter in inland waters, which in turn will intensify the eutrophication of lakes and wetlands (IPCC, 2007b; IPCC, 2008).

Wetlands (which are in general characterized by high levels of biodiversity) will also be affected by climate change (particularly by increases in the variability in precipitation) in the Danube River Basin. Climate induced changes of wetlands will particularly affect waterfowl bird populations whose habitats will be destroyed. Although projections say that the survival rate of most bird species in Europe is likely to improve because of the rise in winter temperatures, this might not be the case in southeast Europe where lower

precipitation levels might endanger wetlands - important bird habitats. This is important e.g. for Serbia, which has 253 nesting species or 84% of the total number on the Balkans, and the Danube Delta, with its 340 bird species, including globally important populations of red-breasted geese and Dalmatian pelicans.

Table 1: Selected expected impacts of climate change and adaptation measures related to freshwater habitats and species in the Danube-Carpathian region

Expected impacts include:	Possible adaptation measures:
▪ Deteriorating water quality (higher risk of algal bloom, salinisation, intensifying eutrophication of lakes and wetlands) ▪ Increase in the distribution of invasive species ▪ Harm to natural biodiversity, including loss and extinction of plant and animal species.	▪ International cooperation in river basin management ▪ Protect remaining natural and wetland areas and ensure an ecological network that can safeguard migration of species and habitats ▪ Restoration of floodplains and wetland areas

3.1.2 Impacts on forest and grassland habitats and species

Forest and grassland habitats and species will be and are already affected by climate change through four main factors. These include changes in CO_2 concentration, in mean temperatures, in the dispersion of precipitation and in the occurrence of extreme weather conditions. The impacts of climate change on forest and grassland habitats will result in combined effects of the before mentioned factors. Increased CO_2 concentration in itself would result in increased plant growth, however combined with an increase in mean temperature, decrease in precipitation and increase in the occurrence of extreme weather events will result overall in unfavorable conditions for vegetation.

In the Carpathian region on average, forest cover is currently nearly 60%, with the percentage varying significantly among countries and areas (UNEP, 2007). The largest forest complexes can be found in the Eastern Carpathians, while in the Western and Southern Carpathians substantial areas have been converted to other land uses, and in the foothill areas forests are small and scattered with other land uses dominating (UNEP, 2007). The main forest types currently found in the Carpathians include deciduous, coniferous and mixed forests, with a distinct vertical zonation (UNEP, 2007).

According to the IPCC, it is very likely that forest ecosystems in Europe will be strongly influenced by climate change and other global changes (IPCC, 2007b). Moisture limited forests (Mediterranean forests) and temperature limited (boreal) forests characteristic to

central Europe have been identified as especially vulnerable to climate change, and will face difficulties in terms of adaptation (IPCC, 2007b). In central Europe the stability of the forest ecosystems is expected to decrease, and a northward and inland shift of tree species is expected to occur, while natural disturbances (e.g. fire, pests, wind storms) are expected to increase, although to a lesser extent than in the Mediterranean region (IPCC, 2007b). Climate change induced migration of species and current life zones towards higher altitudes can also be expected (IPCC, 2007b; UNEP, 2007).

In the Carpathian Mountains, less favorable conditions for high forests will develop as a result of climate change because of increased water deficits during the vegetation period, increasing air temperatures and decreasing precipitation in warm periods that will lead to a relative decrease in air humidity (UNEP, 2007). At the same time, areas of temperate forests realm are expected to be extended (UNEP, 2007). The precipitation deficit affecting high mountain forests will lead to weakened spruce and mountain pine communities, making them more vulnerable to wind storms and intensive rains (UNEP, 2007). At the same time, these changes in conditions will be favorable for xerothermic shrub and steppe vegetation. Oak, beech-oak and oak-beech mixed forests will mostly be affected by the expansion of these vegetation forms (FNCCC, 2005). The changed conditions are also expected to favor species such as hornbeam, linden and acacia (FNCCC, 2005). In the Ukrainian Carpathians, the combination of increases in temperature and precipitation are causing the drying up of pine and fir-tree forests.

As a result of climate change, scrubs will be more endangered by fires, while low lying forests will be more susceptible to floods (FNCCC, 2005). For example, the forests of the Gemenc National Park in Hungary have been affected by recent floods and inland inundations. Among the countries in the focus of this study, increased occurrence of wild fires can be expected particularly in Serbia and Bulgaria, which are already experiencing stressed water resources. As for already occurring natural disturbances, between the years 2000 and 2004 weather related events (droughts, fire, ice, snow, wind) have cumulatively affected 131,000 hectares of forest in Hungary (VAHAVA, 2006).

A case study by Ďurský et al. (2006) (based on the simulation results of the CCCMprep climate model) found that spruce forest in the Horná Orava region of Slovakia will grow faster during this century, with more than 80% of trees responding positively to increasing temperatures, while precipitation is not a limiting factor. The authors conclude that stands at the upper limits of occurrence will be most affected. However, this study considered only temperature and precipitation as driving factors. Midriak (2004) identifies probable impacts of climate change with relevance to forest ecosystems in Slovakia. These include desertification with increasing extent and intensity of wind erosion, encroachment of steppe (and forest-steppe) ecosystems, salinization and alkalization of soils, increase of intense precipitation with subsequent increased intensity of pothole erosion, retreat of nival and cryogenic processes in higher altitudes, expansion of desolated soils; weakening, withering and gradual – possibly mass – extinction of non-original forest species, and species with narrow climatic valence (especially fir and spruce), gradual entering and increasing range of forest ecosystems with species that have

broader climatic valence (beech and oak), gradual upward increase of upper range of forests, as well as more frequent strong winds and wildfires.

In central Europe, a change in the type of impact (positive or negative) in terms of net primary productivity of grasslands is expected during the course of the century (IPCC, 2007b). Water scarcity is expected to cause the most serious problem for grassland ecosystem in the Danube River Basin. Droughts have already been affecting the Duna-Tisza köze, Tiszai-Alföld and Dunától regions of Hungary. Research on climate change impacts in the natural grassland ecosystems in the Carpathian-basin has shown that recovery after long lasting heat stress is much faster and much more effective in the case of plants grown in grasslands experiencing larger concentration of CO_2 than in ones grown under lower levels of concentration. In case of loess and sand grasslands, only a few years of increased CO_2 concentration led to changes in the relative proportion of grassland species, which is due to species' differing ability to acclimatize (Tuba et al., 2004).

Table 2: Selected expected impacts of climate change and adaptation measures related to forest and grassland habitats and species in the Danube-Carpathian region

Expected impacts include:	Possible adaptation measures:
▪ Northward, inland shift of tree species ▪ Increase in natural disturbances (e.g. fire, pests, wind storms) ▪ Migration of species and current life zones towards higher altitudes ▪ Less favorable conditions for high forests ▪ Extension of temperate forest realm ▪ Weakened spruce and mountain pine communities ▪ Improved conditions for shrub and steppe vegetation ▪ Increased incidence of fires	▪ Improved monitoring and management ▪ Further scientific research to forecast forest conditions

3.2 Impacts on human economy and society

3.2.1 Impacts on freshwater resources

Freshwater resources are fundamental for economic and social development in the Danube-Carpathian region, being used for direct human consumption and serving as a basis for agricultural and industrial production, fisheries, power generation and tourism.

The Danube-Carpathian region is characterized by an abundance of freshwater resources, both in terms of surface waters and groundwater resources. This is particularly true in the mountain areas (UNEP, 2007). Groundwater extracted mostly from porous and karstic aquifers serves as the basis for over 80% of human water consumption in the Carpathian region (UNEP, 2007). These bicarbonate, calcium and/or magnesium type waters are potable and some of them are of outstanding quality (UNEP, 2007) providing a basis for the mineral water production industry.

In terms of surface water, the main river system of the Carpathian region consists of the Danube and its tributaries. The Danube River Basin (total area: 801,463 km^2) is the second largest river basin in Europe. It consists of three sub-regions, the Upper, the Middle and the Lower Danube Basin. The focus of this study is mainly the Middle and the Lower Danube Basin, extending from Bratislava, Slovakia through the Iron Gate dams between Serbia and Romania through the border with Bulgaria and the three main branches of the Danube Delta in Ukraine and Romania. The largest tributary of the Danube is the river Tisza. Other tributaries in the Middle Danube Basin include the Váh, Hron, Ipoly and Juzna Morava. The most important rivers in the Lower Danube Basin include the Timok, Jiu, Olt, Arges, Ialomita, the Siret and the Prut.

It is likely that climate change will have a range of impacts on hydrological systems (IPCC, 2007b), some of which will be profound (UNEP, 2007). According to projections, runoff is expected to decrease in central and eastern Europe, while groundwater recharge is likely to be reduced, with greater reduction occurring in valleys and lowlands (e.g. in the Hungarian Great Plain) (IPCC, 2007b). This will have serious consequences, as groundwater plays a key role in water consumption. In general, decrease in surface, ground and soil water availability will be expected in the future.

Even if on the country level water is abundantly available, decrease in water availability will have serious consequences in specific areas within countries. In terms of use of country level available water resources, Hungary has a quite favorable water withdrawals-to-availability ratio (7%), while the ratio in Bulgaria reaches 49%, which is generally considered to be severe stress on available water resources (WWF, 2006c). Despite average abundance of water on the country level, several areas in the Danube-Carpathian region have already been affected by drought. In the Danube River Basin

examples of such areas include the Homokhátság region in Hungary and the Serbian and Romanian Banat.

Further unfavorable impacts of climate change on hydrological systems in central and eastern Europe are expected to include increase in winter flows and decrease in summer flows of rivers, with summer flows decreasing by as much as 50% in central Europe (IPCC, 2008; IPCC, 2007b). In connection to this, risk of snowmelt floods is expected to shift from spring to winter (IPCC, 2008) in this way contributing to the lengthening of the dry season in the summer.

As for already occurring local effects, analysis of long-term monthly averaged flows of smaller rivers showed significant decrease during all months (except for May and June) in middle and southern Slovakia, while in western Slovakia decrease in summer and autumn and increase in winter river flows has been experienced (Lapin et al. 1997, 2004; Škoda et al. 2005). Local flash floods occurring as a result of extreme weather events are also expected to pose a serious problem. Historical data already shows the increase of these events in Slovakia. During the 1993-2000 an increase in daily precipitation extremes was detected, thus increasing the likelihood of local flash flooding (TNRCC, 2001). The period of 1996-2000 experienced more frequent occurrence of floods – both local and widespread (Lapin et al. 1997, 2004). Also an assessment of the historical floods in the rivers of the Bodrog River Basin in East Slovakia indicated an increased extremeness of the flood regime on the Uh River (Halmová, 2001).

An increase in the occurrence of high floods will pose serious risks for areas currently protected by dykes. Lives will be disrupted in rural as well as urban areas. Although reservoirs and dykes are likely to remain the main structural measures to deal with floods, other options such as expanded floodplain areas and preservation of areas for flood waters are becoming increasingly popular measures (IPCC, 2008). Working with nature rather than against it through floodplain protection and restoration can be cost effective and have multiple benefits beyond flood protection, including avoidance of nutrient removal, improved water management, biodiversity preservation, fish and waterfowl habitat protection, as well as improved circumstances for tourism and recreation.

The more frequent occurrence of droughts in the region will increase demand for water. Increased irrigation needs will arise in agricultural production, while reduced overall water supply will also negatively affect industrial and household water use (increasing costs of water). Water scarcity and resulting decreased river flows are expected to have serious negative consequences for energy generation. Hydropower potential for the whole of Europe is expected to decline by 6%, with the decline reaching 20-50% in the Mediterranean, while remaining unchanged in central Europe (IPCC, 2008). Apart from hydropower, biomass production (because of scarcity of water for irrigation), and thermal and nuclear power plants (because of problems with cooling water availability in terms of reduced quantity or higher water temperatures) will also suffer from decreased river flows (IPCC, 2008). Freight transport on the Danube is also likely to be increasingly affected by droughts as well as floods as these events can disrupt transportation on inland water ways.

Flood on the river Danube, 2006 Budapest

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Table 3: Selected expected impacts of climate change and selected adaptation measures related to freshwater resources in the Danube-Carpathian region

Expected impacts include:	**Possible adaptation measures:**
▪ Decreasing runoff ▪ Reduced groundwater recharge (especially in valleys and lowlands) ▪ Decrease in surface, ground and soil water ▪ Increase in winter flows and decrease in summer river flows, with risk of snowmelt flood shifting from spring to winter ▪ Increase in the occurrence of high floods ▪ Increased pressure on water demand as a result of droughts	▪ Integrated program on sustainable water resource management ▪ Integrated international programs on catastrophic events in the waters of Danube-Carpathian Basin ▪ Vulnerability assessment of water resources

3.2.2 Impacts on agricultural production

Although the service sector and industry play an increasingly important role in the economies of the countries located in the Danube-Carpathian region, agriculture and forestry still make a significant contribution to the Gross Domestic Product of the countries. Agriculture is also important in terms of employment and providing livelihoods in rural areas. Agriculture and forestry are of relatively greatest economic importance in Serbia and Ukraine (see ***Table 4***), but it is also a key sector in the traditionally agricultural producer Hungary, due to the fact that most of the country's land area is excellent for agricultural production. Therefore, possible negative impacts of climate change in agriculture can have serious consequences on economic production as well as on security of food supply in the region. The heat wave of 2003 has already shown the economic impact of extreme weather conditions when crop yields in southern Europe dropped by 25% (Stern, 2006).

Table 4: Agriculture and forestry as a proportion of GDP in the countries of the Danube-Carpathian region

	Agriculture and forestry as a percentage of GDP (2007)
Slovakia	2.6 %
Hungary	4.2 %
Serbia	12.6 %
Bulgaria	7.0 %
Romania	7.5 %
Ukraine	8.3 %

Source: Bank Austria

In terms of agricultural production, countries in the Carpathian Mountains and in the surrounding hilly areas have historically mainly produced grain crops, maize, vegetables, potatoes and fruits (Hungary, Romania and Ukraine) and hops (Slovakia) (UNEP, 2007). While most of the area of the Carpathian Mountains is covered by forest, the second largest form of land cover is agriculture, with the landscape characterized by typically small scale patches of land use (UNEP, 2007). For example, in the Ukrainian Carpathians pastures occupy about 56%, arable land 40%, and perennial crops 4% (Budyakova, 2005). Agricultural production at higher altitudes, steeper slopes and poor soils is characterized by the growing of cold-resistant crops such as oats and potatoes as well as grasslands, clover fields and pastures (UNEP, 2007).

The raising of livestock is more characteristic in the Carpathian foothills, while the montane race of sheep predominates in the higher regions of the Polish, Romanian and Slovak Carpathians (UNEP, 2007). Livestock breeding in the Ukrainian Carpathians is represented by cattle raising, sheep and pig breeding, breeding of the unique species of hutsul horses, and small-scale organic farming (including the growing of vegetables, garden and wild berries, mushrooms and nuts) with the utilization of traditional land-use patterns (WWF, 2008a; Budyakova, 2005). Livestock breeding in the Danube Basin is characterized by intensive livestock systems, with the exception of extensive breeding of native species (for example racka sheep and grey cattle in Hungary).

Four main environmental factors influence productivity of agricultural crops. These include the concentration of atmospheric CO_2, the level of mean temperature, distribution of precipitation, and number and frequency of extreme weather events. While increased levels of atmospheric CO_2 in general will have a positive impact on crop productivity, together with increases in mean temperatures, extremes in the distribution of precipitation, and increased frequency of extreme weather events will make climatic conditions overall less favorable for crop productivity. In northern Europe, increased levels of atmospheric CO_2 are expected to influence crop productivity positively, while reduction in the productivity of crops is expected in the southern parts of Europe (IPCC, 2007b) as a result of increased water and heat stress. As for the impact on output, a 2º C rise in global mean temperatures may lead to a 20% reduction in water availability and crop yields in southern Europe (Stern, 2006).

Climate change is expected to affect agricultural production of the Danube Basin and the Carpathian Mountains in different ways. The potential cropping area of some crops that have currently grown mostly in southern Europe will extend further north and to higher-altitude areas (IPCC, 2007b). The predicted increase in extreme weather events (including spells of high temperature and droughts), higher rainfall intensity and longer dry spells are likely to reduce the yield of summer crops and modify also other processes in agricultural land (for example lead to a decrease in nitrate leaching from agricultural land over large parts of Eastern Europe) (IPCC, 2007b). The increase of extreme weather events in the Carpathian Basin is leading to increased fluctuation in crop productivity (Szász, 2005).

Dynamic changes are expected to occur in soil organic content and, as a result, changes in soil structure, soil erodibility, compaction, infiltration speed, runoff, salinity and turnover of plant nutrients (Sobocká et al., 2005). In general, most resistant to climate change will be high quality and fertile soils (black and brown earth). The expected future occurrence of frequent and intense storms interrupted by periods of longer droughts will significantly increase water erosion of soils (Šurina and Sobocká, 1998). In general, forested soil areas are expected to be less susceptible to water erosion than areas with insufficient protection (e.g. deforested areas). Damage caused by wind resulting in removal of productive top soil layer, or by soil buildup over growing plants will potentially affect all areas under agricultural production (VAHAVA, 2006).

Climate change is also expected to have substantial impacts on livestock breeding. Increasing temperatures could damage the productivity of forage crops in some areas and may also increase the risk of livestock diseases (by supporting the dispersal of insects, enhancing the survival of viruses and improving the conditions for new insect vectors) (IPCC, 2007b). The decrease in fodder production can increase the cost of dairy and cattle farming. The impacts of climate change on livestock breeding require an integrated response with a combination of measures in grazing, fodder production, and the choice of livestock breeds (Bodó, 2005).

Intensive livestock systems are expected to suffer the most. Research has shown a statistically significant relationship between specific meteorological conditions (for example maximum degrees in heat wave periods, air humidity, increased number of days with sunshine) and the productivity of meat cattle stock (Kovacs et al, 2005). Several options are available for adapting livestock breeding to climate change. The buildings of intensive breeding farm facilities have to be modified by the installation of ventilation and cooling systems and improved insulation that enable better adaptation to heat waves. Shading and spraying livestock with water are further options to reduce heat stress and resulting loss in productivity, as well as improvement in water provision, increase in the energy concentration of fodder portions, and improved mineral substance provision (Kovacs et al, 2005). Extensive, traditional forms of livestock breeding and more heat resistant breeds should be supported.

Agriculture, being heavily reliant on climate conditions, especially on the availability of water, could be threatened by climate changes since scenarios predict less precipitation and more frequent droughts. Therefore, the impacts of climate change could have substantial effects on the economies of the countries located in the Danube River Basin. These impacts may vary even in the areas of individual countries. For example, in Hungary in recent years, agricultural production has been facing difficulties related to droughts and floods occurring at the same time in different parts of the country. Aside from the risks of flooding events, the potential impact from climate change on agricultural production in the region includes insufficient access to irrigation water from the parts of Danube that are more vulnerable to summer droughts. In connection with this, desertification is expected to threaten the central part of Hungary (especially the Homokhátság region) and the eastern and southern part of the Vojvodina region of Serbia. Agricultural production in south-east Bulgaria is also expected to be severely impacted by climate change.

A decreasing trend in crop productivity as a result of the above mentioned factors is expected to occur in the Danube River Basin. This raises issues of security of food supply, which can be addressed through development of irrigation systems in areas that earlier did not need to be irrigated, as well as by increasing storage capacity in order to equalize between productivity fluctuations in different years. However, depending on local factors and conditions, drawing water for irrigation can have negative effects including water scarcity for other human uses and nature.

In the Carpathian Mountains with respect to agricultural production climate change is expected to enable the growing of main agricultural crops such as wheat, rye and barley at higher altitudes that were not possible to grow in these locations earlier. Improved temperate conditions for growing main agricultural crops will however continue to be balanced by the mountainous conditions that make farming in these areas difficult and relatively resource intensive.

Table 5: Selected expected impacts of climate change and adaptation measures related to agricultural production in the Danube-Carpathian region

Expected impacts include:	Possible adaptation measures:
▪ Flooding of agricultural areas in lowlands ▪ Insufficient access to irrigation waters in lowlands ▪ Desertification of some areas in lowlands ▪ Growth of main agricultural crops made possible at higher altitudes ▪ Decrease in the stability of productivity in the case of most agricultural crops ▪ Increase in the risk of livestock diseases, decrease in productivity	▪ Improved irrigation systems ▪ Enhanced research on optimal crop profiles in changed irrigation regimes ▪ Measures related to awareness raising and education among agricultural producers about the expected impacts of climate change in their area and what they can do about it

3.2.3 Impacts on forest production

As climate change is expected to strongly influence forest ecosystems in the Danube-Carpathian region, significant implications can also be expected for forest production. This can have substantial economic impacts, as forestry plays an important role in the economies especially of the areas in mountainous regions. In central Europe, a change in the type of impact (positive and negative) in terms of the net primary productivity of forests is expected during the course of the century (IPCC, 2007b). As forests are managed intensively in Europe, there is a wide range of management options, including changing the species composition of forest stands (IPCC, 2007b).

Apart from the timber industry, forests have a number of other economic and crucial ecological functions. These include recreation, conservation of biodiversity, protection of water and soils, and contribution to global carbon circulation. As the impacts of climate change on forest habitats, including natural disasters (excessive floods, storm induced tree falling and catastrophic landslides) are forecasted to intensify, and the spread of new or formerly uncommon diseases and pests that can damage forests occurs, these functions can become increasingly endangered. The negative impacts of climate change can lead to

potential losses in quality and quantity of raw materials for the timber industry in the region, as well as to the deterioration of other forest functions listed above. Further negative impacts of climate change on forests include draughts leading to increased water stress, which in turn result in decreased natural and economic yields of natural growth forest systems (beech, hornbeam-oak, oak groves) (Führer, Mátyás, 2005).

Apart from negative impacts, climate change can also contribute to increased forest production under specific circumstances. Increasing mean temperature combined with increased CO_2 concentration speeds up photosynthesis in most temperate tree species (Tasnády, 2005). However this only occurs if water supply, light and nutrient supply does not emerge as a limiting factor. Analysis of trends in tree growth occurring in the past few decades in Hungary indicate that increases of mean annual temperature could positively have affected growth of the beech, sessile oak and Turkey oak species (see ***Table 6***). At the same time water availability is soon expected to act as a limiting factor to this acceleration of tree growth (Somogyi, 2008).

Table 6: Tree growth increase potentials in three scenarios of temperature increase by tree species

	Mean increase in tree height (m) with increase in mean temperature		
Tree species	**0.5 °K**	**1 °K**	**2 °K**
Common beech	0.5	1	2
Sessile oak	0.25	0.5	1
Turkey oak	0.5	1	2

Source: Somogyi, 2008

Adaptation options for forests in general include changing the species composition of forest stands, development of advanced systems of forest inventories and forest health monitoring (IPCC, 2007b). Specific adaptation options for mountain forests are yet to be defined (IPCC, 2007b). As a result of greater danger of forest fires, the need for fire protection measures will increase. Since in the Carpathian Basin drying of the climate is already being experienced, preservation and potential increase of forest stands is a complex challenge. It is possible to address this challenge through a combination of measures which contribute to the preservation of the microclimate of forests (which includes preservation of favorable water and humidity levels) on the one hand, including the use of native, relative and pioneer species as well as forest renewal and cultivation practices on the other hand (Tasnády, 2005).

Forestry practices need to be adapted to the changing abiotic and biotic factors that are expected to occur as a result of climate change. It is crucial to choose tree species in new forest plantations that will be suitable to the expected changes in climatic conditions (such as increasing temperatures and decreasing precipitation) through the full lifespan of the trees. Planting tree species with shorter life spans (such as acacia with a life span of 30-40 years) rather than tree species that need more time to reach full development (such

as oak, which needs 80-100 years) provides more flexibility in adapting to changes in climate without serious losses in timber production. Existing forest stands can be made more resistant by increasing the number of species in the stand in this way increasing biodiversity, and by deploying native species (keeping in mind their suitability for the expected climactic conditions through their whole life span).

Table 7: Selected expected impacts of climate change and adaptation measures on forest production in the Danube-Carpathian region

Expected impacts include:	Possible adaptation measures:
▪ Losses in quality and quantity of raw materials for the timber industry ▪ Deterioration of forest functions (e.g. recreation, biodiversity conservation, protection of water and soils)	▪ Vulnerability reduction of forests by replacement of highly flammable species, regulation of age-class distributions and changing the species composition. ▪ Increased wood production achieved by preservation of microclimate through the use of native, relative and pioneer species, and forest renewal and cultivation practices

3.2.4 Impacts on tourism

Tourism plays an important role in the economies of countries in the Danube-Carpathian region. ***Table 8*** shows travel and tourism activity's contribution to GDP and employment in the countries of the region (for countries as a whole) for the years 2000 and 2007 as well as forecasts for the year 2010. Since 2000 tourism has been declining in Hungary, Serbia and Bulgaria, both in terms of contribution to GDP and in terms of employment (direct and indirect impact combined), while the relative significance of tourism activity has increased in Slovakia, Romania and Ukraine. These trends are expected to continue in the next couple of years.

Table 8: Travel and tourism activity's relative significance (in percentage %) in gross domestic product (GDP) and employment (direct and indirect impact) for the years 2000, 2007 and 2010 (forecast) for countries in the Danube-Carpathian region.

	Slovakia			Hungary			Serbia			Bulgaria			Romania			Ukraine		
	`00	`07	`10*	`00	`07	`10*	`00	`07	`10*	`00	`07	`10*	`00	`07	`10*	`00	`07	`10*
% GDP	11.0	13.1	13.1	11.4	6.7	6.5	4.8	4.6	4.7	13.2	12.8	11.3	4.5	5.6	6.0	8.5	9.0	8.9
% Empl.	9.8	11.5	11.4	11.4	6.2	6.0	4.3	4.1	4.2	11.2	11.0	9.6	5.5	6.7	7.2	6.9	7.3	7.3

Source: World Travel and Tourism Council
** Forecast*

At the same time, changing climatic conditions can have a significant impact on the tourism sector of countries in the Danube-Carpathian region in the medium- and long-term. Both low-lying and mountainous areas will be affected.

The construction of new ski resorts has become a characteristic tendency throughout southeast Europe. At the same time, mass tourism and development of skiing infrastructure is often harmful for the environment. Negative impacts of mass tourism have already been identified in the Carpathian Mountains, including the introduction of invasive species and the construction of tourist centers and ski resorts endangering protected areas (UNEP, 2007).

While new ski resorts are being constructed, likely decreases in natural snow cover especially at the beginning and end of the ski season can be expected (IPCC, 2007b), which will negatively affect the ski industry (the establishment of the Bansko Ski Zone in Bulgaria provides an example of tourist infrastructure development projects in the region – see ***Box 1***). Therefore, a contradiction exists between the development of new locations for ski tourism being strongly supported by some governments (for example in Romania and Bulgaria), while climate change will likely result in reduction in snow cover and shorter winters in the region.

Erosion in Bansko Ski Zone, Bulgaria

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Observed and predicted changes in Slovakia already indicate what can be expected in the Carpathian region as a whole. As for changes observed in recent decades, analysis of spatial and temporal snow cover changes in the Little Carpathians (South-western Slovakia) based on data from 20 stations for the 1950-2004 time period showed, in spite of significant increase in temperature means and some precipitation decrease, no remarkable decrease after 1990 (Lapin and Fašo, 2005). At the same time analyses of snow cover variability and trends within 1921-2006 time period in the High and Low Tatras regions revealed unequal trends (Lapin et al., 2007). Main drivers of observed changes are increasing average temperature, increasing or decreasing precipitation and to a certain extent also changes in atmosphere circulation patterns. The long-term snow cover time series analysis showed a significant decrease of snow cover characteristics in many parts of Slovakia, with an exception of mountainous regions, where the snow cover is increasing, primarily as a result of increasing precipitation during winter season (Lapin, 2007).

As for predicted changes in general, decrease in snow cover duration in Slovakia with increasing temperature and increasing precipitation is anticipated (Lapin et al. 2005). In case of mountain regions, the largest snow cover decrease (meaning number of days with snow) will be at the beginning (September) and in the end (April) of the winter season. In other words the winter season will become shorter. Assuming an increase of 1°C and 10% in precipitation total, number of days with snow will decrease by two weeks in both, April and September. During other months of the winter season the decrease will be less significant. In lowlands, snow cover decrease will be much more significant during the

whole winter period. For instance, in southwest Slovakia, assuming increase of 1°C and 10% in precipitation total, the number of days with snow will decrease by 2 weeks in January (Lapin et al. 2005). Thus in general, low-lying skiing regions will be more affected by climate change than skiing regions at higher latitudes. In fact, Kostka and Holko (2004) concludes that by 2030 alpine skiing regions within the 1150-1500 m a.s.l. might by uneconomic and by 2075 also regions in 1500-1850 m a.s.l.. Probably also higher variability in snow cover (duration) can be expected with extremely high and low snow cover (such as winter seasons 2005/2006 and 2006/2007).

Tourism will be affected by climate change not only in mountainous but also in low-lying areas. Central Europe and countries in the Danube River Basin will be affected by increased frequency and magnitude of floods, heat waves, severe fires, and deteriorating water quality of natural lakes (IPCC, 2007b). For example, tourism in Hungary will be negatively affected if the water quality of Lake Balaton deteriorates or if the increasing occurrence of extreme heat waves make visiting the Hortobagy (and other flatland areas) less attractive for tourists. At the same time, the summer tourist season will be longer and distribution of tourist visits will be more even. Countries in the Danube-Carpathian region might also benefit from shifting tourist flows form countries in the Mediterranean, where the tourist industry has been identified as vulnerable to climate change, as a result of reductions in thermal comfort of beach tourism (European Commission, 2007b).

Taking into account the impacts of already occurring and future climate change in tourism strategies and when planning new investments in the tourism sector can help reduce potential financial losses (these could occur for example when new facilities are built without considering potential future warming of the climate). Some of the countries in the region have already started to take these concerns into account when developing their national strategies for adaptation to climate change. For example, in the Romanian national climate change strategy impacts of and adaptation to climate change with regards to tourism are analyzed in detail. In the case of Hungary, tourism is mentioned in the national climate change strategy, although no extensive discussion is provided on the sector in the document. It is proposed to be discussed in more detail in the review of the strategy (which is due in two years). Strategic documents on climate change in Bulgaria also contain discussion of tourism. It is necessary for national tourism strategies to contain assessment and discussion of climate change impacts and adaptation measures related to the sector, however in the region in focus only in the case of Bulgaria is climate change discussed in the national strategy for tourism. On the more operative level, integrating climate change considerations into environmental impact assessments and strategic environmental assessments can be a way to deal with future climate change when planning new facilities, provided that the recommendations of these assessments are implemented properly.

The governments of the countries located in the Danube-Carpathian region must take into account the impacts of climate change on the tourism sector. Strategies for the development of the sector exist in the countries in focus; however, in most cases impacts of climate change are not discussed in them (see ***Table 9***). Since substantial amounts of money are already being invested into facilities and infrastructure whose profitability is

likely to be endangered by climate change, it is crucial for impact assessments to be made before further initiation of investments, in order to avoid substantial financial losses. Therefore it is crucial to integrate the consideration of climate change impacts and adaptation measures into national tourism strategies, action plans and individual projects in the region.

In Hungary, Romania and Bulgaria, national climate change strategies and action plans have already been developed (or are currently being developed), and impacts on the tourism sector are taken into consideration (see ***Table 9***). The countries where no national strategies and action plans on climate change and adaptation to climate change exist yet (Slovakia, Serbia, Ukraine) should develop these, integrate them with other national strategies (in the case of tourism mainly with the national strategy for tourism), and implement them. At the same time contradictions can exist between environmental protection and development of tourism even when climate change impacts are taken into consideration. For example, in the case of Romania the national climate change strategy proposes the endowment of ski resorts with machines generating artificial snow to extend and supplement the surfaces covered with natural snow; development of mountain resorts at higher altitudes (e.g. Balea Lac); and development of supplementary touristic attractions in the mountain resorts, as alternatives to winter sports, to minimize the effect of low quantities of snow (e.g. covered skating rinks). These measures might be effective in developing mountain tourism in an adaptive way to climate change; however, substantial environmental harm can be caused by these same measures. Therefore a contradiction exists between nature protection and climate resilient tourism development. The promotion and integration of sustainable and eco-tourism tourism practices into national tourism strategies could at the same time contribute to limiting the already occurring negative effects of mass tourism development in mountain areas.

Table 9: Inclusion of climate change considerations in national tourism strategies and inclusion of tourism sector in national climate change strategies (NCCS) and national action plan for adaptation to climate change (NAPA).

	Slovakia	**Hungary**	**Serbia**	**Bulgaria**	**Romania**	**Ukraine**
Are climate change impacts/adaptation mentioned in tourism strategy?	No	no	no	yes	no	no
Are climate change impacts/adaptation related to tourism mentioned in NCCS/NAPA?	No strategy	yes	no strategy	yes, in the action plan	yes	no strategy

Options for adaptation to climate change in the tourism sector include promoting new forms of tourism, for example ecotourism (responsible travel to natural areas that conserves the environment and improves the well-being of local people[5]), cultural tourism (IPCC, 2007b), or conference tourism. Development of nature friendly forms of tourism, such as hiking and rural holidays can contribute to shifting tourism activity away from mass tourism, in this way providing relief to protected areas negatively affected by the latter.

For a more detailed account of impacts of climate change on the tourism sector and relevant strategic efforts for adaptation (if any) in the countries of the region, please see Annex A.

Table 10: Selected expected impacts of climate change and adaptation measures related to tourism in the Danube-Carpathian region

Expected impacts include:	Possible adaptation measures:
▪ Reduction in natural snow cover in beginning and end of ski season in mountain areas, decrease in the length of the ski season (in ski resorts in Slovakia, Romania and Bulgaria) ▪ Droughts and higher temperatures leading to deteriorating water quality of lakes and rivers resulting in reduced waterside tourism (for example Lake Balaton in Hungary) ▪ Droughts and higher temperatures leading to reduction in city tourism (for example in cities with main cultural attractions in the region) ▪ Lengthening (because summers will be longer) and flattening (because distribution of tourist visits will be more even) of the tourist season in lowland areas (for example Hungary)	▪ Promotion of sustainable tourism ▪ Integration of climate change considerations into national tourism strategies ▪ Cooperation in nature friendly tourism development in the Danube-Carpathian region

[5] Ecotourism as defined by the International Ecotourism Society.

Box 1: The case of the Bansko Ski Zone - Bulgaria

Bansko Ski Zone case

The Bansko Ski Zone, initiated in 2000, is the first precedent in the Bulgarian mountain regions of the construction of massive ski resort facilities. It includes the construction of 12 new ski slopes, 21 cable ways, buildings and canteens, an artificial lake, and 3 ski roads on the territory of 100 ha. Environmental NGOs claim that the zone stretches over an additional 150 ha which were not included in the Environmental Impact Assessment procedure. In 2005, the Zone was approved to expand to another 120 ha. Out of this territory, 99 ha overlap with the territory of the National Park Pirin. The Park is a UNESCO world cultural and natural heritage, a potential NATURA 2000 and EMERALD site. From the ecosystems point of view, the Ski Zone imposes a significant negative impact on natural habitats, water resources, biodiversity and soil (MEW and BFB 2004). Within the campaign 'Save Pirin', a team of independent experts prepared a report assessing the impact of the ski zone on the biodiversity and soil of the area. The report showed that the habitats are extremely vulnerable to climate changes, which are largely enhanced by the mass ski facilities.

According to the report, most of the land at the bottom of the new ski slopes and the ski slopes' clearings (such as Bunderishka Polyana) were intensively ploughed. "The production of large amounts of artificial snow and the snow cover compaction on the ski slopes, the continuous trampling of the ground and its mechanical destruction, the induction of ice layers in the ground and the delayed vegetation will create difficulties in coping with erosion in the ploughed lands", the report claims. The EIA recommends mitigation measures such as the use of style nets and artificial walls, as well as the planting of non-indigenous genetic material. These measures were implemented only after two years, when the erosion processes have seriously advanced. The EIA report also declares that the impact of climatic changes will inevitably further enhance the erosion processes in this vulnerable area. According to some of the experts, the excessive logging of the forest was also one of the reasons for the more devastating consequences of the floods in this area in the last couple of years.

Given the climatic changes which are projected to occur in the country, ski mass tourism contributes additionally to the vulnerability of particular mountain areas. Yet, the national plan for managing Pirin National Park does not include any projections on climate variability nor does it stipulate the necessity of climate change adaptation measures.

Sources: Save Pirin NGO Coalition, Bulgarian Ministry of Environment and Water and Bulgarian Foundation Biodiversity

4 Adaptation to climate change – current government efforts and the efforts of other actors

4.1 National strategies on adaptation to climate change in the countries of the Danube-Carpathian region

As for the international context of the countries in the focus of this study, the **United Nations Framework Convention on Climate Change (UNFCCC)** is the main treaty concerning climate change action on the international level. It considers what can be done to reduce global warming and to cope with unavoidable temperature increases. Parties that have also signed the **Kyoto Protocol** (a legally binding international agreement linked to the UNFCCC that commits industrialized countries to stabilize their greenhouse gas emissions) have to submit national communications on the status of implementation. The six countries in the focus of this study are all parties to the Kyoto Protocol (with the exception of Serbia, they are all Annex-I parties, meaning that they have to reduce their greenhouse gas emissions to a target level). Reports on activities related to adaptation to climate change are parts of the national communication documents, at the same time issues related to mitigation of climate change are emphasized much more in them. Although the vital importance of adaptation is acknowledged by the UNFCCC, it mainly focuses on least developed countries of the world in terms of provision of support in their adaptation efforts.

The **Convention on Biological Diversity (CBD)**, the international treaty that aims to sustain biodiversity of the planet, acknowledges the connections between climate change and biological diversity. It has been recognized by the CBD that by integrating climate change and biodiversity policies through the adoption of biodiversity-based adaptive and mitigative strategies the resilience of ecosystems can be enhanced at the same time with reducing the risk of damage to human and natural ecosystems. Through this approach dealing with climate change can be achieved by working with nature, not against it. All six countries in the focus of this study are parties to the CBD; therefore they have a commitment on the international level to adhere to this principle. The inter-linkages between biodiversity and climate change have also been recognized by European Environment Ministers in 2007 in the **Belgrade Statement on Biodiversity**, furthermore the need for an intersectoral approach to deal with climate change was also stressed, along with the need to put biodiversity on the top of the political agenda.

In order to avoid and reduce damage related to the negative impacts of climate change, countries in the Danube-Carpathian region should develop adaptation strategies and action plans. Precautionary policies and measures are important, as they contribute to adapting to climate change in an effective and cost-efficient way. Some adaptation measures even prove beneficial in the absence of climate change. According to the

European Commission's Green Paper on adaptation to climate change[6], anticipating potential damages and minimizing threats by taking early adaptation action will result in clear economic benefits and even contribute to gaining competitive advantage (European Commission, 2007). Furthermore, according to the **Stern Review** on the economics of climate change, in climate-sensitive sectors many adaptation options will provide benefits that exceed costs (Stern, 2006). Therefore, it makes sense to identify adaptation measures as early as possible and develop and implement strategies that incorporate them.

In the form of the European Commission's Green Paper in 2005, adaptation to climate change explicitly entered the EU policy agenda. The Green Paper on adaptation rests on four pillars of action. These include early action (integrating adaptation when implementing and modifying existing legislation), the integration of adaptation into EU external actions, expanding the knowledge base through integrated climate research, and involving European society, business and the public sector in the preparation of coordinated and comprehensive adaptation strategies. A **White Paper on adaptation to climate change** (a document containing an official set of proposals) is expected to be adopted in the autumn of 2008. At the moment, even though the need for adaptation has been recognized, an EU level overall adaptation strategy still needs to be developed, and the EU's role in climate change adaptation is yet to be defined. At the same time it has been recognized that the majority of adaptation action will have to be undertaken at the local, regional and national level, as the impacts of climate change will arise on the local and regional level. The principle of integration means that adaptation policy should be integrated with development and cohesion policies in the EU.

Policy development processes on the EU level are followed by implications in policy processes in the member states. Adoption of the White Paper on adaptation to climate change means it will become part of EU law that member states have to comply with and as a result they will develop their national strategies for adaptation. Some member sates have already created climate change strategies, and adaptation policy is not only being developed on the national, but the sub-national level as well (for example in the UK). Some countries in the Danube-Carpathian region have also already developed or are currently in the process of developing national climate change strategies and action plans (see ***Table 9***). Romania and Hungary have the most developed climate change policies, while there has already been indication that Slovakia and non-EU member state Serbia are ready to develop climate change strategies. An action plan on climate change also exists in Bulgaria. The non-EU member Ukraine should also follow suit by developing its strategy on climate change. The developed strategies should be supported by appropriate

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[6] "Green papers are documents that are published with the intention to launch a consultation process on the European level. White papers are documents containing proposals for Community action in a specific area. They sometimes follow a green paper. While green papers set out a range of ideas presented for public discussion and debate, white papers contain an official set of proposals in specific policy areas and are used as vehicles for their development." European Commission, http://europa.eu/documents/comm/index_en.htm

action plans that include the steps and actions, as well as the financial resources for implementation.

Table 11: Comparative table on existence and status of development of national climate change strategies and action plans related to adaptation to climate change

	Slovakia	Hungary	Serbia	Bulgaria	Romania	Ukraine
National Climate Change Strategy	no, but intention to develop it	yes (2008-2025)	no, but intention to develop it	yes (action plan 2005-2008)	yes (2005-2007)	No
Adaptation section included	-	yes	-	yes (only agriculture and forestry)	yes	-
Action plan for implementation	-	currently being developed	-	-	yes	-
Separate strategic document on adaptation	no, but intention to develop it	yes	no	no	yes, currently undergoing public consultation	No

As climate change is seen as a cross cutting issue, it is not sufficient to develop specific climate change strategies and action plans. Climate change considerations must also be integrated into sectoral policies, plans and projects. Providing sufficient funding for the implementation of climate change strategies and action plans is an important aspect to be taken into account.

Slovakia

In Slovakia, the Ministry of Environment has developed both the Strategy and Action Plan for Achieving Commitments under the Kyoto Protocol. However, these are primarily concerned with mitigation measures (FNCCC, 2005). No common strategy or action plan for adaptation measures has been developed. However, the Ministry of Environment intends to develop a strategic document on Climate Change Adaptation in cooperation with all stakeholders and especially with the Ministry of Agriculture.[7] Moreover, currently there are partial strategies and action plans that include climate change adaptation measures in the cases of water management, forestry, agriculture and public health. The adaptation strategies outlined in these sectors are generally formulated quite broadly.

[7] Personal communication with representative of the Ministry of Environment, Slovakia.

Hungary

Hungary in the last four year has made substantial steps in order to develop a comprehensive climate change policy. Adaptation to climate change has also received attention in these policy making processes. The **VAHAVA** scientific project that ran between the years 2003 and 2006 had adaptation to climate change as its primary focus. One result of the VAHAVA project has been the organization and mobilization of the Hungarian scientific community with regard to the issue of climate change, with experts being ready to assist the further development and implementation of strategies.

The Hungarian **National Climate Change Strategy** (NCCS) for the years 2008-2025 has been developed by the Hungarian Ministry of Environment and Water and has been accepted by both the government and Parliament (in February and March 2008, respectively). Several financial sources are available for implementing the measures of this strategy, however, more financial sources and more intensive integration with other sectoral strategies of the country would be necessary for these to be successful. At the same time, the acceptance of the NCCS by all political parties is a positive sign for the future. An action plan to implement the NCCS is currently under development.

Serbia

In Serbia the draft of the **National Sustainable Development Strategy** (NSDS, 2007) foresees several strategic documents on climate change: the **Strategy for Implementation of Clean Development Mechanisms** and the **National Strategy for Climate Protection** as well as a harmonization of the legislation with regard to climate change (related to greenhouse gas emissions) with that of the EU (NSDS, 2007). In addition, the NSDS envisages the introduction of practices in the sectors of energy generation, industry, transport, agriculture, forestry, and utilities-housing in line with the EU climate protection policy and international agreements. The future climate change strategy will deal with both mitigation and adaptation measures related to climate change.

Bulgaria

Bulgaria does not have a comprehensive climate change adaptation strategy. In 2000, the **Second National Action Plan on Climate Change 2005-2008** was approved. It recognizes the importance of climate issues and calls for their integration in sectoral policy-making in Bulgaria. However, it also vocalizes the limited financial resources in Bulgaria to address climate change issues. In large part, the Plan deals with impacts and mitigation measures, whereas adaptation is only slightly touched upon.

At the same time, issues related to climate change adaptation occur in other strategies. In 2006, a project for a **National Strategy for Sustainable Development in the Forestry Sector 2006-2015** was developed. The likely negative impacts on the forestry sector in Bulgaria due to climatic changes are acknowledged as a serious problem which the strategy addresses. The document identifies three key objectives for the forestry sector,

one of which aims to improve the sustainability and productivity of the forestry sector in order to ensure the adaptation to climatic change. The Strategy puts forward concrete measures towards this strategic objective.

An Inter-Ministerial Committee on Climate Change was set up in July 2000 in Bulgaria under a Governmental Decision to take the lead and coordinate the implementation of the First National Action Plan on Climate Change. The role of the body is very general and includes the coordination of various climate change activities and projects in the country. The representatives of the various Ministries do not hold a special status in relation to climate change issues nor do they have mandate to coordinate all sectoral policies with climate change objectives and targets. Thereby, as a consequence "a lot of the sectoral activities were undertaken and adopted without taking into account the NAPCC" (MEW n.d.).

Romania

The first **National Strategy on Climate Change** of Romania (NSCC) was approved by the Romanian Government in 2005. The NSCC represents the policy framework for Romania's climate change policies for the period between 2005 and 2007. The strategy should have been revised and updated in 2007.

The **National Action Plan on Climate Change** (NAPCC) is the main instrument for the implementation of the NSCC and establishes how the implementation progress is to be reported. The NAPCC assigns tasks and responsibilities for every stakeholder institution and identifies the main actors for each specific action and relevant task. The NAPCC provides clear deadlines for the actions that need to be implemented and identifies potential funding sources for specific actions.

The Romanian Ministry of Environment and Water Management has been the authority[8] in charge of coordinating the development, implementation and update of the NSCC and the NAPCC, but other ministries play important roles in the implementation of the NSCC (e.g. the Ministry of Economy and Commerce is responsible for coordinating the energy and industry policies). Other ministries playing significant roles in implementing the NSCC and NAPCC are represented in the NCCC (National Commission on Climate Change).

The NSCC also states that the capacity of the governmental institutions, together with that of the supporting research institutions involved in the implementation of the NSCC and NAPCC should be increased in several fields, among which "research and policy making in the field of vulnerability assessment and adaptation".

The **National Action Plan for Adaptation** (NAPA) is currently under elaboration in Romania and undergoing a form of public consultation. A version was made available to

[8] In May 2007, the Ministry of Environment and Water Management (MEWM) changed its name into Ministry of Environment and Sustainable Development (MESD).

the public and published on the website of the Ministry of Environment and Sustainable Development (MESD), on March 31, 2008.

The NAPA acknowledges the fact that the limitation and reduction of the emission of green-house gases will not be sufficient to avoid the phenomenon of climate change and, therefore, adaptation to changes in climate should represent a consistent part of the national policy on climate change. The NAPA employs a longer term perspective than the NSCC, generally until 2030, but sometimes going beyond. In contrast with the NSCC, the NAPA discusses the impacts not only in terms of human economic and social life, but also in terms of impact on nature (habitats and species). The NAPA argues for efforts at all levels (local, regional, national and international) and represents a document in which most of the ministries have made a contribution (each chapter was elaborated by the corresponding ministry).

Ukraine

In Ukraine a lot of national and regional actions and initiatives in the form of various programs, policies and laws, which are relevant to the reduction of detrimental impacts of global climate change are ongoing. However, there is no clearly established climate change adaptation policy for the Danube-Carpathian region.

Considering all potential environmental, social and economic risks that global climate change entails, it is deemed to be very important to develop a consistent and integrated climate change adaptation plan with well-defined measures to mitigate climate change impacts on human economy, society and ecosystems in the Danube-Carpathian region of Ukraine.

4.2 Intergovernmental cooperation efforts related to adaptation to climate change in the Danube-Carpathian region

Various agreements and cooperation efforts related to environmental policy exist between the countries located in the Danube-Carpathian region. The climate change policy and environmental policy in the region is also influenced by the policies and directives of the European Union, not only in member countries, but neighboring countries as well.

The European Union regards climate change as a serious hazard to its citizens. Its objective is to keep global average temperature increase below 2ºC compared to pre-industrial levels, as an increase beyond 2ºC is expected to lead to escalating impacts and costs of adaptation (European Commission, 2007). Therefore, the EU adopted its first policy document on adapting to the impacts of climate change **(Green Paper on Adaptation to Climate Change)** in June 2007. Currently, a consultation process is taking place in order to develop a **White Paper on Adaptation to Climate Change** (which will be an official set of policy proposals) to be adopted by the EU Commission in the autumn of 2008.

Other EU legislation and strategies that are connected to efforts to adapt to climate change in the Danube-Carpathian region include the **EU Water Framework Directive** (2000/60/EC) and the **EU Floods Directive** (2007/60/EC) through integrated river basin management and assessment and management of flood risks, the **Natura 2000 network**, and the **Birds Directive (**79/409/EEC) and **Habitats Directive (**92/43/EEC) through biodiversity conservation, and the **Common Agricultural Policy** through land use planning, as well as the **EU Sustainable Development Strategy**. The issue of **water scarcity and droughts** has also been addressed by the European Union. An initial set of policy options has been presented in a Communication from the Commission to the European Parliament and Council. These policy options included emphasizing the need to fully implement the Water Framework Directive, the need for effective water pricing policies, effective land-use planning and water saving measures (European Commission, 2007c).

No intergovernmental cooperation agreements exist that focus specifically on the impacts of or adaptation to climate change in the Danube-Carpathian region. At the same time, there are two main areas of intergovernmental cooperation related to environmental issues that can be connected to climate change adaptation. These are cooperation agreements related to **water management** and the **sustainable development of mountain areas**. Both issues are connected to climate change, as both rivers in the region and mountain areas will be impacted by climate change, and therefore, management and sustainable development of these areas must take climate change into consideration.

There are cooperation agreements between countries on water management issues an environmental protection in the Danube-Carpathian region. These include the **Danube River Protection Convention** implemented by the **International Commission for the Protection of the Danube River (ICPDR)**, the **Tisza River Basin Memorandum**, the **Tisza Water Forum**, the **Tisza Environmental Program** and **Tisza River Basin Sustainable Development Program**. At the same time the effectiveness of these agreements has been criticized as a result of few improvements in the environmental situation. The main reasons for this have been identified as lack of political commitment and coordination (REC, 2004).

International cooperation related to protecting water resources of the region was also demonstrated by signing the **Lower Danube Green Corridor (LDGC) Declaration** in June 2000. The signatory countries were Bulgaria, Romania, Moldova and Ukraine. The main aims of LDGC are to restore and protect floodplains and develop sustainable economic activities in these areas. These aims are in line with the requirements of adapting to climate change. At the same time no evaluation of the effectiveness of the LDGC has been found.

The **Framework Convention on the Protection and Sustainable Development of the Carpathians (CFC- Carpathian Framework Convention)** represents the only intergovernmental cooperation instrument focusing exclusively on the Carpathian region itself (UNEP, 2007). The objective of the CFC is to achieve sustainable development in

the Carpathians. It has seven signatory countries (the Czech Republic, Hungary, Poland, Romania, Serbia, Slovakia and Ukraine). The CFC could serve as a framework for cooperation and multi-sectoral policy coordination and would be as an ideal instrument to develop a united, comprehensive regional effort on adaptation to climate change in the Carpathians.

The initiative that aims to enhance South-East European regional cooperation in climate change policy is also an example of regional cooperation on adaptation to climate change within the Danube-Carpathian region. The cooperation was initiated in 2007 as a result of the South-East European Ministerial consultation process within the **UNECE Sixth Ministerial Conference "Environment for Europe"** held in Belgrade. The initiative focuses on specifically on adaptation to climate change and it is presented in the Conference document of category I, prepared by the Expert team of the Republic of Serbia and the Regional Environmental Centre for Central and Eastern Europe (REC). The Belgrade Initiative proposes two main activities, namely the development of a **SEE Climate Change Framework Action Plan** (SEE/CCFAP) in accordance with the principles and objectives of the UNFCCC, and establishment of a **Sub-regional Virtual Climate Change related Centre** in Belgrade, which plans to improve sub-regional cooperation and facilitate and coordinate implementation of the SEE/CCFAP (UNECE, 2007).

Although the above-mentioned intergovernmental cooperation efforts related to adaptation to climate change exist between the countries of the Danube-Carpathian region and the individual countries have environmental policies in place, an appropriate coordination of these policies at the regional level has been identified as still lacking (REC and EURAC, 2005, sited in UNEP, 2007). For example, contradictions between policies being currently implemented in the region and the goals of the CFC have been identified (REC and EURAC, 2005, sited in UNEP, 2007). The already existing intergovernmental cooperation efforts (indirectly or directly) related to adaptation to climate change can be viewed as a step in the right direction.

5 Conclusions and recommendations

There is now **overwhelming scientific evidence** that **climate change is a fact**, it is already happening, and poses **serious risks** that governments have to deal with (IPCC, 2007a; Stern, 2006; European Commission, 2007). Apart from **damaging natural systems**, climate change will also have serious **economic and social effects** through inhibiting growth and development.

In order to **reduce vulnerability** and deal with the impacts of climate change, the governments of the countries in the Danube-Carpathian region will have to make substantial adaptation efforts. These efforts will be costly in many cases, at the same time they contribute to the reduction of financial losses (through avoided damage costs, accrued benefits), and often provide net benefits. **Early action can contribute to the reduction of adaptation costs**, which are expected to rise sharply as temperatures increase (Stern, 2006).

The **Danube River Basin** as well mountainous areas have been identified as being **ecologically highly vulnerable** to climate change (SEG, 2007; UNEP, 2007). At the same time, as natural systems form the basis of human economy and society, economic production and populations of countries will also suffer from the negative effects of climate change in the region, unless sufficient preparatory action is taken. **Recent extreme weather events** and natural disasters have caused significant human, natural, economic and **financial losses**. The **heat wave** of 2003 is a good example of this. It caused about 35,000 deaths, and costs for European farming were estimated to reach €13.1 billion[9]. In the same year in Portugal as a result of **wild fires** more than 350,000 ha of land was burnt, 300,000 ha of which where forests and 44,000 ha agricultural land[10]. In 2002, insured losses related to **floods** on Eastern Europe's river systems amounted to between €15-20 million; at the same time economic loss was substantially higher than insured loss due to the fact that insurance penetration is generally low and/or limited in the affected countries (Austria, the Czech Republic and Germany)[11]. **Water scarcity and droughts** have also had widespread negative effects: in 2003 over 100 million people and a third of the EU territory were affected, the cost of the damage to the European economy was at least €8.7 billion[12]. These losses show that it is crucial that governments of the countries in the **Danube-Carpathian Region** take effective preparatory measures to **tackle** the challenges posed by **climate change**, and do this **in a way that works with nature, not against it**.

[9] Sources: http://www.metoffice.gov.uk/education/secondary/students/european_heatwave/index.html and Stern (2006)
[10] Source: http://www.euractiv.com/en/science/fire-damage-commission-proposes-316-euro-emergency-measures/article-116495
[11] Source: http://www.insurancejournal.com/magazines/southcentral/2002/09/16/features/23361.htm
[12] Source: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0414:FIN:EN:PDF

Countries that have already developed **strategies for climate change** and included adaptation aspects in them (Hungary, Bulgaria and Romania) should focus on implementation of these strategies, while the ones that still do not have climate change strategies should develop them (Slovakia, Ukraine, Serbia). Apart from the development of comprehensive climate change strategies, **vulnerabilities in individual sectors** (agriculture, forestry, tourism, water management, etc.) should also be assessed, adaptation measures identified, early warning systems put in place and relevant funds for adaptation made available. As it has been recognized by the international **Convention on Biological Diversity**, **nature protection and climate change action can mutually reinforce each other** (by adopting biodiversity-based adaptive and mitigative strategies the resilience of ecosystems can be enhanced at the same time with reducing the risk of damage to human and natural ecosystems). Therefore adaptation to climate change must take place on the national and sub-national levels as well by working with nature, not against it. On the EU level the implementation of existing directives that contribute to adaptation to climate change (for example of the **EU Water Framework Directive**) should be enforced.

There is a need to intensify **international cooperation** between countries in the region in the field of policy making and strategic planning, with focus on adaptation to climate change, river basin management and protection of mountain areas. The **CFC (Carpathian Framework Convention)** could serve as a framework for cooperation, and multi-sectoral policy coordination could be an ideal instrument to develop a united, comprehensive regional effort on adaptation to climate change in the Carpathians. The **Danube River Protection Convention** and the work of the **International Commission for the Protection of the Danube River (ICPDR)** can and already are serving as vehicles of cooperation in the field of water management in the area. Strengthening these already existing institutions for cooperation can contribute to adaptation to climate change in the Danube-Carpathian region.

In the following section selected recommendations will be provided on how this can be done through adaptation measures in the areas and sectors that this study touched upon. At the same time in order to successfully address adaptation needs main **principles** can be identified that **must be applied in all areas**. Adaptation must be achieved by **forward-looking policies** that take into account expected likely impacts of climate change. Other principles include **long-term planning**, **supporting scientific research** to increase understanding of climate change impacts and adaptation needs, **policy integration and implementation**, capacity building and **awareness raising**, and **enhancing existing institutional mechanisms**. **Early warning systems** and **contingency planning** must be developed and improved. Keeping these principles in mind when designing policies, making decision and operating institutions in the relevant sectors will contribute to successfully meeting the challenge posed by climate change at the least possible cost, in some cases even at possible net benefit. In the last section recommendations will be provided for WWF on how it can contribute to effective adaptation to climate change in the Danube-Carpathian region by working with nature, not against it.

5.1 Recommendations for governments in the region

General principles:

Invest in the future, not the past
Very significant investments are being made in the Danube-Carpathian region, from private homes and office buildings to transportation and energy infrastructure. It is essential that these investments are made in the future rather than the past – that they fully take into account the current and anticipated future effects of climate change in the region. Construction of new homes and office buildings, for example, should not only mitigate climate change by incorporating low-energy technology in order to minimise the need for energy and production of CO_2; they should also be built to withstand heat waves and more severe weather events. Ski facilities constructed at lower altitudes (below 1,500 m a.s.l.) may have a very short life span as winters warm and snowfall is reduced.

Work with nature, not against it
Securing and strengthening the resilience of ecosystems, e.g. through protection and restoration, not only is an efficient and effective measure for addressing specific climate change impacts, but usually yield a multiplicity of additional benefits and services. Restoring river floodplains, for example, can contribute to flood protection while also enhancing fish and waterfowl, tourism and recreation. Protecting and restoring forest habitats not only has a cooling effect for local microclimates and can help maintain water cycles, but also can provide wood resources, biodiversity, tourism and recreation.

Freshwater habitats and species

Secure existing freshwater habitats and species
Ensure the protection of existing freshwater habitats and species through protection and sustainable management, e.g. through effective implementation of the EU Natura 2000 network of specially protected sites as well as national and international measures.

Ensure ecological networks
Secure ecological networks that make it possible for species and habitats to migrate as climate conditions change, through protection and sustainable management as well as restoration of selected areas. On the Danube, for example, restore passage for fish and other species across existing dams and other barriers.

Restore floodplains
Restoration of flood plains contributes to minimizing flood risk related costs, while at the same time contributing to biodiversity conservation. They also allow groundwater aquifers to recharge and natural water purification processes to function Therefore

restoration of floodplains is a good example of working with nature, not against it, while adapting to climate change.

International cooperation in river basin management
Intensify international cooperation with countries in the Danube-Carpathian region in the field of policy making and strategic planning to increase spatial and temporal scale of planning to enable adaptation to climate change, with focus on river basin management and protection of mountain regions. Regional watershed planning and integrated drought and flood watch systems are examples of such cooperation.

Forest and grassland habitats and species

Secure existing forest habitats
Ensure the protection of existing forest habitats through protection and sustainable management, e.g. through effective implementation of the EU Natura 2000 network of specially protected sites as well as national and international measures, FSC certification for sustainable forest management, etc.

Ensure ecological networks
Secure ecological networks that make it possible for species and habitats to migrate as climate conditions change, through protection and sustainable management as well as restoration of selected areas. In the Carpathians, for example, ensure that new motorways and other infrastructure do not obstruct migration paths for bears and other animals by optimizing design and e.g. installing ecoducts, tunnels, etc.

Restore forest and grassland habitats
Restore degraded forest and grassland areas, especially where these can contribute to maintaining habitats and species, e.g. as part of an ecological network.

Improve monitoring and management
Monitor climate induced changes in biodiversity and improve management of protected areas.

Further scientific research to forecast forest conditions
More detailed scientific research will be required in the areas including innovative methods to monitor and forecast forest conditions, and to provide information support to the decision-making process for forestry. Also a sound methodology to protect forests against pests and diseases should be developed, at the same time possibilities for selection and introduction of new tree species should be evaluated.

Freshwater resources

Integrated program on sustainable water resource management
The issue of climate change and relevant adaptation plans should be integrated in regional programs of sustainable development. Sustainable water resource management considering the impacts of climate change on freshwater resources should be addressed at all levels of government and in all countries in the region. A relevant integrated program with specific climate change adaptation measures should be developed and implemented, including e.g. water stewardship measures for industry, agriculture and households.

Integrated international programs on catastrophic events in the waters of the Danube-Carpathian Basin
In order to mitigate trans-boundary impacts caused by floods and catastrophic water pollution, relevant integrated international programs should be developed between the countries in the Danube-Carpathian region. The international program on flood mitigation for Tisza River may be taken as an example. Preventative measures on flood management should dominate above those that deal with the overcoming of flood consequences. Sufficient funds should be allocated from state budgets to mitigate flood impacts.

Vulnerability assessment of water resources
Vulnerability of water resources to climate change should be thoroughly assessed. This will determine the extent of potential climate-induced water stress, putting emphasis on drinking water quantity and quality, and the recharge of aquifers.

Agricultural production

Enhanced research on optimal crop profiles in changed irrigation regimes
Changed irrigation regimes (both induced by flood and drought events) will have direct impact on crops adaptation and consequently on crop yields. That is why more research will be needed to identify optimal crop profiles for farm areas in the region. Also more detailed studies are required to define agricultural crops that will be more resistant in changing climate conditions.

Measures related to awareness raising and education
Activities on raising public awareness in the region regards to climate change and its impacts on agricultural production should be carried out. Educational programs for experts in agriculture, and particularly agronomists, specialists on plants protection, agronomist-chemists, and veterinary surgeons should be amended. This can contribute to vulnerability reduction in the agricultural sector.

Improved irrigation systems
Improving irrigation systems and introduction of policy measures that ensure rational use of water in agricultural practices will help deal with the future water scarcity expected as a result of climate change. Governments should prepare for the initiation of programs to

support agricultural producers in developing irrigation systems for crops (for example wheat) that under usual climate conditions did not require irrigation, but as water scarcity is expected decrease, will need to be irrigated.

Forest production

Vulnerability reduction of forests
Assess potential vulnerability of forest stands to climate change and develop measures for strengthening their resilience to higher temperatures and wildfires (by replacement of highly flammable species, regulation of age-class distributions), change the species composition and stabilize the soil, improve forest conservation. Increase the implemenation of fire protection measures.

Tourism

Promotion of sustainable tourism
It is essential to develop national tourism strategies in a way that not only economic development, but also nature protection considerations are taken into account, for example through adopting the concept of sustainable tourism (such as eco-tourism or small scale tourism).

Integration of climate change considerations into national tourism strategies
Climate change related considerations must be taken into account when national tourism strategies are adopted, both in terms of mitigation of climate change and adaptation to it. Existing tourism strategies should be revised taking into account climate change scenarios, temperature and precipitation forecasts (in mountainous regions, snowfall in particular). Due to significant risks linked to potential economic losses from project failures, cost benefit analysis for large investment projects such as mountain ski resort construction should be conducted. It should include a detailed risk assessment, and specifically account for economic risks arising from potential climate change consequences (e.g. absence of snow, natural disasters etc.).

Cooperation in nature friendly tourism development in the Danube-Carpathian region
Since tourism is a common activity for all countries in the Danube-Carpathian region, and since in many cases it entails international aspects, it is deemed to be important to create a single Tourism Development Strategy for the region as a whole. Such a strategy should come as an integrated document developed on behalf of all interested parties and should address the issue of climate change, its potential impacts on tourist activities and possibilities for reduction of negative impacts of tourism in the Danube-Carpathian region.

5.2 Recommendations for WWF

- WWF should raise awareness about the dangers of climate change and the importance of adaptation to it on all levels of government. In international and national level discourse, adaptation to climate change often plays a secondary role to mitigation. On the local level, especially where increased frequency of extreme weather events and resulting damages have already occurred, the importance of adaptation is more acknowledged. Therefore, WWF should work on **raising awareness among decision makers on various levels of government of the need for adaptation to climate change** and the **importance of precautionary action** to avoid later occurring much higher damages and costs, in this way contributing to save limited resources.
- **Facilitate international cooperation** among the countries in the Danube-Carpathian region regarding **strategic planning**, **river basin management** and **protection of mountain areas**, **with a focus on working with nature not against it**. In this way while protecting nature, resilience in the region as a whole can be enhanced and adaptive response capacity can be increased by organized international efforts.
- In countries where climate change strategies and action planes are currently being developed, **participate in the strategy development process** with a focus on developing climate change policy measures that do not harm the environment and are **in line with principles of nature protection**. In countries where climate change strategies and action plans have already been adopted, WWF should follow the implementation of these policies and point out if contradictions arise with nature protection considerations, as well as lobby for changing the problematic measures.
- WWF should push for **decision makers to adopt a long-term view** in all sectors and for **impact assessments** as well as economic and social cost-benefit analysis to be made that take into account the likely consequences of climate change. This is especially important in case of large scale investments (such as development of new skiing facilities and infrastructure) that harm nature and often have irreversible consequences, but at the same time are not likely to result in the expected economic effects due of climate change impacts not accounted for.
- Since resources of governments are limited and climate change is a new policy issue, it is important for it to be integrated with other sectoral policies. Therefore, WWF should raise awareness of the need for **mainstreaming adaptation and mitigation considerations** into sectoral policies and sustainable development policy. WWF should also point out possible **trade-offs** and identify **synergies** (primarily in land and water management) between mitigation and adaptation policies, in this way also contributing to saving limited resources.

- Raise awareness among decision makers regarding **synergies between nature protection and agricultural policy**, in this way also contributing to increasing resilience to climate change, working with nature, not against it. For example in EU member states it is possible to use funds for nature protection for small-scale agricultural producers. At the same time, agricultural producers are often not aware of this and even feel threatened by strengthened nature protection measures. Therefore, WWF should raise awareness among policy makers regarding the need to inform agricultural producers of EU funds for nature protection that can also be utilized for nature friendly agricultural production.

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Interviews have been carried out with the following experts:

Dr. Zoltán SOMOGYI – Hungarian Forest Research Institute
Dr. János MIKA – Hungarian Meteorological Service
Dr. Otto VEISZ – Agricultural Research Institute of the Hungarian Academy of Sciences
Dr. János ZLINSZKY – Pázmány Péter University, Department of Environmental Law; Advisor to the Parliamentary Commissioner for Future Generations, Hungary
Prof. RNDr. Milan LAPIN, CSc – Faculty of Mathematics, Physics and Informatics, Comenius University
RNDr. Pavol NEJEDLÍK, CSc. - Slovak Hydrometeorological Institute, The National Climate Programme
Ing. Helena PRINCOVÁ, CSc. – Ministry of Environment of Slovak Republic
Ing. Janka SZEMESOVA, PhD - Slovak Hydrometeorological Institute
Prof. Ing. Ján SZOLGAY, PhD - Slovak Technical University
RNDr Pavla PEKÁROVÁ, CSc – Slovak Academy of Science

Glossary

(Source: IPCC Fourth Assessment Report, Appendix, Annex II)

Adaptation – Initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects. Various types of adaptation exist, e.g. anticipatory and reactive, private and public, and autonomous and planned. Examples are raising river or coastal dikes, the substitution of more temperature-shock resistant plants for sensitive ones, etc.

Impacts of climate change - The effects of climate change on natural and human systems. Depending on the consideration of adaptation one can distinguish between potential impacts and residual impacts:

- Potential impacts: all impacts that may occur given a projected change in climate, without considering adaptation.
- Residual impacts: the impacts of climate change that would occur after adaptation.

Mitigation – Technological change and substitution that reduce resource inputs and emissions per unit of output. Although several social, economic and technological policies would produce and emission reduction, with respect to climate change mitigation means implementing policies to reduce greenhouse gas emissions and enhance sinks.

Vulnerability – Vulnerability is the degree to which a system is susceptible to, and unable to cope with adverse effects of climate change, including climate variability and extremes. Vulnerability is the function of the character, magnitude, and rate of climate change and variation to which is a system is exposed, its sensitivity, and its adaptive capacity.

Annex A – Impacts of climate change on tourism and tourism related adaptation responses in the six countries of the Danube-Carpathian region

The following section presents an overview of expected impacts of climate change on the tourism industry in selected countries located of the Danube-Carpathian region (Slovakia, Hungary, Serbia, Bulgaria, Romania, Ukraine). A review of existing efforts to integrate these impacts into country strategies will also be provided.

Slovakia

Mountain tourism plays an important role in the Slovak economy. However, winter sports and winter tourism are expected to be the segments of the Slovak tourism industry expected to be most affected by climate change.

According to the **New Strategy on Tourism Development in Slovak Republic until 2013** (Slovak mid-term strategic document on tourism development), winter sports and winter tourism continue to be one of the five key segments of tourism in Slovakia. Moreover, this segment is perceived to be a competitive advantage of Slovakia when compared to the tourist potential of the neighboring countries. Thus, the Strategy envisages 'effective and intensive' development of skiing activities, especially in the north and east of the country. Enhancement, renewal and reconstruction of old winter sport facilities will be preferred to the construction of new ones. The strategy also acknowledges that demand for artificial snow production will increase in the winter sport centers in order to secure smooth services in the future. The Ministry of Environment has identified the negative cumulative effects of artificial snow production, especially in the area of increased water demand and changes of the water cycles in respective regions. However, these effects can be defined only in a general way, as the Strategy does not identify concrete regions or investment projects for winter tourism. Each future investment project will have to be monitored and subjected to Environmental Impact Assessment. The Strategy plans to consolidate the tourist industry, which may be beneficial for the eventual future climate change adaptation strategies.

Issues related to adaptation to climate change are not stated explicitly in **New Strategy on Tourism Development in Slovak Republic until 2013**. However, the general goal of the Strategy is to manage the sustainable development of tourism in its economic, social and environmental dimension, which may be understood as an implicit claim regarding adaptive strategies in the tourism industry.

Hungary

Hungary is a landlocked and relatively flat country. The **Hungarian National Tourism Development Strategy for the years 2005-2013** distinguishes Budapest, the capital city and Lake Balaton as the first two priority tourist attractions in the country. Further important tourist attractions include the two other large natural lakes (Velencei-tó, Fertő-tó) besides Lake Balaton, and the flatlands in the Eastern part of the country. Hungary is rich in close to surface level thermal water stock. Therefore, attracting tourists to thermal baths is an important goal of tourism policy and the building of new thermal baths is widespread throughout the country.

Climate change is going to affect the Hungarian tourism sector in both positive and negative ways. As climate change across the world is expected to impact seaside tourism and mountain tourism the most, Hungary as a landlocked, relatively flat county will not have to deal with these negative impacts. The positive effects of climate change in terms of tourism will include the decreasing number of rainy and cloudy days. Warmer weather throughout the year and warmer winters will contribute to the lengthening and flattening of the tourist season. At the same time, negative effects will include the deterioration of water quality of natural lakes. As such lakes – especially Lake Balaton – are among the country's main tourist attractions, alternative and complementary forms of tourism must be developed to help relieve the lakes from the combined negative impacts of tourism and climate change. Sustainable tourism activities such as village tourism, tours of natural parks and cultural heritage sites need to be developed in an integrated way. Deteriorating water quality as a result of climate change will not only affect natural lakes, but also aqua parks and bath resorts.

As Hungary does not have high mountains, winter tourism and skiing do not play an important role; therefore, warmer winters will not cause serious harm to the Hungarian tourism sector. At the same time, substantial adaptation efforts are needed to keep the attractiveness of the country when heat waves and hotter summers occur.

Impacts of and adaptation to climate change are not explicitly addressed in the **Hungarian National Tourism Development Strategy for the years 2005-2013**. However, both the **VAHAVA** report on climate change and the **Hungarian National Climate Change Strategy** address climate change impacts on the tourism sector. The adaptation measures proposed in these documents are yet to be integrated into the strategic documents specifically dealing with tourism.

Serbia

In Serbia, mountain tourism plays a significant role in the tourism sector, constituting about one-fifth of tourist visits and the total number of tourist overnight stays. The recently developed strategic documents for the planning of tourism development in Serbia suggest the building of new skiing centers. The priority areas for tourism development were set in the **Tourism Strategy of Republic of Serbia** (published in

2006), with skiing centers high on the agenda (MERR, 2006). After that strategy, a **Plan for tourism development on Stara Planina with pre-investment study and technical characteristics of skiing center** was developed (MERR, 2007). In the latter document it is stated that 15-20 years from now, Serbia will generate a demand for 3 million skiing days per year. This means that the current market is only 15% of that potential, and that the vision of tourism development in Serbia includes building more of these capacities. On the other hand, there is a growing concern that such developments might seriously endanger nature reserves, such as the **Stara Planina Nature Reserve**.[13]

Bulgaria

The tourism industry is rapidly developing in Bulgaria, especially along the Black Sea coast and in mountain areas. The analysis of the **National Strategy for Sustainable Development of Tourism 2008-2013** explores the various types of tourism, their potential and threats to development. As a major problem for sea tourism development is identified the sliding of coastal sands and erosion processes combined with massive illegal construction at vulnerable sites along the coast line. Importantly, the Strategy highlights that climatic changes are one of the major threats to the tourism development in Bulgaria and points at the ski tourism type as the most vulnerable in relation to the climatic changes. This, in addition to the massive construction at the coast line and mountain regions puts significant pressure on vulnerable ecosystems. Thereby, the Strategy suggests that "alternative" forms of tourism such as ecotourism, cultural tourism, spa tourism, conference and events tourism, etc. shall be promoted. Furthermore, the Strategy has embraced the 12 principles of sustainable tourism development, which include preservation of natural sites, local habitats and the wildlife, effective utilization of natural resources in terms of growing mass construction and environmental protection. The incorporation of these principles is favourable also in terms of dealing with the impacts of climate change.

Some of the concrete measures to achieve the goals of the Bulgarian strategy on tourism include limiting the massive and illegal construction for tourism purposes in mountain areas as well as numerous ambitious measures for the promotion of alternative forms of tourism. The Strategy also prioritizes balanced territorial development patterns, which can be accommodated in the development of the so called **"Detailed territorial plans of vulnerable territories"**, such as those along the coastline and in the mountains.

[13]More information is available on the development of this project : http://www.savestaraplanina.info/eng/index.php?option=com_content&task=view&id=20&Itemid=1

Romania

In Romania, the most vulnerable areas to climate change in terms of tourism are the coastal areas and the mountain regions. Climate change is expected to cause coastal erosion and a rise in the level of the Black Sea. In the mountain areas, the winter sports resorts are most affected by climate change. Temperature rise will determine a shortening of the winter season, which will lead to diminished opportunities to practice recreational and sportive activities. As a consequence, there will be increased pressure on the areas situated at a higher altitude. Simultaneously, the summer season will face higher demand, with negative effects on the environment, and not enough capacity to deal with the increased demand in some resorts.

The **Romanian National Action Plan for Adaptation to Climate Change**[14] proposes several measures to decrease the negative impacts of climate change on mountain tourism. These include the endowment of resorts with machines generating artificial snow; the development of mountain resorts at higher altitudes (e.g. Balea Lac); the development of supplementary tourist attractions in the mountain resorts, as alternatives to winter sports (e.g. covered skating rings); the diversification of the form of tourism practiced in the mountain resorts, directed towards different market sectors (e.g. business tourism, wellness tourism); the extension of the summer season and special offers for the persons that can have holidays in the down season (for example pensioners).

In Romania, the most famous destinations for winter sports are those located in the Prahova Valley (Sinaia, Predeal, Azuga, Busteni) and Poiana Brasov. The decrease in snowfall has been felt in all these resorts and tour operators have recorded diminishing tourist numbers. In some resorts, winter sports do not represent the main and/or only form of tourism. Sinaia, Poiana Brasov or Predeal have facilities for conferences and business meetings, which determines an important share for business tourism among other forms (both as revenue and number of tourists). Other mountain resorts (Arieseni, Borsa, Stana de Vale, Valiug, Lupeni, Cavnic, Baia Sprie etc.), which do not have other facilities for activities to supplement skiing during the cold season, will suffer more from climate change.

Ukraine

Tourism is among the prioritized activities in the economic development of the Ukrainian Carpathians. The region has significant recreational potential, which is not being fully realized. One of the major problems in the development of tourism is the absence of an appropriate spatial planning of settlements. Often the construction works are justified only by the attractiveness of the facilities for tourists. For example, the creation of the mountain ski resort Dragobrat in Zakarpattya region takes place without any

[14] A version of the National Action Plan for Adaptation of Romania has been provided for public consultation on 31st March 2008 and at the time of writing this report is undergoing public consultation process.

consideration of sanitary and environmental norms, which leads to soil erosion, pollution and the deforestation of nearby ecosystems (Budyakova, 2005).

Such situations are rather typical for other mountain ski resorts in the Ukrainian Carpathians, as well. The tourism sector of the region also faces a number of financial, infrastructural, institutional, information and other barriers that need to be solved. The possibility of the development of sustainable tourism in the region has been addressed in studies by Ukrainian scientific research institutions supported by the technical assistance of international organizations (Budyakova, 2005). Impacts of climate change will pose further problems for the development of the tourism sector in the region, therefore adaptation measures will need to be integrated into relevant strategies and will need to be properly implemented, as well.