

# 1 Assessing risks and vulnerabilities to climate change

## 1.1 Analysis of past weather events

The South East European (SEE) region is highly vulnerable to floods, landslides, droughts, forest fires, extreme temperatures, windstorms, earthquakes and technology related hazards. On average, climate related disasters account for the major share of total disaster events in SEE countries (about 70 %). The available economic loss data show the SEE countries' economic vulnerability, particularly to climate related hazards. It was found that the total annual economic losses from hydrometeorological hazards and unfavourable weather/climate conditions (floods, droughts, hail, frost, heavy rain, snow, strong winds, extreme low temperatures, etc.) in the SEE countries are about 200 million USD on average (Table 1).

Table 1. The average annual incidence of major perils and vulnerability of SEE countries.

Country (period taken for the average)	Annual average incidence of major perils					Annual average number of deaths due to perils	Annual average economic loss due to all perils (million USD)	Economic loss in comparison to GDP in SEE countries
	Drought	Earthquake	Flood related	Wind storm	Technology related			
Albania (1974-2006)	0.12	0.09	0.24	0.06	0.06	7.82	68.67	2.49
Bosnia and Herzegovina (1989-2006)	0.17	NA	0.28	0.11	0.17	3.72	22.94	0.96
Macedonia (1974-2006)	0.17	NA	0.22	NA	0.11	13.39	24.59	
Serbia and Montenegro* (1989-2006)	0.17	0.06	0.50	0.06	0.56	10.00	82.0	1.66

\*Available combined data for Serbia and Montenegro are presented here to understand the risk in the region.

NA – data not available on the website

Different economic sectors in Serbia show various levels of vulnerability to natural disaster and extreme hydrometeorological events. One of the most vulnerable sectors is agriculture, followed by energy, water management and air traffic. The share of sectors that depend on weather conditions in the gross national product of Serbia is considerably substantial and amounted to 47.18 % in the year of 2005. An overview of the loss estimates by sector caused by natural disasters is presented in Table 2.

Table 2. Loss estimates by sectors caused by natural disasters

Sector/ Dangerous or extreme hydrometeorological events	Damage assessment by sector	
	Average annual economic loss in millions of RSD	Average annual loss in human lives
Agriculture/ floods	3.100 - 8.500	several to tens
Water management/ floods	approx. 1.960	-
Agriculture/ hail, heavy precipitation, strong winds	approx. 7316	several to tens from thunder stroke
Agriculture/ drought, frost	approx. 40.000	no losses
Energy production (heating energy)/ extremely low air temperatures	approx. 716	several to tens
Road maintenance/ snowfall, ice, freezing	approx. 3.500	-
Human losses on highways, regional and local roads caused by bad weather conditions vary annually from 105 to 131		
Commercial air transport	54 - 72	-
TOTAL	16.648 - 48.572	several to 160

Droughts also represent a major risk to many economic sectors. Forest fires, as a drought consequence, represent a significant threat factor in Serbia and cause enormous damage. It is estimated that the total damage caused by fires in public forest estates in the period from 2000-2009 exceeded 36 billion dinars (Table 3).

Table 3. Damage caused by fires in public forest estates in the period of 2000-2009

Activity	RSD
Firefighting costs	44.498.395
Damage caused by fire	34.199.158.808
The costs of remediation, breeding and protection of forests	2.211.105.203
TOTAL	36.454.762.406

## **1.2 Climate change risks and vulnerability assessment**

Climate change poses a real and growing problem for south-eastern Europe. In this region, already vulnerable to climate variability and climate extremes, climate change are projected (IPCCAR4) to worsen the conditions. In particular, climate change may enhance the existing problems of desertification, water scarcity and food production, while at the same time introducing new threats to human health, ecosystems and national economies of the countries.

The potential effects of climate change are very diverse and are likely to alter the basic necessities of life, such as food, water, health, land usage and the environment, and will be more damaging with increased warming and significantly decreased precipitation. As the United Nations Framework Convention on Climate Change (UNFCCC) indicated, "countries in arid and semi-arid areas or areas liable to floods, drought and desertification are particularly vulnerable to the adverse effects of climate change". As the consequence of the projected regional climate change, the frequency and severity of droughts could increase across the region. The analysis showed that several months of summer drought every year is to be expected in most SEE countries. In some parts, droughts could occasionally persist throughout the year. Hotter and drier conditions would extend the areas prone to desertification to encompass areas not currently at risk. In addition, the rate of desertification would increase due to increases in erosion, salinization, fire hazard and reductions in soil quality. The IPCC project revealed that rainfall is expected to decline throughout the year in southern Europe, particularly in the summer but, paradoxically, intense events of rainfall are expected to increase in the region. River flood hazards, especially flash floods, across much of south-eastern Europe will increase even further, endangering settlements, infrastructures and waterways.

Climate change will affect many sectors, including water resources, agriculture and food security, forestry, ecosystems and biodiversity, human health, coastal zones, energy and tourism, infrastructure. Many environmental and developmental problems in the SEE region will be exacerbated by climate change.

- Water resources

It is likely that the first impacts of climate change will be felt in the water resource systems of SEE. Reductions in water availability would hit SEE countries the hardest. The overall water availability in the SEE countries for the 2070s is expected to be reduced by –10 to –50 %.

The SEE region could suffer increasingly frequent regional water shortages due to the twin problems of reduced water resources in terms of their quantity and quality and rising demand. Economic activities depending on water availability, such as agriculture, tourism, industry and energy, will be particularly adversely affected, since increased climate variability will threaten,

among other things, infrastructure, waterways, hydropower, crop yields and timber harvests as well as recreational areas.

- Agriculture and food security

Agricultural production is very climate-sensitive. The increased intensity and frequency of storms, drought and flooding, altered hydrological cycles and precipitation variance have implications for future food availability due to their physiological effects on crops, pastures, forests and livestock (quantity, quality). A 2 °C global temperature rise could lead to a 20 % reduction in water availability for crop yields in southern Europe. Extreme weather events, such as spells of high temperature, heavy storms or droughts, can severely disrupt crop production. As far as live-stock is concerned, the impact of climate change is twofold: direct through alteration of the physiology of farm animals and indirect through changes in the food supply. Thus, the projected increases in temperature and precipitation variability across south-eastern Europe may have severe impacts on agricultural production in the region.

- Forestry

A temperature increase combined with a precipitation decrease during the summer boosts the risk of fires, which represents a major concern in the SEE region. In summer, high temperatures, low air humidity and fuel moisture represent favourable conditions for forest fires. The changing climate conditions could thus affect the frequency and magnitude of forest fires. In addition, extreme climate events, such as spring temperature backlashes and summer drought, are expected to increase in frequency and duration. These impacts might negatively precondition trees to other challenges, such as new pests and diseases. Insect and fungal attacks could also be enhanced by climate change.

- Energy

In all SEE countries that are heavily dependent on hydropower for the supply of energy and electricity, a decrease in precipitation and hence in river flow and runoff will provide further challenges to already stress national and regional energy security. In the SEE region, the hydropower potential is expected to decline by –34 to –40 % on average by the 2070s.

### **1.3 Climate change impacts on water resources (Serbia)**

The total multi-annual average quantity of available waters on the territory of Serbia is 5648.34 m<sup>3</sup>/s or 178–125.4 million m<sup>3</sup>/year. Of the total available waters, 184 mm/year (16234.3 million m<sup>3</sup>/year) originates in the state territory. The remaining 1832 mm/year (161–891.1 million m<sup>3</sup>/year) are transit waters, flowing through Serbia via the Danube, the Sava, the Tisa and other waterways. From the territory of Serbia, the waters gravitate towards the Black Sea (the rivers of the Danube basin), the Adriatic Sea (the Drim and the Plavska Rivers) and towards the Aegean Sea (the Pcinja, the Dragovistica and the Lepenac Rivers). Southern, south-western and western parts of the country are richer in water than the northern, central and eastern regions. As mountainous areas receive more precipitation, there are specific runoffs above 15 litres per second/km<sup>2</sup> from these areas. In the lowlands and highlands, in the north and central parts, the specific runoff is below 6 litres per second/km<sup>2</sup>. The basins of the Rivers Bistrica, Gradac, Lopatnica and Studenica have the most abundant runoffs in Serbia, ranging from 15 to 17 litres per second/km<sup>2</sup>. Vojvodina has the lowest water abundance in the basins of the left tributaries to the Great Morava and the Kolubara Rivers (from 2 to 5 litres per second/km<sup>2</sup>).

A preliminary assessment of climate change effects on the water resources indicate that a decrease of water flow on the national level, is to be expected in the forthcoming period (up to 2100). The results of numerical models indicate that the average annual discharge in Serbia will drop by 12.5 % until 2020 and by 19 % until 2100. Since these assessments are preliminary, need for further research on the impacts of climate change on the water resources is necessary, as is the adoption of a detailed programme of adaptation measures.

All studies and analyses on the climate change impact are summarized in Second National Communication and will be available during 2015. This document examines the public possibilities for how to respond to the growing pressures in relation to this natural resource, i.e. to predict certain “limits” (for the next 100 years) of country’s water management, further to check on available water resources and ways of their exploitation and to provide specific guidelines for a rational “closure” of the water balance, all under the circumstances of possible climate change effects.

According to the newest hydrological and climate model results, we will face with the reduction of water resources in this region as result of an increase of average temperatures and decrease of precipitation quantity. This is especially related to the summer months, when a substantial reduction of available water resources could be expected. A higher water demand in the whole Danube River Basin could have significant consequences of available water resources in Serbia, bearing in mind that of all available water resources in the territory of Serbia over 90 % comes from the upriver territories.

In the field of water defence, there are no explicit trends, but a substantial number of studies predict an increase in intensity and frequency of flooding, particularly in the winter season. On the other side, there are studies that do not foresee such a trend, so that a low level of reliability must also be taken into account when it comes to projection of adaptive measures. In addition, certain studies indicate a potential increase in frequency of torrent floods in smaller basins, but the reliability of these predictions is also quite low, primarily because of the shift from global models to regional ones and the accuracy of this process when smaller basins are concerned.

The projected increase of water demands due to climate change, as well as decrease in precipitation amounts resulting in lower runoffs in rivers, will lead, especially in the summer, in low flow periods, to a higher pressure on surface waters in regard to their quality. These pressures are most significant for water bodies which are then, because of natural characteristics, extremely poor in water in the low flow periods, mainly in the summer. This is mainly valid for rivers in the south of Serbia (South Morava Basin), but also rivers in some other parts of Serbia (Central Serbia – Sumadija, eastern Serbia, etc.).

#### **1.4 Climate change impacts on agriculture (Serbia)**

Agriculture is a very important economic sector in Serbia. Agricultural production made up 9 % of the total gross national income in 2011. This is a very high percentage in comparison to the 27 EU countries, where the percentage of agricultural production lies below 3 % of the gross national product. Since the crisis period in the early 1990s, when agricultural production suddenly dropped, this sector has recovered gradually. In 2000, the income from agriculture increased to 21.9 % of the GDP. After this period, the share of agriculture in the GDP has fallen again, but more as a result of the development of other sectors than because of a decline in agricultural production itself. Projections about the agricultural development are that the share of agriculture will continue to drop and that by 2020 it will fall under 8 %. Agricultural products make up a substantial component of exports with more than 20 %. Apart from this, the number of persons employed in this sector amounts to 21 %. In some regions in Serbia, agriculture represents the core activity and a large number of households depend on it.

The natural potential for the development of agricultural production is extraordinarily large. Climatic conditions are favourable; there is a good quality of soil which mostly has not yet been notably polluted. Serbia also owns considerable water resources that could be used for the development of agricultural production. More than half of the country's territory is agricultural land (4867000 ha), which explains such a high share of agriculture in the overall production and positively defines Serbia as an agrarian country. In addition, Serbia has a long tradition of agricultural production, which indisputably represents an important capacity.

Agriculture is by nature highly dependent on climate change. Different technological solutions are being developed and implemented with the aim to reduce the dependence of agricultural production on unpredictable climate conditions, primarily in terms of protective measures from adverse weather conditions (greenhouses, hail suppression, anti-hail net), irrigation, development of animal breeds and plant varieties more resistant to unsteady conditions, use of artificial fertilizers and chemical protective agents. Despite all this, agriculture is still very vulnerable to unsteady weather conditions, and thus to long-term climate changes.

The predictions of climate change impacts to agriculture in Serbia are not promising. Several models project a decrease in yields for almost all arable cultures. A slight increase is expected only for maize, but only in case of an intensified irrigation. For the territory of Vojvodina it is projected that the rising temperature and summer droughts will generally more affect the yields of spring sowing than winter crop. In case of winter sowing, more favourable effects are expected to exceed the indirect negative ones, due to prolonged vegetation season. Of course, climate change impacts will have a variety of manifestations in different areas in Serbia, but there is still no reliable information on different regional scenarios. Nevertheless, it should be mentioned that the most important arable land in Serbia lies in Vojvodina and in the valleys of large rivers, just in that lower part of the country where drier climate conditions are expected.

The assumed higher frequency of natural disasters and extreme weather conditions will also affect agricultural production, primarily the plant production. Apart from the direct climate change impact that will be reflected in temperature and precipitation regime changes, production can be also endangered by various types of diseases and parasites whose incidence and spread may alter due to climate change. The prolonged vegetation seasons due to increased winter or early spring temperatures would lead to a higher possibility of disease or insect occurrence. According to the survey results among farmers that were carried out within the project ADAGIO a larger incidence of fungal diseases has been observed with grain and fruit products over the past years. On the other hand, it is to be expected that in case of some types of insects, particularly those that depend on the soil moisture, it will come to decreased incidence and population due to prolonged dry periods.

Another adverse phenomenon that might be enhanced by climate change is erosion of soil. The expected higher frequency of floods and high waters will certainly influence intensity of water erosion in some areas. Besides, large part of Vojvodina is most susceptible to the wind erosion that could be significantly increased due to prolonged periods of drought and high temperatures.