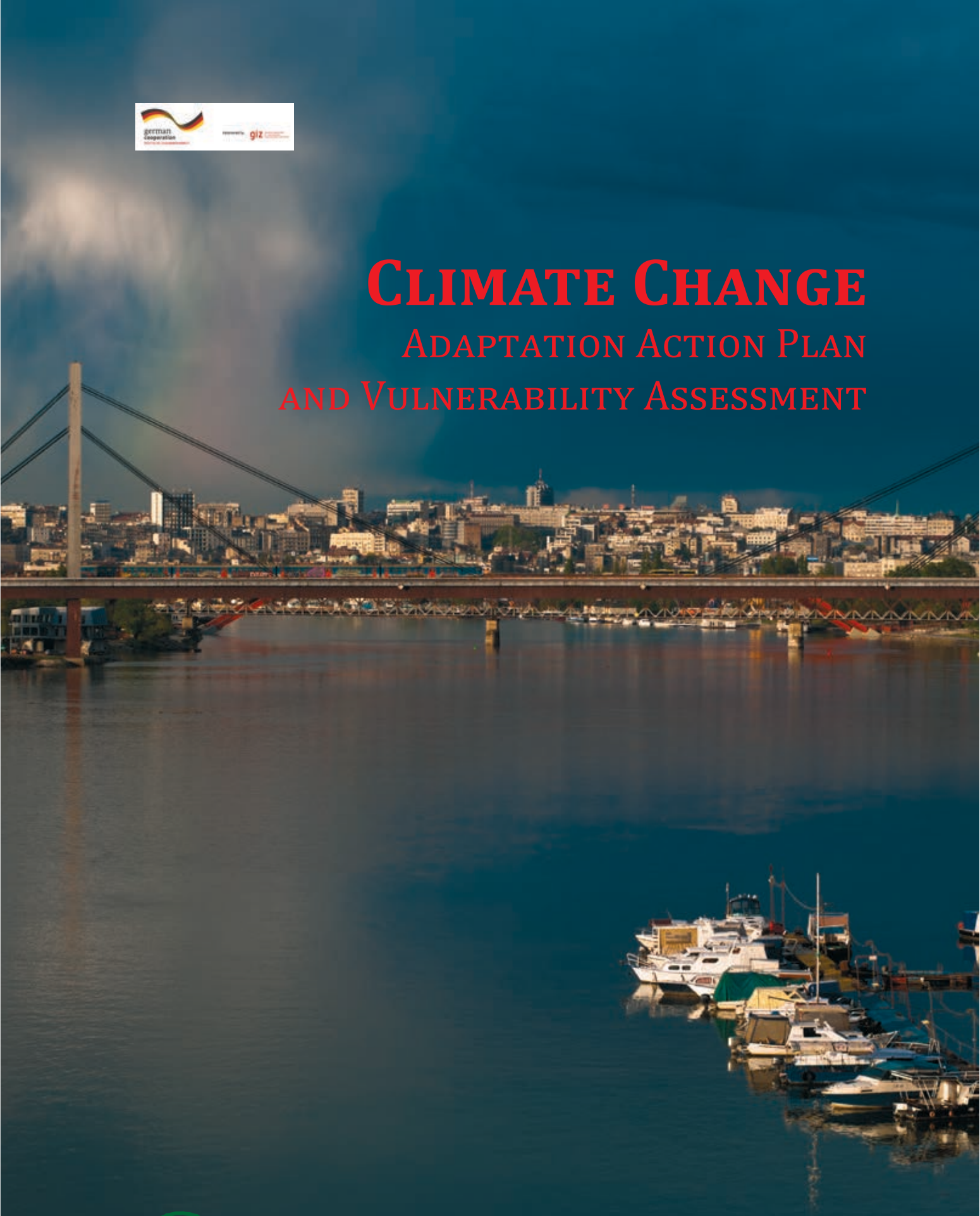
Climate Change

Adaptation Action Plan and Vulnerability Assessment



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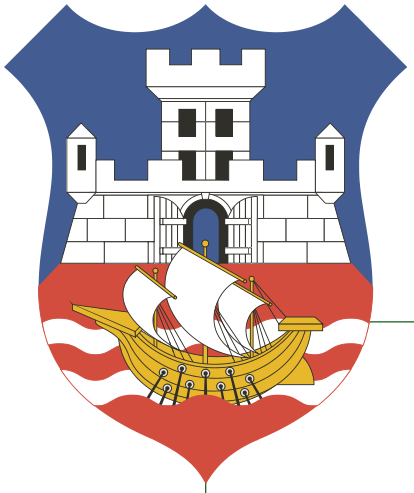

CITY OF BELGRADE
SECRETARIAT FOR ENVIRONMENTAL PROTECTION

Climate Change Adaptation Action Plan and Vulnerability Assessment

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Abbreviations:

CC	Climate Change
CCA	Climate Change Adaptation
CCAWG	Climate Change Adaptation Working Group
CMCC-CM	Centro Euro-Mediterraneo sui Cambiamenti Climatici - Climate Model
CWS	Climate Watch System
FBUR	First Biennial Update Report
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
RCP	Representative Concentration Pathways
SNC	Second National Communication
UNFCCC	United Nations Framework Convention on Climate Change

PREFACE

Climate change is one of the greatest challenges we all face. The earth's climate is changing so that there will be more frequent and intense extreme weather events than we have been used to in the past. Current extreme weather will no longer be exceptional, but will become the norm and Belgrade needs to be aware of this and prepared to adapt to new circumstances.

The Republic of Serbia is a party to the UN Framework Convention on Climate Change and the Kyoto Protocol (the law ratifying the Kyoto Protocol to the United Nations Framework Convention on Climate Change – Official Gazette of RS, 88/07) with the status of a "Non-Annex I Party".

The Republic of Serbia has shown its willingness to combat climate change in the First National Communication, adopted in 2010, while the Second National Communication (SNC) is under preparation and will be submitted to the UNFCCC Secretariat in 2016. At the same time, the First Biennial Update Report (FBUR) of the Republic of Serbia is currently being prepared and will be delivered in 2015.

Development of a Climate Change Strategy and related Action Plan, will start in September 2015. Analyses conducted for the purposes of the Strategy will include needs assessment, in terms of adaptation to climate change, in order to define a sustainable path towards limitation/reduction of GHG emissions. The Strategy and its Action Plan will determine GHG emission thresholds and the GHG reduction targets by 2020 and 2030, respectively, in compliance with the provisions of the sectoral strategy documents (primarily the new Energy Development Strategy).

Rising temperatures and weather extremes like floods and storms could be detrimental to the quality of life in Serbian towns – these are all challenges we have to face. Our towns must be prepared to cope with the effects of climate change as structures and the urban living environment are especially vulnerable.

At the same time well-functioning towns and cities are among the most important prerequisites for sustainable economic development. Lack of systematic planning in response to climate change impact will lead to increased costs for adaptation measures. Anticipatory strategies and plans including climate change projections must be continuously developed to ensure the adaptation of urban structures to mitigate the impact of a changing climate on the urban living environment.

In full awareness of these facts, the City of Belgrade developed this Climate Change Adaptation Action Plan and Vulnerability Assessment within the regional project "Climate Change Adaptation in the Western Balkans" implemented by the German International Cooperation Agency (Deutsche Gesellschaft für Internationale Zusammenarbeit – GIZ).

„Climate Change Adaptation Action Plan and Vulnerability Assessment" is published in the official Gazette of the City of Belgrade, No. 65/15 issued on October 26, 2015.

INTRODUCTION

Strategic and legislative framework

Baselines

The baseline for the development of the document "Climate Change Adaptation Action Plan and Vulnerability Assessment" is the participation in the regional project "Adaptation to climate change in the Western Balkans".

The Secretariat for the Environment was authorised by the Interim authority of the City of Belgrade (Conclusion No 501–56/13–S–20, of November 22, 2013) to establish cooperation within the framework of the above mentioned project, on behalf of the City of Belgrade. The project's Steering Committee and Working Group were established following the Conclusion of the Deputy Mayor (No 020–5442/14–G–01, of September 26, 2014). The Multisectoral Working Group was composed by representatives of the City of Belgrade, representatives of the city public enterprises, representatives of other relevant institutions and experts (Annex 1). This document is the result of the work of Multisectoral Working Group.

The baseline for the development of the document titled "Climate Change Adaptation Action Plan and Vulnerability Assessment" were the aims and principles defined within the framework of the regional project "Climate Change Adaptation in the Western Balkans". The aim of this component is the integration of climate change adaptation in the city management and urban planning in Tirana, Podgorica and Belgrade. Document drafting is one of many measures, but a very important one, that should be implemented in order to establish the climate change adaptation system, which will favourably affect the whole range of aspects needed to raise living standards (protection of the environment and human health, improvement of the landscape and scenic values, preservation of tangible values, the economic aspect, etc.).

Links with other strategies and plans

- **National Sustainable Development Strategy** (Official Gazette of the RS No 57/08) was passed in 2008, including the Action plan that passed in 2009. The aim of the Strategy is strengthening of interaction and realization of the significant effects between environmental protection, economic growth and social welfare, as well as contribution to the harmonization of sectoral policy objectives**.**
- **National Environmental Programme** (Official Gazette of the RS No 12/10) defines strategic goals of environmental protection, as well as the specific objectives of protection of air, water and soil, protection from the impact of certain sectors on the environment (industry, energy, agriculture, mining, transport, etc.). The Programme determines necessary reforms, including regulatory instruments, economic instruments, institutional framework, monitoring system, the financial system in the field of environmental protection and the necessary infrastructure in the field of environmental protection.
- **The Energy Sector Development Strategy until 2015** (Official Gazette of the RS No 44/05) and the Draft Energy Sector Development Strategy until 2025 with Projections until 2030 provide for a higher share of renewable energy sources, increased energy efficiency, the introduction of cogeneration plants for combining the production of electricity and heat and other measures of relevance to climate change mitigation.
- **The Forestry Development Strategy of the Republic of Serbia** (Official Gazette of the RS No 05/06) envisages increasing the capacity of forests as a necessary measure.

- **Strategy of Scientific and Technological Development of Serbia for the period from 2010 to 2015** (Official Gazette of the RS No 13/10) proposes environmental protection and climate change as one of the priority investments.
- **Regional Spatial Plan of the Administrative Territory of the City of Belgrade** (Official Gazette of the City of Belgrade No 10/04) and Amendments to the Regional Plan of the Administrative Territory of the City of Belgrade (Official Gazette of the City of Belgrade No 38/11), in the chapter "Spatial development of the region of Belgrade" under item 1 "Nature, environmental development and protection", provide a definition of environmental protection also outlining the effects of climate change. The document defines, as a primary objective, the inclusion of climate change as a factor of sustainable development and the environment in sectoral strategies and the development of a sustainable system for the management of climate change risks. The concept of spatial development in the context of climate change effects involves:

– the development of spatial databases and information on climate change in the administrative area of Belgrade, including information on extreme climate events and disasters, and the vulnerability of certain areas, for their use in spatial and urban planning;
– determining the effects of climate change on the availability of natural resources, especially water resources, arable land, forests and other ecosystems and biodiversity in order to plan for sustainable development and environmentally friendly activities in areas vulnerable to climate change;
– the adoption and implementation of new measures in the conservation and protection of water resources, agricultural land and forests and the use of renewable energy sources in the context of the assessment of the effects of climate change and adaptation to changed climate conditions;
– updating sector strategies, instruments, measures and policies, including the harmonization of inter-sectoral coordination and participation of relevant institutions and local communities, as well as raising awareness of the need for including the issue of climate change in sectoral strategies;
– development of multidisciplinary research programs of climate change impacts on spatial development.

In order to protect the climate and to establish a system of climate change risk management are determined by the following strategic priorities:

– development of climate monitoring systems and spatial databases and information on local climate change, including information on climate extreme events and disasters and the vulnerability of certain areas, for their use in strategic planning and spatial development planning;
– implementation of the program of multidisciplinary research of climate change and local impacts of climate change on agriculture, forestry, water, energy, biodiversity and ecosystems, infrastructure and health, and the creation of **sectoral plans and programs of climate change adaptation and mitigation;**
– implementation of the strategy for the introduction of environmentally friendly technologies in manufacturing, energy, transportation and other sectors, including greater use of available renewable energy sources with the active participation of local government;
– establishment of operational, research, communications and information functions of the National Centre for Climate Change, which performs the functions of sub-regional Climate Change Centre for Southeast Europe.

- **Development Strategy of the City of Belgrade** (Official Gazette of the City of Belgrade No 21/11) determines the basic vision of the development of the city of Belgrade,

capital of Serbia, which includes: the rise of the city of Belgrade to the level of high rank among the metropolitan cities and capitals of Central, East and Southeast Europe, according to the criteria of a sustainable economy and advanced technology, greater territorial cohesion of the city, a higher level of accessibility, fixed polycentrism and decentralization and developed urban identity. The future development of the city of Belgrade will respect two basic principles. The first principle is the introduction of environmental awareness or ideas about the necessity of a sustainable nature and environment as a precondition for development. The second principle is to strengthen the identity of the city of Belgrade and its distinctive geographical and cultural programs as a precondition for a higher level of attractiveness for its citizens, business people, investors and guests.

- In the chapter titled "Interregional dimension of the development of the City of Belgrade", as one of the possible capital projects that include themes and the exchange of good practice on projects of importance for the spatial development of the city or the region, the protection and regulation of the environment and control of the impact of climate change was highlighted, including the water quality and use control, disposal and treatment of solid waste, drainage and treatment of liquid waste, control of risks of natural disasters, the elimination of the so–called "black spots". This is one of the topics that are the basis for connecting the city of Belgrade with other similar cities in the network of European metropolitan regions and areas.

National climate change legislation

Since 2008 the Republic of Serbia is a member of the Kyoto Protocol to the United Nations Framework Convention on Climate Change:

- Law on Ratification of the United Nations Framework Convention on Climate Change, with Annexes (Official Gazette of the FRY – International Agreements, No 2/97);
- Law on Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (Official Gazette of the RS – International Agreements, No 88/07);

Other regulations relevant to climate change are numerous, but the most important ones are:

- Law on Environment (Official Gazette of the RS No 135/04, 36/09 and 72/09);
- Law on Strategic Environmental Impact Assessment (Official Gazette of the RS No 135/04 and 88/10);
- Law on Environmental Impact Assessment (Official Gazette of the RS No 135/04 and 36/09);
- *Law* on *Integrated Prevention* and *Control* of Pollution (Official Gazette of the RS No 135/04).

Significant efforts have been invested from 2008 until today to establish the legal, institutional and policy framework on climate change.

The process of EU accession and harmonization of national legislation with the EU acquis has started (Serbia was granted candidate status in 2009; the first intergovernmental conference for the start of negotiations was held in 2014; explanatory and bilateral screening of Chapter 27 negotiations took place in September/November 2014). Basic principles of relevant EU legislation in the field of climate change are based on international agreements (UNFCCC).

For this reason the EU accession process is conditional on the fulfilment of international obligations, including reporting on the implementation of multilateral agreements (among which the UNFCCC), as one of the most demanding ones.

Scope of the Action Plan

Climate Change Adaptation Action Plan and Vulnerability Assessment have been developed for the administrative territory of the City of Belgrade. The administrative territory of the City of Belgrade covers an area of 323,496 ha and is divided for administrative purposes into 17 municipalities (Čukarica, Voždovac, Vračar, Novi Beograd, Palilula, Rakovica, Savski Venac, Stari Grad, Zemun, Zvezdara, Barajevo, Grocka, Lazarevac, Obrenovac, Mladenovac, Sopot, Surčin).

The General Urban Plan of the Belgrade Administrative Territory (i.e. the Master Plan) was adopted in 2003 (with amendments in 2005, 2007, 2009 and 2014), for the area covered by the General Urban Plan of Belgrade until 2021 ("inner city area of Belgrade"), which amounts to 77,347 ha. However, given that the effects of climate change cannot be limited to the inner city area and given that local administration of the City of Belgrade is responsible for the whole administrative territory of Belgrade, the anticipated activities in this action plan will better serve the purpose of climate adaptation if applied regionally, so the decision was made to cover the whole administrative territory of Belgrade with this adaptation action plan.

Structure of the document

The **introduction** provides a definition of the terms used herein and basic methodological guidelines by which the Climate Change Adaptation Action Plan and Vulnerability Assessment for the City of Belgrade was developed.

The vulnerability assessment builds on the analysis of information about extreme weather events in the past and the assessment of the current vulnerability to extreme weather events in Belgrade, including spatial relevance with regard to extreme weather events, and mapping of current vulnerability in the administrative area of Belgrade.

The assessment of future risks and opportunities builds on an analysis of climate data for the city of Belgrade in the present time period and an analysis of projections of climate change on the basis of modelling as well as on the results of the vulnerability assessment for the city of Belgrade.

The action plan includes a list of measures and activities that will be undertaken to adapt to climate change, including responsibilities, time frame, i.e. description of short–term measures and activities (until 2017); medium–term measures and activities (until 2020); long–term measures and activities (until 2025) and prioritization of measures.

Methodological considerations

Key definitions

For the purposes of this Action Plan, the term "adaptation" is used to denote *adjustments in natural or human systems in response to actual or expected climatic changes or their impacts*, in order to define actions to:

- *understand the risk and opportunities we face from extreme weather today and further changes to our climate in the future;*
- *identify, assess and prioritise the options to manage the risks and opportunities, and*
- *develop, deliver and monitor actions to manage these risks and realise these opportunities.*

Adaptation mitigates harm (risks) or exploits benefits (opportunities). Various types of adaptation can be distinguished, including anticipatory, autonomous and planned

adaptation. For the purposes of this report, the term adaptation is used to denote planned adaptation, i.e. adaptation that is the result of a deliberate policy decision.

The term "vulnerability" refers to the degree to which a system is susceptible to, and unable to cope with, adverse climate or weather induced impacts. Vulnerability is a function of sensitivity and exposure of a receptor (local physical features and/or socioeconomic conditions) to the climate/weather impacts and the capacity to adapt to those conditions.

The term "risk" is used to denote the combination of the current vulnerability (high, medium, low) and the climate change impact (balancing, indifferent, reinforcing), and is ranked as very high, high, medium, low.

Methodological approach

The vulnerability assessment and adaptation action plan for the city of Belgrade are based on the methodology of the FUTURE CITIES Adaptation Compass, developed within the framework of the EU project FUTURE CITIES (FC, 2013).

Both the Climate Change Adaptation Action Plan and Vulnerability Assessment for the City of Belgrade were developed by a multi–sectoral working group, appointed in accordance with the Conclusion of the Deputy Mayor No 020–5442/14–G–01 of September 26, 2014. The composition of the multi–sectoral working group and a list of other participants in the drafting process are shown in Annex 1.

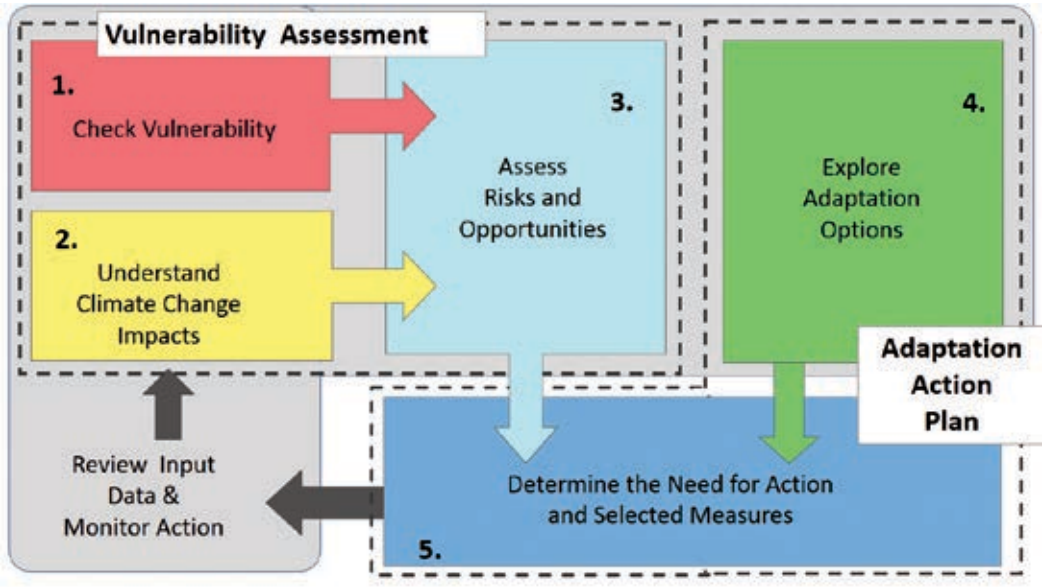

Figure 1. Overview of the methodological approach (FC, 2013)

The **Vulnerability Assessment** was carried out in three phases – Check Vulnerability, Understand Climate Change Impacts and Assess Risks and Opportunities, (see Figure 1). In the 1st phase (Check Vulnerability) the working group conducted an assessment of current vulnerability to extreme weather events in the administrative territory of Belgrade. The assessment was based on an analysis of weather events in the past and collected information about spatial aspects of local vulnerabilities. In the 2nd phase (Understand Climate Change Impacts) an analysis of climate change trends on the territory of Belgrade was carried out on the basis of climate change modelling (performed on the basis of RCP 8.5 scenarios, provided by IPCC). The modelling was carried out based on the

results of the ORIENTGATE project for the periods 2021–2050 and 2071–2100, compared to the reference period 1971–2000. The results of the first and second phase (current vulnerability and climate change impacts) were used to carry out the Assessment of Risks and Opportunities (3rd phase).

Based on the results of the Vulnerability Assessment, the working group explored adaptation options (4th phase), determined the need for action and selected measures (5th phase) to develop an **Adaptation Action Plan** for the city of Belgrade. The Action Plan contains measures and actions to adapt to climate change, including descriptions of each measure, potential locations, responsibilities, additional specifications (criteria like additional benefits or negative external effects), as well as prioritization of measures (based on specific criteria).

The remaining step of the methodological approach is a circulatory step that focuses on both reviewing input data and monitoring actions (see chapter “Monitoring the Implementation”).

ASSESSMENT OF CURRENT VULNERABILITY IN BELGRADE

The vulnerability assessment was based on the analysis of the current situation in Belgrade.

The local physical features and socioeconomic conditions in the City of Belgrade were analysed (perceived through the five receptors – population; infrastructure; built environment; economy; natural resources). Possible effects of the most pronounced manifestations of climate change in cities – extreme weather events (heat waves, extreme cold, drought, heavy precipitation/floods and storms) – on local physical features and socioeconomic conditions in the administrative territory of Belgrade were evaluated.

The Vulnerability Assessment included three steps:

1. Analysing information about extreme weather events in the past;
2. Assessing current vulnerability to extreme weather events in Belgrade, including spatial relevance with regard to extreme weather events;
3. Mapping current vulnerability to extreme weather events in the administrative area of Belgrade.

Extreme weather events in the past

The following subchapters summarise the evaluation results of local vulnerability to extreme weather events related to climate change (heat waves, extreme cold, droughts, heavy precipitation/floods and storms) in the past (1995–2014), including an assessment of the consequences, the steps taken, the receptors affected by extreme weather events and preliminary analysis of locations. Detailed results of extreme past weather events for the Belgrade administrative territory can be found in Annex 2.

Heat waves

According to data of the Republic Hydrometeorological Service of Serbia, there were several heat waves on the territory of Belgrade in the past two decades, specifically:

- **The heat wave of the summer of 2013**: The mean, maximum and minimum air temperatures exceeded the multi-annual average; it was an extended heat wave – high temperatures (above 39°C) for more than 6 consecutive days, with 52 "tropical" days and 27 "tropical" nights (minimum air temperature exceeding 20°C); the heat wave was accompanied by extreme lack of precipitation (over 25% relative to the normal). The whole territory of Belgrade was affected.
- **The heat wave of August 2012**: Extended heat wave with high temperatures (above 39°C) for more than 6 consecutive days; 62 "tropical" days and 52 "tropical" nights (minimum air temperature exceeding 20°C); mean summer temperature 4.9°C higher than the average for 1960–1991. The whole territory of Belgrade was affected.
- **High temperatures** (above 40°C) in July and August 2009.
- **The heat wave of July 2007:** Extreme temperatures for more than 22 consecutive days; absolute maximum ever recorded in Belgrade (43.6°C); mean summer temperature between 4 and 5°C higher than the average for 1960–1991. The whole territory of Belgrade was affected.
- **The heat wave of June/July 2006:** 12 "tropical" days and 9 "tropical" nights in June (8 days and 8 nights above the 1961–1990 average); 21 "tropical" days and 12 "tropical" nights In July (12 days and 9 nights above the 1961–1990 average), only 35% of the average amount of precipitation. The whole territory of Belgrade was affected.
- **The heat wave of June 2003:** 18 "tropical" days and 12 "tropical" nights; only 37% of the average amount of precipitation.

- **The heat wave of the summer of 2000:** 15 "tropical" days and 7 "tropical" nights in June (11 days and 6 nights above 1961–1990 average), only 21% of average amount of precipitation; 22 "tropical" days and 14 "tropical" nights In August (13 days and 11 nights above the 1961–1990 average), only 15% of the average amount of precipitation.
- **The heat wave of the summer of 1998:** 13 "tropical" days and 5 "tropical" nights in June (9 days and 4 nights above the 1961–1990 average); 18 "tropical" days and 10 "tropical" nights In July (9 days and 7 nights above the 1961–1990 average).

Heat waves caused increased heat stress among the population, with negative health effects on vulnerable groups (elderly, children, people with cardiovascular and/or respiratory diseases and psychiatric illnesses). For example, mortality among the elderly in the July 2007 heat wave increased by 76% relative to the baseline mortality (between 16 and 24 July 2007). Female mortality was more than twice higher than male mortality. Moreover, heat waves caused a decrease in work productivity, particularly in agriculture, infrastructure and construction sector, a decrease in other economic activities (trade, communal services), increased electricity consumption (estimated up to 22%), and increased water consumption.

Extreme cold

According the Republic Hydrometeorological Service of Serbia data, there were several cases of extreme cold on the territory of Belgrade in the past two decades, specifically:

- **The extreme cold of the winter of 2012**, with extremely low temperatures (average daily ambient temperature from 30 January to 11 February ranged from -6.6°C to -12°C), 17 consecutive ice days (from 29 January to 14 February), followed by high snowfall (52cm).
- **The extreme cold of the winter of 2008/2009** with 20 consecutive ice days (from 26 December to 14 January).
- **The extreme cold of the winter of 2007/2008** with 15 consecutive ice days (from 19 December to January 2).
- **The extreme cold of the winter of 1998,** with 14 frost days in March (8 days above the 1961–1990 average), 12 ice days in December (7 days above the 1961–1990 average), 18 days with snow cover (7 days above the 1961–1990 average).

Extreme cold caused health effects in vulnerable groups (elderly, children, people with cardiovascular deceases), transport problems due to the snow cover, formation of ice cover on the Danube and the Sava, increased electricity consumption and stress on the energy system.

Droughts

There were several droughts on the territory of Belgrade in the past two decades, specifically:

- **The drought of the summer of 2012**: lack of rainfall from late June to the end of August; extreme heat over a prolonged period of time (above 35°C).
- **The drought of August 2000**: lack of rainfall, only 15% of the average amount of precipitation (7.8 mm).

Droughts caused restricted availability of drinking water and serious damage in agricultural production in suburbs and rural municipalities. For example, in the summer of 2012, in the Lazarevac Municipality, the yield of corn dropped by 30–70%; of fruits and vegetables by 50 %; of soy by up to 80%, etc. River water levels dropped to the biological minimum (for example, the Sava river water level dropped to 80% of the biological minimum on

August 16, 2012). Smaller water streams dried up. Serial droughts also caused damage to biodiversity, particularly fish stock and urban wetlands. The effects of the drought included the drying of grasslands and vegetation, which are less resistant to high temperatures and require more water, and overheated pedestrian and car tracks, which further increased the air temperature both during the day and at night. Urban dwellers increased pressure on green areas, already weakened by the high temperatures, which led to their further devastation.

Heavy precipitation and floods

There were several heavy precipitation and flooding events on the territory of Belgrade in the past two decades, specifically:

- **The flood of May 2014**: the catastrophic floods were caused by heavy rainfall in Western and Central Serbia (more than 200 mm of rain in a week, i.e. the equivalent of 3 months' rain under normal conditions). This resulted in the rapid and substantial increase of water levels of the main rivers that partly cross the territory of Belgrade (Sava, Tamnava, Kolubara), and the discharge of groundwater to surface streams. The floods have had a devastating effect:
  - widespread flooding in urban and rural areas, particularly in the City Municipality of Obrenovac.;
  - 51 fatalities, of which 23 by drowning (not all of them in Belgrade);
  - 25,000 people were evacuated from Obrenovac, of which 5,000 required temporary shelters in camps established in Belgrade;
  - 114 individual houses were completely destroyed and more than 3,000 damaged;
  - significant infrastructure damage in Obrenovac (bridges, roads, embankments)
  - temporary shutdown of health and education facilities and suspension of related activities due to damage;
  - flooding of the Kolubara open mine pit and other energy and industrial facilities;
  - flooding of mine disposal facilities, hazardous to the environment and public health;
  - damage to many small and medium farms; Agricultural land was contaminated by a large amount of sediments and other materials. Total loss in the manufacturing sector in Obrenovac was estimated at EUR 23 million;
  - contamination of drinking water that can lead to intestinal infections and diseases;
  - contamination of raw water with pesticides, as a consequence of agricultural pollutants carried by the flash flood.

The entire territory of Belgrade was affected by the flooding, however, the city municipalities of Obrenovac, Lazarevac, Čukarica (Ostružnica) and Barič, proved particularly vulnerable, along with the areas at risk of flooding from torrential streams (Topčider River and Kumodraž Stream watershed) .

- **The floods of April 2006**: flooding was caused by the melting of snow and heavy rainfalls in the Danube, Sava, Velika Morava and Tisa river basins in December 2005 and March 2006 (rainfall in Belgrade in March was 104 mm; in April 97 mm). This resulted in the rapid rise of the Danube and Sava river water levels (at the maximum rate of 1 cm per hour).
  - The Danube water levels exceeded the historical maximum (783 cm in Zemun) and the Danube spilled over its banks in the City Municipalities of Zemun and Novi Beograd, and in the suburban area of Veliko Selo;
  - The Sava spilled over its banks in urban areas (New Belgrade wharf; Sajam; Kula Nebojša – Kalemegdan; City Municipality of čukarica; Ostružnica);

- 1,000 people were evacuated in the Municipality of Grocka;
- Wastewater spilled into floodwaters in the lower urban areas (Vojvode Mišića boulevard and Karađorđeva street).

The embankments of the Danube and Sava Rivers in Belgrade (particularly the lower plateaus in the Stari Grad municipality – from Sajam to the Sava estuary; Ada Ciganlija; Zemun); Pančevački Rit; Veliko Selo; the Topčider river and Barič river basins; lower areas of the municipalities of Savski Venac and Čukarica.

- **The extreme precipitations of 2001 (April, June and September)**: extreme rainfall was recorded for April (157.9 mm) and September (183.7 mm), with 17 wet days in June.
- **The extreme precipitations of July 1999**: extreme rainfall was recorded for July (265 mm).

Storms

The intensity and frequency of storms on the territory of Belgrade is increasing. Storms have been occurring frequently in summer during the last 4–5 years. This has had a particularly damaging impact on the transport infrastructure, and on the green infrastructure, downing trees and branches. The electricity network, water supply and sewerage systems also sustained damage.

Conclusion

Extreme weather events frequently affected Belgrade in the past and caused serious and sometimes disastrous consequences. As discussed in previous chapters, heat waves in the summer seriously affected the entire administrative territory of Belgrade, (most severely in densely populated urban structures – urban core), due to the shortage of vegetation combined with the proliferation of tarmac and concrete surfaces and reduced air ventilation. The most affected areas of Belgrade include the central municipalities of Stari Grad, Savski Venac and Vračar, and the densely populated areas of Novi Beograd, Zemun, Voždovac and Čukarica. The droughts were somewhat less frequent and intense compared to heat waves, but also had consequences for the entire administrative territory of Belgrade.

However, the intensity and severity of floods rose. The most vulnerable parts of Belgrade are the flood prone areas near the Sava river (Obrenovac, including Ostružnica and Barič, the Lazarevac municipality, embankments of the Sava River in the Belgrade inner city, particularly the lower plateaus in the Stari Grad municipality from Sajam to the Sava-Danube estuary and Ada Ciganlija), the Danube (Zemun, Pančevacki Rit and Veliko Selo) and lower areas of the municipalities of Savski Venac and Čukarica. These areas are below the maximum elevation of the Sava and Danube and are at risk of flooding. They are protected by embankments, but in some places these are old and not sufficiently high. On the administrative territory of Belgrade there are about 160 small torrential streams+, which pose a threat of flooding to populated areas, , with short–term but highly dangerous effects. The small watersheds of the Topčider and Barič River, Kumodraž Stream and other, are particularly vulnerable to floods and stormwater.

Current vulnerability to extreme weather events

The current vulnerabilities of specific receptors to extreme weather events in Belgrade have been assessed by combining their sensitivity/exposure (depending on different types of extreme events) and their respective capacity to adapt. For this purpose, information was collected about former weather events and spatial aspects of local vulnerabilities:

- the evaluation of local vulnerabilities to extreme weather events in the past included an analysis of extreme weather events in the 1995–2014 period, with an assessment of the consequences, response to extreme weather events, the receptor affected by extreme weather events and preliminary analysis of locations;
- the evaluation of spatial aspects of local vulnerabilities included a detailed analysis of the current vulnerability of receptors (public health/vulnerable groups, transport infrastructure, electricity services, water supply and sanitation services, social infrastructure, building stock and materials, tourism, industry, retail, green spaces, water resources and water quality, air quality, agriculture, forestry and biodiversity/ecosystems). The analysis consisted of selected indicators to specify each receptor, respective spatial aspects (location of sensitive receptors) and potential future changes in spatial vulnerability.

The level of sensitivity/exposure of receptors was ranked as low, medium and high, (see Table 1). The adaptive capacity of receptors (the financial, technological or social ability, willingness and preparedness to cope with weather extremes) was ranked as:

- high (the receptor is highly able, willing and ready to cope with such events),
- medium (the receptor has only little ability, willingness and/or is partly ready to cope with such events) or
- low (the receptor alone is not able, willing and/or ready to cope with such events; any change or adaptation to a change will require significant efforts).

Table 1. Matrix to determine the class of vulnerability of receptors

Class of vulnerability		**Capacity to adapt**		
		Low	**Medium**	**High**
Sensitivity/ Exposure	**High**	High	High	Medium
	Medium	High/Medium	Medium	Medium/Low
	Low/No	Low	Low	Low

The resulting current vulnerability of the receptors ranges from low to medium to high. Detailed results of the assessment of current vulnerability to extreme weather events for Belgrade administrative territory can be found in Annex 3.

Population

	VULNERABILITY				
	Heat wave	Extreme cold	Drought	Heavy precipitation / floods	Storms
Public health / vulnerable groups	High	High	Medium	High	Medium

Increase in temperature and heat waves, extreme cold and floods can have major negative impacts on public health and, in particular, on the health and position of vulnerable groups of the population of Belgrade. The **vulnerability of the population to the effects of heat**

waves, extreme cold and floods in Belgrade is estimated as high, due to the high exposure to these effects, and low adaptive capacity. Potential effects of these extreme weather events are:

- For heat waves:
  - fatalities, mainly due to cardiovascular diseases;
  - spread of vector-borne and infectious diseases;
  - altered allergy patterns;
  - heat strokes;
- For extreme cold:
  - deterioration of the health of cardiovascular patients;
  - spread of respiratory and infectious diseases and circulatory disorders caused by the narrowing of blood vessels;
- For heavy precipitation and floods:
  - casualties and fatalities;
  - spread of infectious diseases due to contaminated water.

The vulnerability of the population to the effects of droughts and storms in Belgrade is estimated as medium. Potential effects of these extreme weather events could include the accumulation of microelements and deteriorated general hygienic conditions, especially the deterioration of air and water quality, diseases caused by consuming poor quality water and food, and also an increase in the number of injuries and deaths due to the effects of storms.

All people who reside and work in the affected areas are vulnerable, in particular the elderly, infants and children, people with mobility impairments, chronic illnesses, etc. There is no pronounced spatial distribution of poverty – we can say that vulnerable social groups in terms of poverty are spread across the entire administrative area of Belgrade. As regards the eldest population (over 80 years of age), and the allocation of chronically ill patients, it is estimated that most vulnerable parts of Belgrade include central city municipalities,– i.e. the central urban administrative territory (Stari Grad – 20.5 % of population over 65 years of age, Vračar – 20.2%, Savski Venac – 18.4 %), and suburban municipalities Sopot and Barajevo (Sopot 20.2%; Barajevo 18.3%).

Infrastructure

	VULNERABILITY				
	Heat wave	Extreme cold	Drought	Heavy precipitation / Floods	Storms
Transport	Medium	High	Low	High	Medium
Electricity and heating services	Medium	High	Medium	High	High
Water supply and sewage	High	Medium	High	High	High
Social infrastructure	Medium	Medium	High	Low	Low

The vulnerability of traffic infrastructure to the effects of extreme cold and floods in Belgrade is estimated as high, mainly due to high exposure to extreme weather conditions. This may cause damage to transport infrastructure, traffic and public transport problems and higher infrastructure networks maintenance costs of. The busy routes and streets are the most vulnerable (highway E70 – part of Corridor 10 – which passes through the central city core; Radnička, Savska and Karađorđeva Street – along the Sava River to its delta and then to Pančevo Bridge; direction from New Belgrade over Branko's bridge and

through the Terazije tunnel, via Despot Stefan Boulevard, to the Pančevo Bridge; Knez Miloš and Takovska Street), and major traffic intersections (the main railway station in the Sava amphitheatre, Slavija Square, Republic Square, the Mostar interchange, etc.).**The vulnerability of traffic infrastructure to the effects of heat waves and storms is estimated as medium.**

The vulnerability of systems for the production and distribution of electricity and district heating systems to the effects of extreme cold, floods and storms is estimated as high, mainly due to the high exposure of the systems to these effects, and low adaptive capacity. Systems for the production and distribution of electricity in the affected parts of Belgrade are particularly vulnerable (the Nikola Tesla thermal power plant in Obrenovac; the Kolubara A thermal power plant in Veliki Crljeni; the Novi Beograd and Dunav heating plants).**The vulnerability of systems for the production and distribution of electricity and district heating systems to the effects of heat waves and droughts is estimated as medium.**

Water supply and sewerage is particularly vulnerable to extreme weather events in Belgrade. The vulnerability of water supply and sewerage **to effects of heat waves, droughts, floods and storms is estimated as high, while the vulnerability to effects of extreme cold is estimated as medium.** The water supply and sewerage are among the most sensitive systems exposed to the effects of extreme weather conditions. Public health, technical infrastructure systems for the production and distribution of drinking water, drinking water quality, and other systems of water supply and channelling of wastewaters, operation of public utilities in the area as well as the city budget (due to increased costs) may be affected. Increasing consumption (water demand) during heat waves and droughts, damages to the water system (due to exacerbated effects of extreme precipitation, floods and storms), and not only higher maintenance costs, but also the deterioration of the quality of drinking water (in case of heat waves and droughts) can be expected. Drinking water supply facilities in Makiš, and water supply wells are particularly vulnerable. The sewerage infrastructure would probably be further compromised in case of extreme rainfall and storms. The storm water drainage system is only partially separated from the sewerage system (this is the case in the newer parts of the city). Open retention basins for storm water collection are vulnerable (Galovica in Agostina Neta Street and Gazela in Milentija Popovića street), and indoor retention pool Retenzija in John Kennedy Street is slightly less vulnerable. The most critical points are the core zone of the Old City (low Danube basin zone, which covers part of Dorćol beneath the streets of Car Dušan to the Danube river), which do not have rain drains, so these locations are often exposed to flooding (the sewerage network gets overloaded). Besides, without storm water sewer system (and even sewerage) are parts of Dedinje, Kaluđerica and Banovo Brdo as well as parts of Lazarevac Municipality. Almost 25% of households are without sewage connection (including some parts of the city in the central core – the municipality of Vračar, Savski Venac, Palilula, Voždovac, Zvezdara, Čukarica). Particular problems are created by suburbs Mali Mokri Lug, Kaluđerica, most of Kumodraž, Jajinci, most of Batajnica, Krnjača, Ovča, Vinča and Leštane.

Social infrastructure facilities and systems (health care facilities, retirement homes, educational institutions, public sports facilities, etc.) **are highly vulnerable to the effects of drought,** (primarily indirect effects through increasing pressure on the social infrastructure, leading to increased poverty and social unrest resulting in higher pressure on health care facilities and social system institutions)**. The respective vulnerability to the effects of heat waves and extreme cold is estimated as medium**. Although it is extremely hard to identify the most vulnerable social infrastructure facilities in Belgrade, health care facilities seem

to be at the forefront (e.g. the Clinical Centre of Serbia; the four big hospitals – Zemun, Novi Beograd – Bežanijska kosa, Zvezdara, and Dedinje; and a large number of specialised hospitals and institutes). The same applies to school and kindergarten facilities. The adaptation capacity of the social infrastructure to the effects of heavy precipitation/floods and storms is estimated as high, consequently its vulnerability is estimated as low.

Built environment

	VULNERABILITY				
	Heat wave	Extreme cold	Drought	Heavy precipitation / Floods	Storms
Building stock and materials	High	High	Medium	High	Medium

The vulnerability of the built environment (existing buildings, urban infrastructure, roads, etc.) **in Belgrade to the effects of heat waves, extreme cold and floods is estimated as high**, due to high exposure to extreme weather conditions of building stock and materials. Buildings, technical and urban infrastructure –including —road and pavement surfaces (asphalt, concrete, etc.) are particularly vulnerable to heat waves and extreme cold, especially in densely built–up areas. Extreme precipitation and floods can contribute to the damage of the building stock, especially residential and office buildings, roads and urban infrastructure.

Economy

	VULNERABILITY				
	Heat wave	Extreme cold	Drought	Heavy precipitation / Floods	Storms
Tourism	Low	Medium	Medium	Low	Low
Industry	Medium	High	Medium	High	Low
Retail	Medium	Medium	Low	Low	Low

Economic activities in Belgrade are slightly less sensitive to extreme weather events compared to other receptors. **Only the industry is assessed as highly vulnerable to the effects of extreme cold and heavy precipitation/floods**. The list of highly vulnerable locations includes the power complex in Obrenovac (already severely hit by floods in 2014); the mining and energy sub–sector in Lazarevac and particularly the road and rail transport corridors in the urban core of Belgrade (industrial road and rail transport, including transport of dangerous goods from Banat passes through the urban core – banks of the Danube and Sava rivers, the main railway station; already overloaded bridges, especially the Pančevo Bridge). In addition to damage caused by extreme weather events, industrial buildings on the territory of Belgrade may be further exposed to an increase in electricity consumption and higher costs of heating, problems in the supply chain and, as a consequence, disruption of the functioning of all branches of the economy. It is estimated that economic activities and entities have a higher capacity to adapt to changing conditions caused by extreme weather events, which makes them less vulnerable than the other receptors.

Natural resources

	VULNERABILITY				
	Heat wave	Extreme cold	Drought	Heavy precipitation / Floods	Storms
Green spaces	High	High	High	Medium	High
Water resources and quality	High		High	Medium	Medium
Air quality	High	High	Medium	High	
Agriculture	High	High	High	High	High
Forests and forestry	High	High	High	Medium	High
Biodiversity and ecosystems	High	Medium	High	Medium	Low

In general, the vulnerability of natural resources to the effects of climate change in Belgrade is very high.

Open green spaces demonstrate a high level of vulnerability to almost all of the potential effects of climate change. The reason is the high exposure and insufficient capacity of adaptation of green spaces. Disturbances in physiological processes in plants during heat waves can be expected, leading to slow growth, damage of the plant tissue and even wilting. Costs for maintenance of green areas in these circumstances will be incomparably higher, especially costs for watering. Extreme cold and droughts may cause a slowdown in fundamental physiological processes of plants (photosynthesis, metabolism, transpiration, growth), physical damages, frost damages and wilting. Heavy precipitation/floods and storms can lead to physical destruction of plant tissue as well as damage to the green areas infrastructure. Urban green areas are highly vulnerable, particularly green spaces within the "inner city", as defined in the "Draft Master Plan of the System of Green Areas in Belgrade" ("Plan generalne regulacije sistema zelenih površina Beograda", 2015). These are Kalemegdan, Park Prijateljstva and part of the green areas along the right bank of the Danube and the left and right bank of the Sava River, Veliko Ratno Ostrvo, parts of the forest in the foreland on the left bank of the Danube (from the new Zemun–Borča bridge to Branko's bridge). The "inner green belt" can also be vulnerable: the city park in Zemun, the park at SIV, green areas within the open blocks of Novi Beograd, Braće Jerković, Medaković, Konjarnik, Mirijevo, Višnjička Banja and Bežanijska kosa; the Novo Groblje and Bežanija cemeteries; and other smaller parks, squares and avenues.

It is estimated that the Belgrade water resources and their quality are highly vulnerable to the effect of heat waves and droughts. Due to the effect of evapotranspiration, the water flow of the Danube and Sava will be reduced. Groundwater recharge and problems in water supply can also be expected, given the lack of alternative water supply systems for the city. This will also lead to the deterioration in the quality of surface and groundwater.

It is estimated that heat waves, extreme cold and heavy precipitations/floods, as effects of climate change, will significantly affect the deterioration of air quality in Belgrade. Higher concentration of pollutants and allergens in the air during periods of increased heat and droughts is possible, which will exacerbate health problems of the population, the flora and fauna, and contribute to the deterioration of the general image of the city. Similar effects are associated with the periods of **extreme cold** without wind, when the vulnerability in terms of deteriorating air quality in Belgrade **can also be considered as high**. Increased air pollution is expected in the inner city areas already severely hit by

air pollution (Knez Miloš Street; Kralj Aleksandar Street; Savska Street near the main rail station; Despot Stefan Boulevard; Karađorđev Park, etc.).

The vulnerability of agricultural land and agriculture in general has been estimated as high to all the effects of climate change (heat waves, extreme cold, droughts, heavy precipitation/floods and storms). In addition to high exposure of agriculture and agricultural land to the effects of climate change, the high vulnerability is a result of the inadequate capacity to adapt to changing conditions. The consequences of the altered growth cycle in agriculture, damages and soil pollution (due to climate change effects), as well as the physical damage, (caused by extreme rainfall, floods, torrential water flows and erosion), will affect not only farmers, but also the food industry and consumers in Belgrade. Higher vulnerability may be expected in almost all suburban municipalities, as well as in urban municipalities where agriculture is present. Suburban municipalities in the Šumadija area (Sopot, Barajevo and Obrenovac) and particularly the municipality of Grocka (slopes towards the Danube, Vinča, Vrčin, Ritopek and Begaljica) may expect increased vulnerability of the effects of erosion.

Like agricultural land, **forests and forest land also have a high level of vulnerability to the effects of climate change, especially to the effects of heat waves, extreme cold, droughts and storms**. **The vulnerability of forests to the effects of extreme precipitation/floods in the Belgrade area is estimated as medium**. Increased temperatures will cause a change in the cycle of forest growth (growth will be reduced and this also may lead to forests drying – up). Each extreme weather event will inflict damage to forests: damage and tree mortality due to extreme cold with frost, root damage and death in cases of heavy rainfall, flooding and soil erosion or physical damage caused by storms. The increased risk of fire in periods of heat waves and droughts should be noted as one of the main dangers that contribute to the vulnerability of forest systems. Particular vulnerability may be expected for forests in the inner ring of the green areas (Makiš forest, Košutnjak and Topčider, Manastir forest, Banjica forest, Zvezdara forest), forests in flood-prone areas of the Danube (particularly on its left bank in the Banat area), forests in Pančevački Rit, as well as at parts of the forests in the outer ring (Miljakovačka and Lipovička forest, etc.).

The vulnerability of biodiversity and ecosystems in Belgrade as an effect of heat wave and drought is estimated to be high, due to high exposure and low capacity to adapt. All plant and animal species with low capacity to adapt to changing climatic conditions would be jeopardised in this case. Heat waves can cause alterations of flora and fauna and the emergence of new and invasive species. Mortality of plants and animals would increase and this would result in the loss of some species and migration of animals. **The vulnerability of biodiversity and ecosystems to the effects of extreme cold is estimated as medium**.

Mapping current vulnerability to extreme weather events of the administrative area of Belgrade

Figure 2 shows the spatial distribution of potential climate change impacts related to the highly vulnerable receptors within the administrative territory of Belgrade. Figure 3 shows the spatial distribution of potential climate change impacts related to the highly vulnerable receptors within the boundaries of the area covered by the Master Plan of the City of Belgrade.

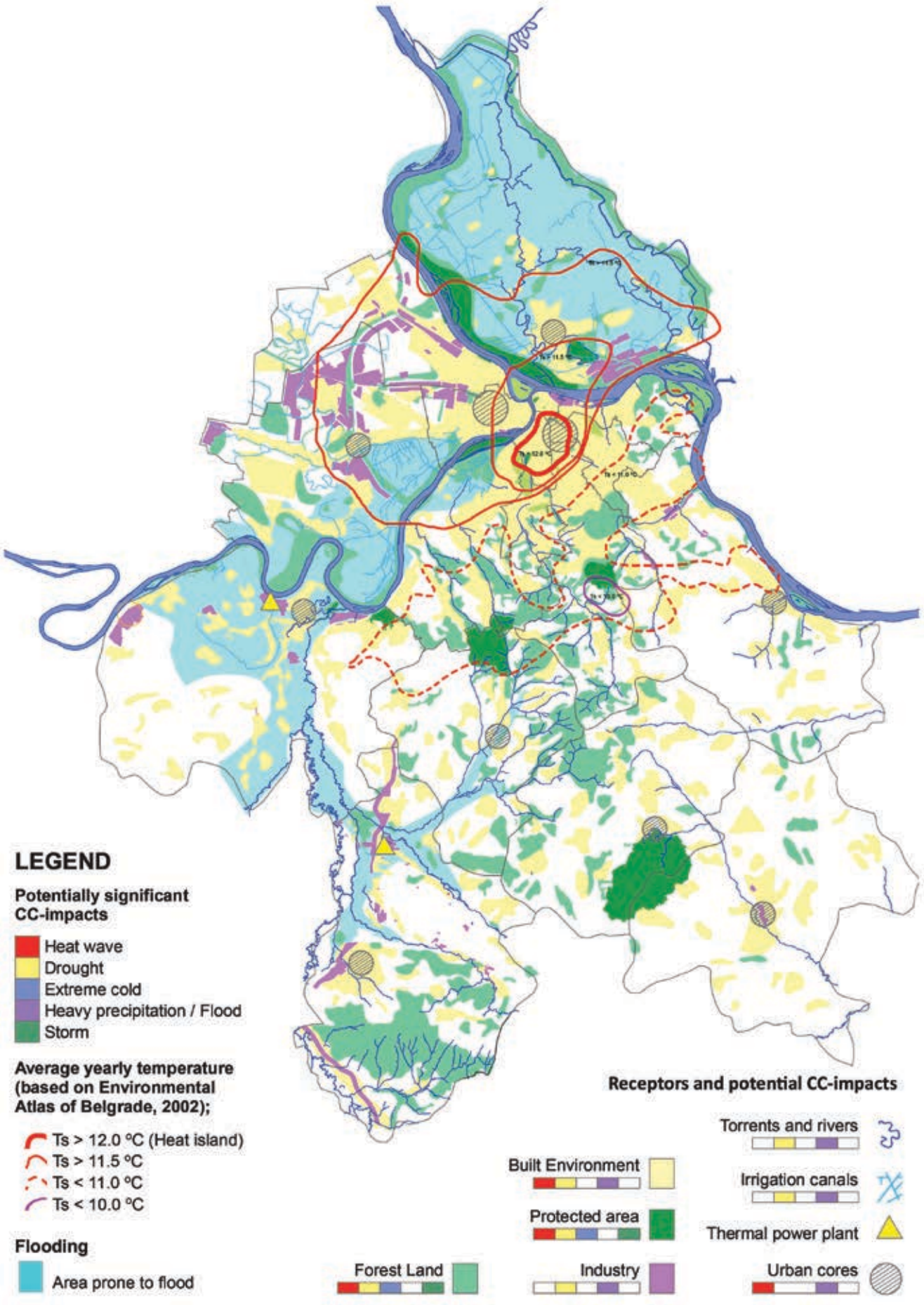

Figure 2. Spatial distribution of potential climate change impacts related to the highly vulnerable receptors within the administrative territory of Belgrade

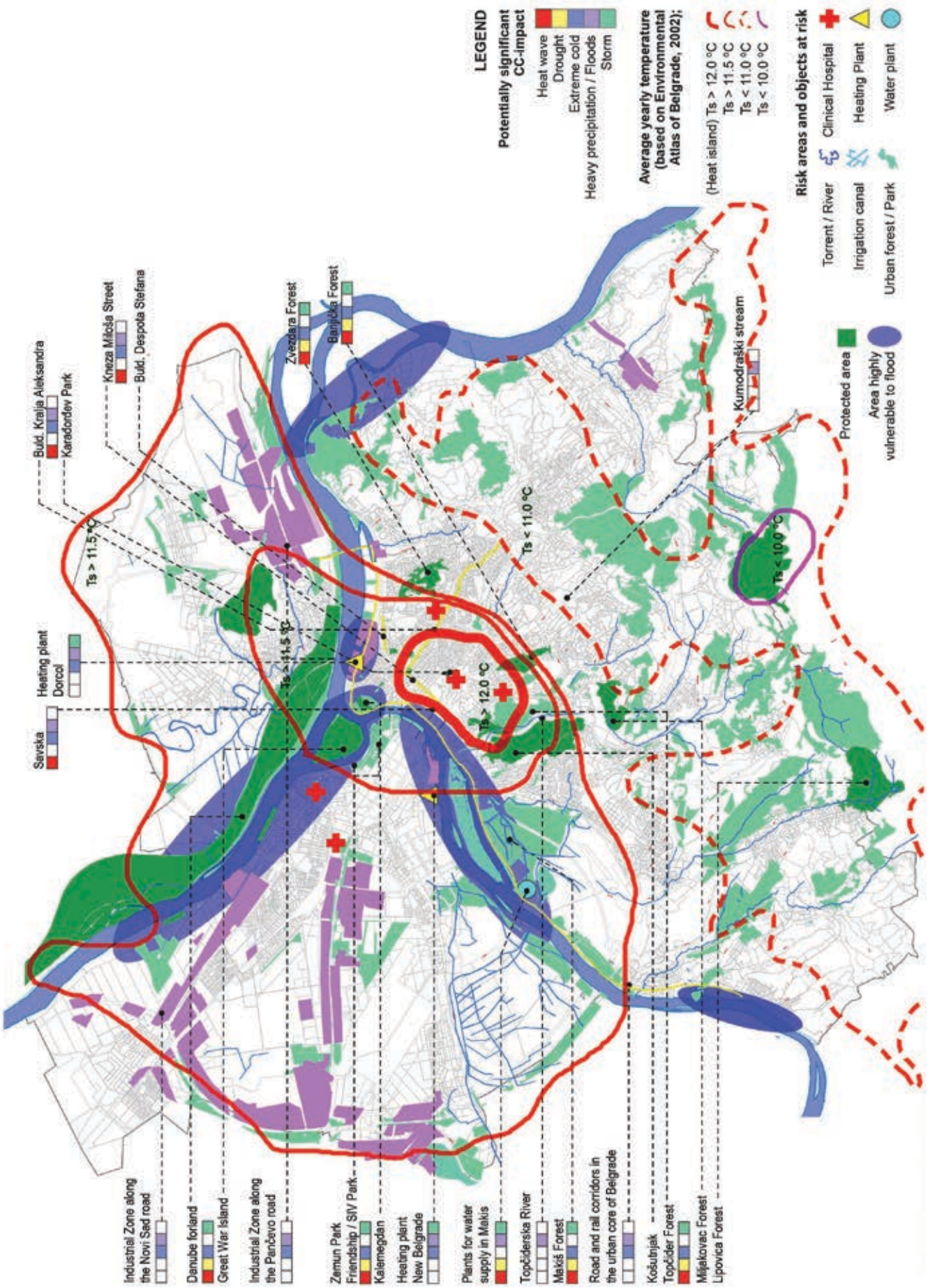

Figure 3. Spatial distribution of potential climate change impacts related to the highly vulnerable receptors within the boundaries of the area covered by the Master Plan of the City of Belgrade

Both figures are a schematic representation of the territorial distribution of the strongest potentially significant impacts of climate change (heat waves, droughts, extreme cold, extreme precipitation and/or floods, storms), bearing in mind the current vulnerability of individual receptors to the effects of extreme weather events, as was discussed in the previous chapters. As this Climate Change Adaptation Action Plan and Vulnerability Assessment has been developed for the administrative territory of Belgrade, Figure 2 shows the territorial distribution of potentially significant impacts of climate change within the administrative territory of Belgrade, while Figure 3 shows the territorial distribution of potentially significant impacts of climate change for the area covered by the Master Plan of Belgrade, with more details in a suitable scale. Both figures should be seen as schematic representations.

CLIMATE CHANGE TRENDS

Observed climate changes

An analysis of observed changes was undertaken for the Initial Communication of Serbia under the United Nations Framework Convention on Climate Change. Conclusions for the area of Belgrade are:

Temperatures

In the period analysed (1949–2009) Belgrade registered the highest increase of air temperatures within the Republic of Serbia. The analysed daily data shows a warming trend for the mean annual air temperature (see Figure 4). The highest increase in temperature was registered in the spring and summer (see Table 2).

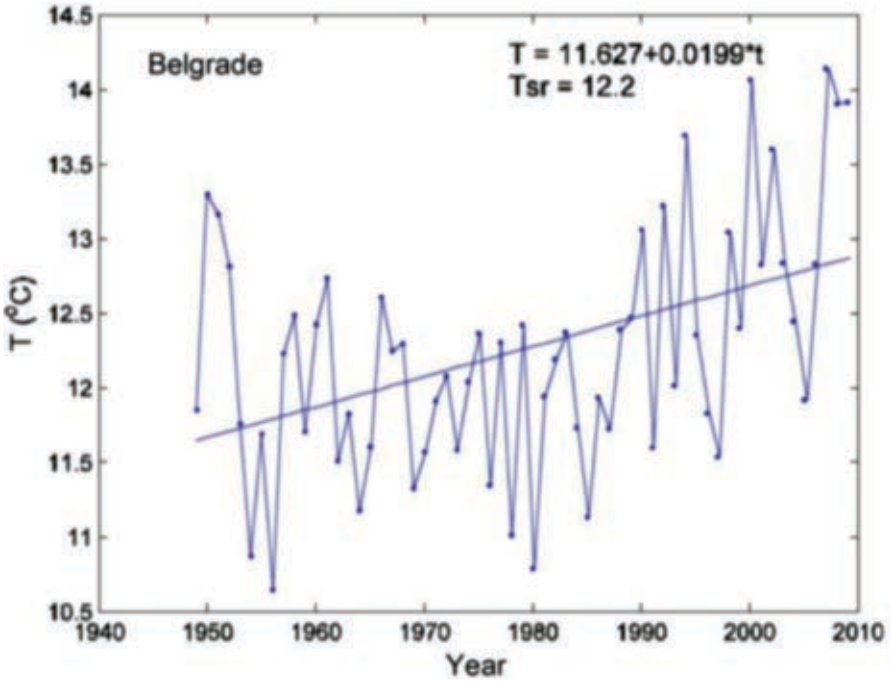

Figure 4. Mean annual air temperature (°C) 1949–2009

Source: Initial Communication of Serbia under the United Nations Framework Convention on Climate Change

Table 2. Mean air temperature rise by season (°C/decade) in the period 1949–2009

WINTER	SPRING	SUMMER	AUTUMN	ANNUAL	60 YEARS
0.20	0.32	0.26	0.04	0.20	1.2

Source: Initial Communication of Serbia under the United Nations framework convention on climate change

Precipitation

In the period analysed (1949–2009) a slight rise in mean annual precipitation was recorded (see Figure 5). The seasonal trends show a decrease during winter and spring and an increase during summer and autumn (see Table 3). The number of days with heavy precipitation increased for the whole of Serbia.

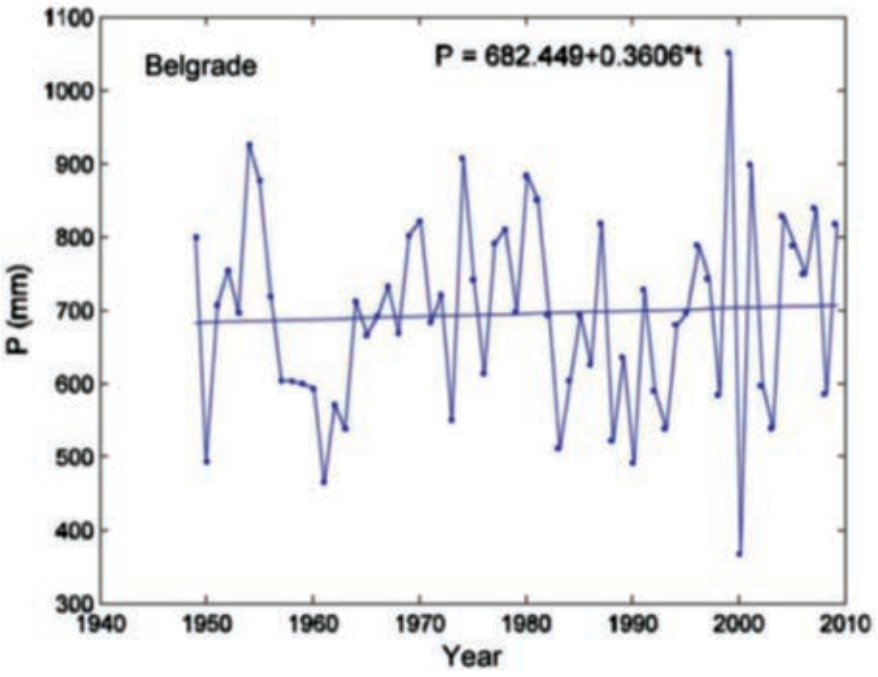

Figure 5. Mean annual precipitation (mm) 1949–2009

Source: Initial Communication of Serbia under the United Nations Framework Convention on Climate Change

Table 3. Precipitation trend by season (mm/year), 1949–2009

WINTER	SPRING	SUMMER	AUTUMN	ANNUAL
–0.101	–0.530	0.473	0.486	0.361

Source: Initial Communication of Serbia under the United Nations Framework Convention on Climate Change

Climate Change Scenarios

Here follow some conclusions on climate change projections made using the climate model of the ORIENTGATE project (http://www.orientgateproject.org/) for the time periods 2021–2050 and 2071–2100 in comparison to the reference period 1971–2000 (Đurđević and Kržić, 2014). The modelling uses the RCP8.5 scenario.

Temperatures

The modelling results indicate a further increase in air temperatures, in the mean annual temperatures as well as mean seasonal temperatures (with a relatively higher increase in autumn and winter) and in the number of hot days per year. Results for the “medium” scenario (A1b), described in Serbia’s Initial Communication under the United Nations Framework Convention on Climate Change also indicate a temperature rise in the last 30 years of the 21stcentury ranging from 2.4 to 2.8 degrees relative to 1961–1990.

Table 4. Projected air temperature changes in Belgrade

Change of	Future time period compared to the reference period 1971 – 2000	
	2021 – 2050	2071 – 2100
– mean annual temperature	+2°C (+2,05°C)	(+5,65°C) +5,6°C
– mean seasonal temperature		
winter	+2,95°C	+6,3°C
spring	+1,7°C	+4,65°C
summer	+1,25°C (+1,3°C)	+5,4°C (+5,45°C)
autumn	+2,4°C	(+6,05°C) +6,10°C
– number of hot days per year (temperature over 25°C)	+12	+60
Figures in parenthesis refer to results of the projection for smaller parts of Belgrade area.		

Source: Climate modelling results provided by Vladimir Đurđević, Institute of Meteorology, Faculty of Physics & South East European Virtual Climate Change Center, December 2014.

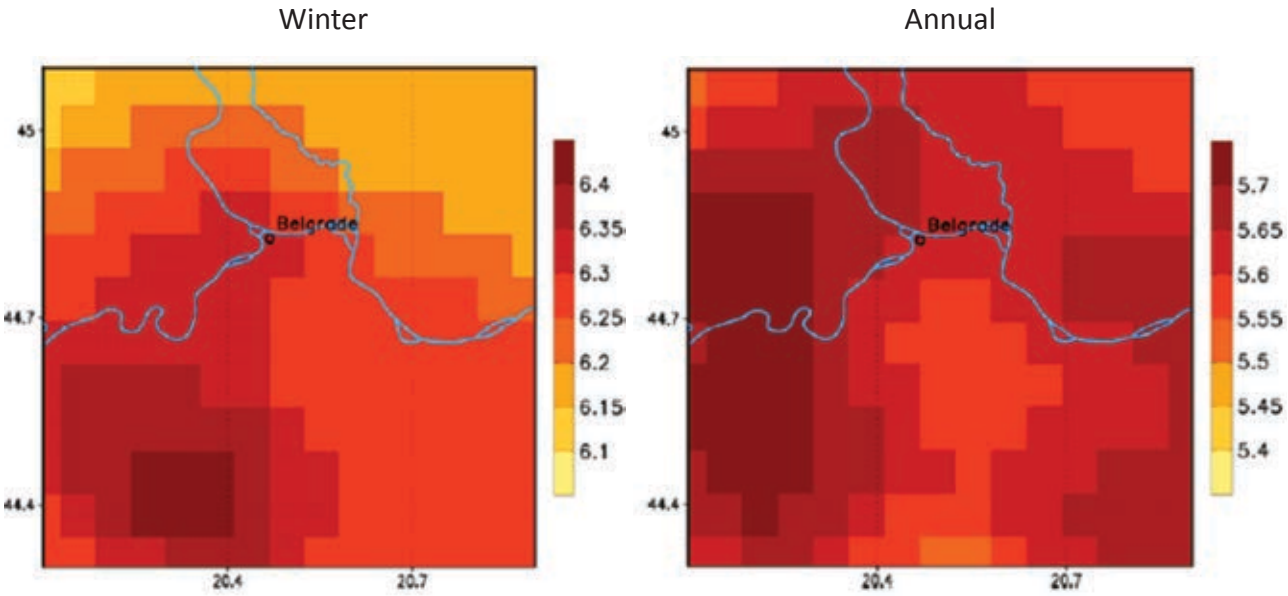

Figure 6. Projected change of mean temperature 2071–2100 relative to 1971–2000

Source: Climate modelling results provided by Vladimir Đurđević, Institute of Meteorology, Faculty of Physics & South East European Virtual Climate Change Center, December 2014.

Precipitation

The results of the modelling indicate only slight changes of the amount of precipitation, both for the mean annual, as well as for winter, spring and autumn season precipitation. A noticeable decrease during summer is projected (ranging from minus 20 to minus 40 percent) for the last 30 years of the 21st century. The very slight increasing trend during spring for the period until 2050 is still within the natural variability. The modelling results

indicate no change in the mean annual number of days with heavy rain (over 20 mm). The results concerning the accumulation of rain on these days indicate a slight to moderate increase in the intensity of rain for both future periods.

Table 5. Projected precipitation changes in Belgrade

	Future time period compared to the reference period 1971 – 2000	
Change of	**2021 – 2050**	**2071 – 2100**
– mean annual precipitation	+0 to 10%	–10 to –20 %
– mean seasonal precipitation		
winter	0 to –10%	0 to +10%
spring	+10 to +20%	0 to –10%
summer	0 to +10%	–20 to –40%
autumn	0 to +5%	–5 to –10%
– number of days with heavy rain (over 20mm) per year and accumulation changes during these days (in brackets) per year	0 to 0.5 (+10 to +40%)	0 to 0.5 (+10 to +20%)

Source: Climate modelling results within the framework of ORIENTGATE Project (Institute of Hydro–meteorology of the Republic of Serbia, South East European Virtual Climate Change Centre and the Institute of Meteorology of the Faculty of Physics, December 2014).

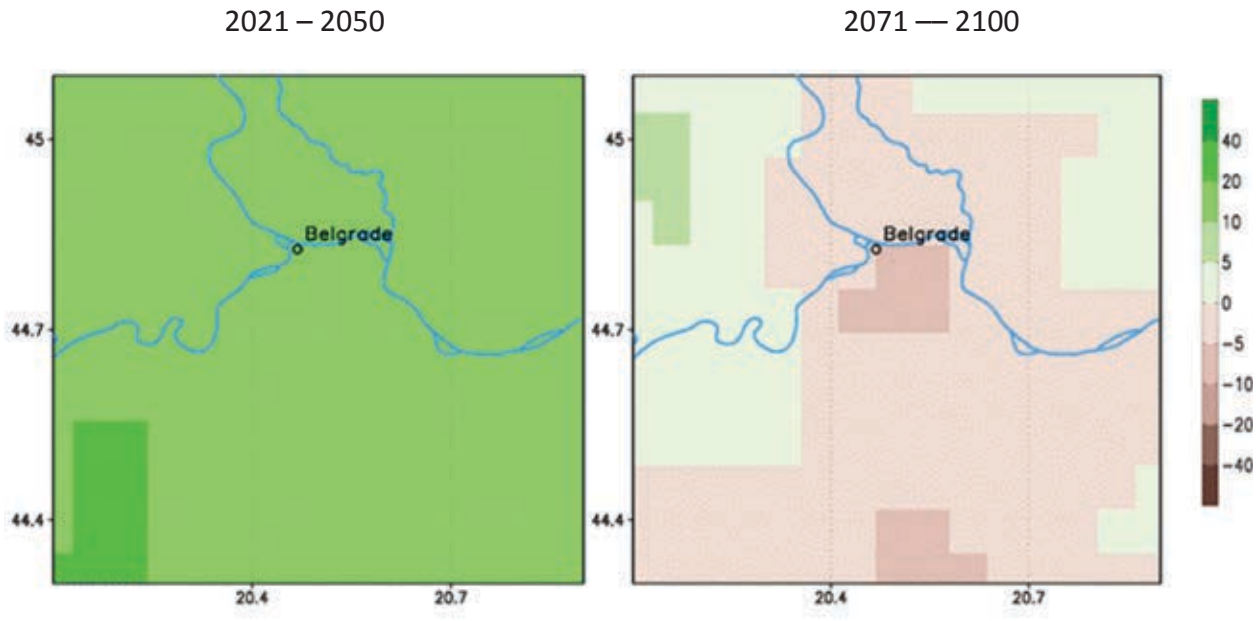

Figure 7. Change of mean precipitaiton (%) during spring for 2071–2100 relative to 1971–2000

Source: Climate modelling results within the framework of ORIENTGATE Project (Institute of Hydro–meteorology of the Republic of Serbia, South East European Virtual Climate Change Centre and the Institute of Meteorology of the Faculty of Physics, December 2014).

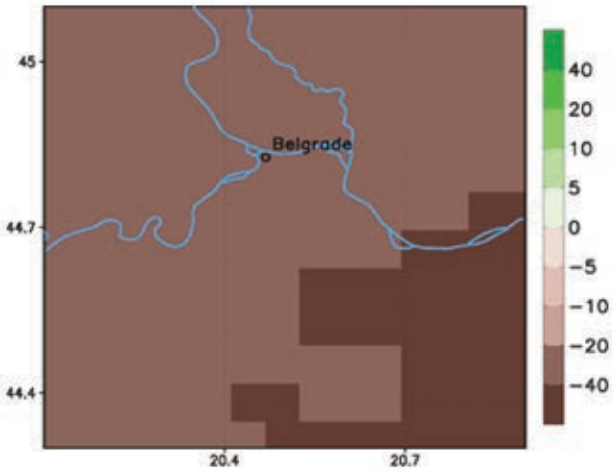

Figure 8. Change of mean seasonal precipitation (%) during summer for 2071–2100 relative to 1971–2000

Source: Climate modelling results within the framework of ORIENTGATE Project (Institute of Hydro–meteorology of the Republic of Serbia, South East European Virtual Climate Change Centre and the Institute of Meteorology of the Faculty of Physics, December 2014).

Wind

The modelling results indicate no decisive changes of the mean annual and seasonal wind for both future periods, the projected change is within a small percentage range (from minus 3 to plus 3 percent). An increase of wind is projected for the summer season. According to projections, the number of days with strong wind – here calculated as days exceeding the threshold of the 90th percentile — will increase slightly (by 5–15 percent) in the last 30 years of the 21stcentury, mainly during summer. In the reference period, this threshold amounted to 10%.

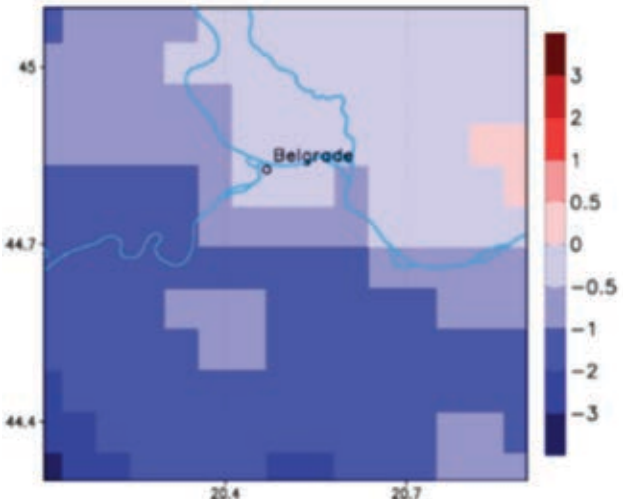

Figure 9. Change of mean annual wind speed (%) for 2071–2100 relative to 1971–2000

Source: Climate modelling results within the framework of ORIENTGATE Project (Institute of Hydro–meteorology of the Republic of Serbia, South East European Virtual Climate Change Centre and the Institute of Meteorology of the Faculty of Physics, December 2014).

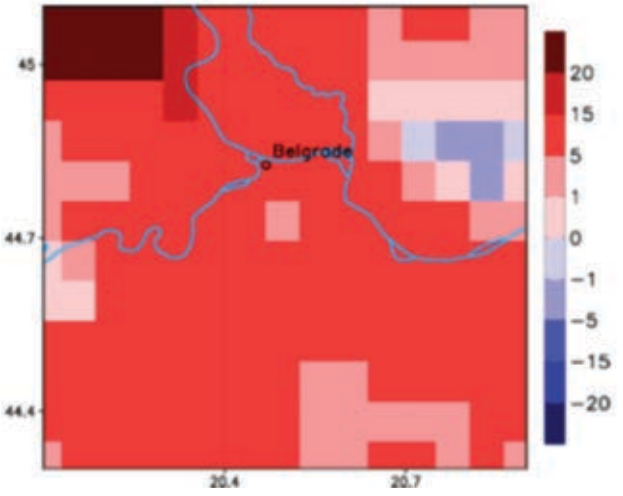

Figure 10. Change (in %) in the number of days with strong wind (90p) during summer for 2071–2100 relative to 1971–2000

Source: Climate modelling results within the framework of ORIENTGATE Project (Institute of Hydro–meteorology of the Republic of Serbia, South East European Virtual Climate Change Centre and the Institute of Meteorology of the Faculty of Physics, December 2014).

Scenario analysis

Here we present some conclusions of climate change projections made using the climate modelling methodology of the ORIENTGATE project for the time periods 2021–2050 and 2071–2100 relative to the reference period 1971–2000. The modelling uses the RCP 8.5 scenario.

Background on the projections:

- Downscaling run over Serbia, from 1971 to 2000 – reference period run from 2011 to 2100 – RCP 8.5 scenario; the RCP 8.5 scenario (Representative Concentration Pathways - RCPs), at ~8 km resolution, corresponds to the pathway with the highest greenhouse gas emissions and was chosen in the ORIENTGATE project because there is no observable declining tendency for greenhouse gas emissions currently.
- Integration was done using the Non–hydrostatic Multi–scale Model (NMMB), which is a regional model. The model was developed at –the National Oceanic and Atmospheric Administration/National Centres for Environmental Prediction – USA (NOAA/NCEP), and CMCC-CM (www.cmcc.it) global climate model results were used for boundary condition.

Results are publicly available at high resolution, approx. 8 km.

Temperature

The observed impacts and vulnerabilities in spring and summer will be reinforced due to expected rising air temperatures and increasing number of hot days. The average air temperatures in winter are expected to increase. Cold extremes are therefore less probable. A balancing effect can be expected.

Precipitation

There is no substantial difference in the general precipitation trends between the time periods 2021–2050 and 2071–2100, except for summer precipitation trends. At the end of the 21stcentury, fewer precipitations, higher air temperatures and consequently higher evaporation rates could cause longer and more frequent droughts in the summer. No decisive change in the average autumn and winter rainfall is expected for both future periods. However, in autumn, rising temperatures, more evapo-transpiration and a longer vegetation period could result in more droughts.

Although no changes are expected in the number of days with heavy precipitation, a more extreme regime with increasing intensity of rain is expected. Heavy precipitation events are more pronounced in spring and summer than in autumn and winter (as shown in the analysis of former extreme weather events).

Winds and storms

An increasing tendency during summer can lead to reinforcing current vulnerabilities, i.e., to trends that intensify the existing situation. –For example, summers are becoming warmer, –which may result in increasing current sensitivity in the future. On the other hand, no substantial changes are expected during winter.

Table 6. Conclusions of the scenario analysis for the 2021–2050 period

Key parameter	Spring/summer	Winter	Consequences for weather events – spring/summer	Consequences for weather events – autumn/winter
Air temperatures and number of hot days	Increasing	Increasing	Heat waves – reinforcing in summer	Cold – balancing in winter
Precipitation	No changes expected	No changes expected	Drought – indifferent in spring/summer	Drought – indifferent in autumn/winter
Rain intensity on days with heavy precipitation	Increasing	No changes expected	Heavy precipitation/ floods – reinforcing in summer	Heavy precipitation/ floods – indifferent in winter
Storm/Wind	Increasing	No changes expected	Storm/Wind – reinforcing in summer	Storm/wind – indifferent in winter

Table 7. Conclusions of scenario analysis for the time period 2071–2100

Key parameter	Spring/summer	Winter	Consequences for weather events – spring/summer	Consequences for weather events – autumn/winter
Air temperatures and number of hot days	Increasing	Increasing	Heat waves – reinforcing in summer	Cold – balancing in winter
Precipitation	Decreasing	No changes expected	Drought – reinforcing in summer	Drought – indifferent in winter
Rain intensity on days with heavy precipitation	Increasing	No changes expected	Heavy precipitation/ floods –reinforcing in summer	Heavy precipitation/ floods –indifferent in winter
Storm/wind	Increasing	No changes expected	Storm/wind – reinforcing in summer	Storm/wind – indifferent in winter

Expected future changes in weather conditions in Belgrade

Spring and summer:

- **Heat waves – reinforcing:** the average air temperature in summer will increasing. Additionally, heat waves are expected to happen more often and last longer in future.
- **Rain intensity on days with heavy precipitation – reinforcing: increasing** rain intensity is expected.
- **Storms – reinforcing:** an increasing tendency is expected, could lead to reinforcing current vulnerabilities during summer.

Autumn and winter:

- **Extreme cold – balancing:** the average air temperature in winter will increase. Cold extremes are therefore expected to be less probable.

Future risks and opportunities

The changing climate conditions lead to an increasing number of risks but also offer opportunities. The assessment of future risks and opportunities was based on the results of the vulnerability assessment, described in the chapter "Vulnerability Assessment" and the projected climate change impacts, described in the chapter "Scenario Analysis".

The future risks were evaluated for different weather sensitivities of each receptor (heat wave, extreme cold, drought, heavy precipitation/floods and storm)., and were ranked as very high, high, medium and low. The categories of future risks were assessed using the evaluation matrix below, that combines the current vulnerability classes (high, medium, low) and climate change impact (balancing, indifferent, reinforcing).

Current vulnerability	Climate change impact		
	Balancing	Indifferent	Reinforcing
High	**Medium**	**High**	**Very high**
Medium	**Low**	**Medium**	**High**
Low	**Low**	**Low**	**Medium**

Results of the analysis of future risk and opportunities are presented in Annex 4. Following chapters will summarise those results for particular receptors.

Expected future risks of climate change in Belgrade

Spring / Summer	RISK				
	Heat wave	Extreme cold	Drought	Extreme precipitations / floods	Storms
Public health/vulnerable groups	Very High		High	Very High	High
Traffic infrastructure	High		Medium	Very High	High
Electricity and heating services	High		High	Very High	Very High
Water supply and sewage	Very High		Very High	Very High	Very High
Social infrastructure	High		Very High	Medium	Medium
Building stock and materials	Very High		High	Very High	High
Tourism	Medium		High	Medium	Medium
Industry	High		High	Very High	Medium
Retail	High		Medium	Medium	Medium
Green spaces	Very High		Very High	High	Very High
Water resources and quality	Very High		Very High	High	High
Air quality	Very High		High	Very High	
Agriculture	Very High		Very High	Very High	Very High
Forestry	Very High		Very High	High	Very High
Biodiversity and ecosystems	Very High		Very High	Medium	Medium

Autumn/Winter	RISK				
	Heat wave	Extreme cold	Drought	Extreme precipitations / floods	Storms
Public health / vulnerable groups		Medium	Medium	High	Medium
Traffic infrastructure		Medium	Low	High	Medium
Electricity and heating services		Medium	Medium	High	High
Water supply and sewage		Low	High	High	High
Social infrastructure		Low	High	Low	Low
Building stock and materials		Medium	Medium	High	Medium
Tourism		Low	Medium	Low	Low
Industry		Medium	Medium	High	Low
Retail		Low	Low	Low	Low
Green spaces		Medium	High	Medium	High
Water resources and quality			High	Medium	Medium
Air quality		Medium	Medium	High	
Agriculture		Medium	High	High	High
Forestry		Medium	High	Medium	High
Biodiversity and ecosystems		Low	High	Low	Low

As a result of above mentioned risks, the following consequences can be expected:

Population:

- Reinforcement of heat stress and increasing number of deaths during the heat waves, altered allergic patterns and increasing spread of new vector-borne and infectious diseases;
- Decreased air quality followed by more respiratory difficulties and increased allergic reactions through pollen flight and other allergens during the droughts;
- Growing spread of diseases due to contaminated water, increasing damages and injured through flooding and increasing utilisation of health care system;
- Increasing number of injured and deaths during the storms.

Infrastructure:

- Transport infrastructure may be severely damaged during the floods, heat waves and storms, which will cause higher maintenance and rebuilding costs and impaired mobility;
- There is also high risk of damage to electricity and heating services during extreme cold, heat waves, storms and floods that may cause a reduction in electricity production, problems with distribution and higher maintenance costs. Hydropower potential may be reduced during droughts;
- Water supply and sanitation services in Belgrade are at very high risk, particularly during heat waves and droughts. Water availability may be significantly reduced due to higher water demand. Moreover, the problems in distribution, water quality deterioration and higher maintenance costs can be expected. Intensification of heavy precipitation, more frequent floods and storms may damage the water and sanitation infrastructure;
- Social infrastructure is at high and very high risk in summer during heat waves and droughts, respectively. This may cause problems with water supply for health care

facilities and higher pressure on social infrastructure institutions. Moreover, increasing use of cooling systems may cause higher costs and pressure to electricity system;

Building environment:

- Building stock and materials will probably face more damage due to high and very high risk of heath waves, droughts, and storms in summer and floods in summer and winter.

Economy:

- Tourism is under high risk of more frequent and severe droughts in summer. Water supply costs may increase and water quality in public areas may deteriorate.
- The risk of floods is very high for the Belgrade industry. This can lead to increased damage to stocks or equipment, or loss of business continuity. Moreover, there is high risk of droughts in summer.

Natural resources:

- Green areas in Belgrade are under severe risk: very high risk of heat waves, droughts and storms in summer, including high risk of heavy precipitation and floods. Moreover, green spaces are at high risk of droughts and storms in winter. This means that the green infrastructure and vegetation may suffer serious damage due to weather conditions and wildfires. Maintenance costs will increase, including higher costs of watering green areas.
- Water resources in Belgrade are also under high and very high risk during the summer. This may lead to problems with water supply, due to lower water recharge and deterioration of water quality in open watercourses. The high risk of droughts is extended to the winter season, as well.
- There is a very high risk of air quality deterioration due to extended heat waves and heavy precipitations and floods, as well as droughts. This may lead to increasing spread of diseases, reinforcement of smog and increasing concentration of air pollutants and allergens.
- Agriculture is under severe risk as a consequence of climate change. The risks of extreme heat, droughts, floods and storms are very high in summer, while the risk of droughts, floods and storms is also high in winter. The consequences can be numerous: changes in the growth cycle and decreasing diversity of species; increasing number of pest infestations; growing need for irrigation; loss of harvest; higher incidence of damage to/death of plants; increasing risk of fire; erosion; etc.
- Similarly, forests in the area of Belgrade are under very high risk in summer, and increasingly so in winter. Heat waves and droughts may lead to changes in the growth cycle, resulting in damages to and dying of trees. Heavy precipitation, floods and storms can cause soil erosion and serious damages to the forest flora. During heat waves and droughts, the risk of forest fires will increase.
- Finally, biodiversity and ecosystems are at very high risk of heat waves and droughts in summer. This may lead to the loss of some species, and occurrence of new and invasive species.

Expected future opportunities of climate change in Belgrade

Some new opportunities may also occur in Belgrade as a result of climate change, almost exclusively in the winter period. Milder winters may cause fewer problems because of lesser snowfall amounts. A reduction in frost and ice days may lead to less damages and limitations in all sectors of transport. The intensity and frequency of respiratory illnesses may decline. Further future opportunities are listed in annex 4.

Adaptation Action plan

Climate change adaptation measures for the City of Belgrade are listed in the Table 9, including the explanation of measures, relevant locations, institutions responsible for the implementation, priority level for the implementation, and the time frame.

Relevant locations for the implementation of the envisaged measures were determined by the Working Group, based on the estimated vulnerability to the effects of climate change and the overall risk.

Implementing institutions are determined on the basis of the existing organization of the City Administration of Belgrade, and the responsibilities that each institution within the organization has.

The level of priority for implementation is determined on the basis of four criteria:

- the expected overall effects of the measures taken, which includes positive effects, and the problems to be solved and/or the consequences to be remedied by the measures foreseen;
- the urgency of taking measures;
- the expected social effects of the adopted measures, which evaluates the confidence and trust of citizens, which should also lead to better interaction and cooperation between citizens and institutions in critical situations but also in the prevention;
- the coverage of the administrative territory of Belgrade.

The working group determined the weight coefficients for each criterion, shown in Table 8.

Table 8. The weight coefficients for the criteria used to evaluate the level of priority for the implementation of the Climate Change Adaptation Action Plan for the City of Belgrade

The expected overall effects of the measure taken	0.4
The urgency of the measure taken	0.2
The expected social effects	0.1
The coverage of the administrative territory of Belgrade	0.3

The Working Group ranked the level of priority for the measures envisaged in the Action Plan on a scale of 1 to 5 according to each of the proposed criteria. The total score is obtained by adding the sum of the individual score and the corresponding weight coefficients for the measure. Depending on the total scores, climate change adaptation measures are ranked as **very high priority** (total score above 4.5), **high priority** (total score between 3.5 and 4.5), **medium priority** (overall between 3 and 3.5) and **low priority** (total score less than 3).

According to the time frame for their implementation all planned measures are classified as short term (with an implementation period of up to two years), medium term (with an implementation period of 2 to 5 years), long term (with an implementation period of over 10 years) and continual.

Table 9. List of climate change adaptation measures

No.	Type of measure	Comments/explanation regarding implementation in Belgrade	Relevant locations	Implementing agencies	Priority	Time frame
Urban green structures						
1	Green infra–structure	Green infrastructure refers to the network of nature friendly spaces (parks, gardens, forests, green corridors, waterways, alleys, open rural areas, systems formed with the natural processes of infiltration of rain water, waste water treatment, etc.) that protects and facilitates the maintenance of ecosystem services, or provides environmental, economic, cultural and other benefits to the quality of life of people, plants and animals, as well as their development in natural conditions. The measure includes: • assessment of existing green infrastructure features/elements and its functionality in order to identify how it needs to be improved and where there is a need to enhance connectivity; • improvement of the health of or converting an area/ecosystem back to its natural state; • creation of connectivity features, new green (urban) areas, sustainable use areas, habitats (forest area, etc.);	City–wide, in accordance with the concept of green areas developed in the framework of the Green Regulation of Belgrade and the Plan of General Regulation of the System of Green Areas of Belgrade.	• City of Belgrade –Secretariat for housing and communal utilities; • Secretariat for the Environment; • Secretariat for Urban Planning and Construction; • Public Utility Belgrade Greenery; • Institute for urban planning of Belgrade; • Serbian Forest Company; • Other institutions;	Very High	Medium term
2	Green open spaces	Green areas (public green spaces – parks, squares; green areas along the shoreline of the Danube and Sava rivers; protective green belts; green corridors; green spaces within public facilities – schools, kindergartens, hospitals, etc.; green spaces for other uses– yards of individual residential buildings, industrial complexes, etc.) all have a positive impact on natural resources such as air, water, land, flora and fauna and thus constitute the "climate infrastructure" of the city. As areas of natural, cultural and aesthetic value for the city, these are places that residents use for meeting, contact, communication, education, recreation and enjoyment, which positively affects the psychological and physical health of people and contribute to the recognition of the social dimension of the city. This measure implies the creation of new and rehabilitation and maintenance of existing urban green areas (urban parks, courtyards, urban gardens, green canopy structures), combined with water surfaces (fountains and waterworks) that provide shaded areas for pedestrians and enable recreational activities.	City–wide, in accordance with the concept of green areas developed in the framework of the Green Regulation of Belgrade and the Plan of General Regulation of the System of Green Areas of Belgrade.	• City of Belgrade –Secretariat for housing and communal utilities; • Secretariat for the Environment; • Secretariat for Urban Planning and Construction; • Public Utility Belgrade Greenery; • The Institute for urban planning of Belgrade; • Serbian Forest Company;	High	Medium term
3	Green alleys	A green alley is a series of nursery cultivated tree seedlings planted, as a rule, equally spaced, in the edges and/or median regulations of roads, in the form of a one-sided/double-sided, single row/multiple-line the avenue. This measure implies the formation of alleys along the streets between the road and sidewalks. The measure includes the maintenance of existing alleys, as well as planting new trees along existing and new streets.	Citywide, in accordance with the concept of green areas developed in the framework of the Green regulation of Belgrade and the Plan of General Regulation of the System of Green Areas of Belgrade	• City of Belgrade –Secretariat for housing and communal utilities; • Secretariat for the Environment; • Public Utility Belgrade Greenery;	High	Medium term

No.	Type of measure	Comments/explanation regarding implementation in Belgrade	Relevant locations	Implementing agencies	Priority	Time frame
4	Green roofs	This measure envisages designing and building roofs that are fully or partially covered with vegetation planted in a growing medium (soil, sand or gravel), over a waterproof membrane. Vegetation should consist of plants or trees well-suited for Belgrade weather conditions. Systems range from extensive green roofs created on a shallow soil base by planting vegetation such as grass, sedum, mosses, flowering plants and similar, which are designed to be self-sustaining and require minimum maintenance, to intensive green roofs with a deeper soil layer (over 60 cm) that can hold shrubs and trees, which require more maintenance, (roof gardens).	• Vračar municipality (70% of territory with high potential for green roofs); • Stari Grad, Novi Beograd,Savski Venac, Palilula, Zemun – where the share of elderly (more vulnerable population) is higher • Public buildings with flat roofs; • Newly designed commercial and industrial buildings;	• Building owners, with the support of City of Belgrade – Secretariat for Communal Affairs and Housing, and Belgrade Greenery;	Medium	Short term, continual
5	Green walls	Green walls are vertical green spaces formed by planting plants that grow on, along or near the façade (vertical surface) of the building.	New commercial zones along the highway, Zrenjanin road, and Vrčin interchange;	• Building owners, with the support of City of Belgrade – Secretariat for Communal Affairs and Housing, and Belgrade Greenery;	Medium	Short term, continual
Water systems						
6	Flood protection	Flood protection involves a combination of measures, ranging from the reconstruction of the embankment in the protection system, reconstruction (overtop) of walls of the quays; reconstruction and construction of river dikes and quays; to the construction of small reservoirs, retentions and regulation of river beds on smaller internal watercourses.	• Embankment in Novi Beograd and Zemun (reconstruction); • Embankment from the delta of the Sava river to Block 70a on the left bank of the Sava (reconstruction); • Parts of the embankment on the right bank of the Sava, from its delta to the upstream barrier at Ada Ciganlija, including embankments near Ostružnica and Umka (reconstruction); • Embankment of the lower course of the Topčider river (reconstruction); • Velikoselski Rit, Ada Huja, upstream from the "Šaran" restaurant (reconstruction and construction of river bank revetments and quays); • Smaller internal watercourses (construction of small reservoirs, retentions and regulation of river beds);	• Serbian Water Company; • Belgrade Water Company	Very high	Long term

No.	Type of measure	Comments/explanation regarding implementation in Belgrade	Relevant locations	Implementing agencies	Priority	Time frame
7	Water retentions	Retention basins should be designed and built as local storm water control facilities, i.e. basins that temporarily store excess storm runoff and then discharge it at a rate not to exceed the downstream channel capacity. The retention basins should provide the 100-year runoff storage volume at the outfall point of the developed watershed.	• Topčider river watershed: Palanka stream; Dučevac stream; location Zbeg on Ciganska Reka; Kovinski Potok stream; Šutilovački Potok stream; location Resnik on Sikijevac stream; Prečica stream; • Železnička Reka watershed, • Mokroluški Potok watershed, • Kumodraški Potok (upper stream) watershed, • Kijevski Potok watershed, • Rakovički Potok watershed, • Vranovački Potok watershed, • Gleđevački Potok watershed;	• Belgrade Water Company	High	Medium term
8	Water saving and reuse	• Development and implementation of Water conservation plan for Belgrade, including the measures for water distribution optimization, water harvesting and reuse, water saving measures in households; water consumption monitoring systems in industry and households, etc.; • Improvement of water distribution systems and better water management; • Reduction of losses through better leakage management; • Increase of the capacity of drinking water reservoir through the construction of new reservoirs for drinking water and rehabilitation of the existing;	• Most of the Belgrade water supply network; • Households, particularly in suburban and rural communities; • Industrial facilities with extensive use of water;	• City of Belgrade –Secretariat for housing and communal utilities; • Belgrade Waterworks and Sewerage Company;	High	Medium term
9	Water drainage	• Design, build and maintain urban rainwater collectors and open canals for draining rainwater, including the regulation of streams; • Extend the use of water permeable surface materials for the paving in new development areas;	• Kalovita, Sebeš, Galovica and Sibnica open channels; • Regulation of Žarkovački Potok stream; • Rainwater collector Čukarička Padina; • Rainwater collector Zemun Polje – Danube; • Rainwater collector for storm water drainage at the Pančevacki Rit industrial zone; • New development areas;	• Belgrade Water Company	High	Medium term
10	Extension of water supply services	• Increase capacity for drinking water production through the improvement of technological processing of recipient waters by introducing green technologies and BAT and by combining modern methods with conventional ones, in compliance with the requirements of environmental protection and sustainable development; • Building or repairing fountains and public drinking fountains in urban areas of Belgrade, which will serve both for drinking water supply and for cooling effect;	Citywide, particularly in the densely populated inner city (Stari Grad, Vračar, Savski Venac, Novi Beograd).	• City of Belgrade – Secretariat for housing and communal utilities; • Belgrade Waterworks and Sewerage Company;	Medium	Short term
11	Rain water storage	This measure envisages the collection and storage of rain water for future use in water storage areas (water bodies, green areas, reservoirs).	Wetlands Veliko Blato, Bara Reva, Velikoselski Rit, as well as depressions in the lower areas of the Sava and Danube rivers; Urban retentions;	• Belgrade Waterworks and Sewerage Company	Low	Short term, continual

No.	Type of measure	Comments/explanation regarding implementation in Belgrade	Relevant locations	Implementing agencies	Priority	Time frame
Urban planning						
12	Urban planning to avoid flood risk	When drafting urban plans: • No need to plan the construction of buildings in areas at risk of flooding; • plan protection of areas which are potentially at risk of floods, in accordance with the specificity of the watercourses and catchment areas (biotechnical and biological protection); • Storm water services should be planned.	• Embankments on the Danube and Sava rivers in Belgrade (particularly lower plateaus in the Stari Grad municipality – from Beogradski sajam to the Sava estuary; Ada Ciganlija; Zemun) • Pančevaski Rit; Veliko Selo); • Watersheds of the Topčider and Barič rivers; • Lower areas of the municipalities of Savski Venac and Čukarica;	• City of Belgrade – Secretariat for Urban Planning and Construction • City of Belgrade – Secretariat for Transport	Very high	Medium term
13	Belgrade Climate Atlas	Development of a Climate Atlas for Belgrade metropolitan, presenting the distribution of temperatures and cold air flows according to the city's topography and land use (regional wind patterns, flows of cold air, air pollution concentrations, area classification based on the role that different locations play in air exchange and cool, based on topography, development density and character, and provision of green space. Based on that, recommendations should be provided for climate sensitive urban design.	N/A	• City of Belgrade – Secretariat for Urban Planning and Construction • City of Belgrade – Secretariat for the Environment;	Medium	Short term
14	Urban setting	• Planning the development of new urban structures must be aimed at forming a compact settlement structure with optimum access functions (trade, services, recreation, etc.) in the vicinity of residential areas, which directly aims to reduce transport needs, and thus emissions of greenhouse gases. • Protect and create cool air generating areas and ventilation paths to reduce urban heat islands. When planning or redeveloping new buildings/ neighbourhoods, cooling effects should be ensured by proper orientation of the buildings, streets and open spaces, and by keeping the ratio between height of a building and width of the street to be less than 1.To ensure that fresh cool air from green areas outside the city can flow in, plan the orientation of buildings and streets to increase ventilation in public areas. • Use appropriate measures of spatial and urban planning to harmonise economic development which has the effect of intensifying transport (and increasing emissions of SO2) with the principles and objectives of environmental protection and policies of adaptation to climate change (for example: economic zones that generate high traffic demand should be planned along the main transport corridors). In addition, wherever possible, achieve planning reserved transport infrastructure for public, pedestrian and bicycle traffic.	N/A	• City of Belgrade – Secretariat for Urban Planning and Construction	Medium	Short term

No.	Type of measure	Comments/explanation regarding implementation in Belgrade	Relevant locations	Implementing agencies	Priority	Time frame
15	Urban texture	Encourage the use of permeable surfaces in the design of landscapes, including the use of material which decreases the thermal load and/or which increase the reflection of sunlight (e.g. choosing lighter colours).	Densely built areas, areas of the city with insufficient amount of greenery, city centre, new residential areas, and new commercial zones.	• City of Belgrade – Secretariat for Urban Planning and Construction	Low	Medium term
Building design						
16	Heat adapted design	Control indoor air temperature in response to the changing exterior climatic conditions, through improved insulation of buildings, passive cooling, e.g. assisted natural ventilation of buildings, design of reflecting surfaces, design of semi-permeable pavement materials on roads or large parking, using bright colours on all surfaces, etc.	Densely built areas, areas of the city with little green space, city centre, new residential areas, new commercial zones	• Building owners, with the support of City of Belgrade – Secretariat for Urban Planning and Construction;	Low	Medium term, continual
17	Flood adapted design	Introduce guidelines for proper design in flood-prone areas, to avoid or minimise direct and indirect flood damages to buildings.	Flood prone areas (embankments on the Danube and Sava rivers in Belgrade, particularly lower plateaus in the Stari Grad municipality – from Beogradski sajam to Sava estuary; Ada Ciganlija; Zemun, Pančevaski Rit; Veliko Selo);	• City of Belgrade – Secretariat for Urban Planning and Construction;	Low	Medium term, continual
Non–structural measures						
18	Awareness raising and behaviour change	Implement activities that raise awareness on changing climatic conditions and the necessity of adaptation. Target groups may include the population, the administration, or specific target groups exposed to high risk. The measure comprises activities that will make target groups aware of the actual assessment of: – flood risks; – risks of heat waves; – the need to save water and – the implementation of other measures. Activities comprise providing information through media, public conferences, trainings; development and distribution of brochures about risks and prevention; actions and campaigns that aim to promote sustainable modes of transport; enforcement actions and campaigns for promoting the use of energy efficient means of transportation in all modes of transport; the use of renewable fuels and diversion of public demand from individual (car) to public transport, etc. Behavioural change aims to avoid or minimise the impacts of extreme weather events.		• City of Belgrade – Secretariat for the Environment; • City of Belgrade – Secretariat for Transport;	High	Medium term
19	Informing the public about adaptation to extreme events	This measure entails the development and dissemination of information materials to public institutions and utilities, private operators and households, about response to extreme weather events – heat, cold, floods; in particular, this activity will target vulnerable groups – elderly, children, population of informal settlements, etc.		• City of Belgrade – Secretariat for the Environment;	High	Medium term

No.	Type of measure	Comments/explanation regarding implementation in Belgrade	Relevant locations	Implementing agencies	Priority	Time frame
20	Institu–tional and organi-za–tional measures	Establish mechanisms for coordination of activi-ties: - within the city administration; - between the city administration and public utilities; - between the city administration and local gro-ups; - between the city administration and state admi-nistration.		• City of Belgrade; Secretariat for the Environment;	High	Short term
21	Warning system	Establish and/or advance the meteorological and hydrological system for early warning, including meteo-alarm, hydro-alarm and climate monito-ring system – Climate Watch System (CWS).		• City of Belgrade; Secretariat for the Environment;	High	Short term – Medium term
22	Land use and urban planning	Make estimates, check lists, etc. Through urban planning and urban renewal projects strive to reduce the impact of heat waves, resilience to flooding, building insulation, allow discussion of the goals of urban design (density, texture, coverage); develop strategic plans in riverbanks areas – ban construction in areas prone to flooding, retention basins and other green areas.		• City of Belgrade – Secretariat for Urban Planning and Construction	Medium	Medium term
23	Mapping	Develop heat island maps, drought risk maps, flo-od risk maps; identify vulnerable groups.		• City of Belgrade – Secretariat for Urban Planning and Construction	Medium	Short term

The application of the multi-criteria decision analyses method, which involves the use of four criteria for defining priorities in the implementation of adaptation measures, has revealed that protection from flooding and green infrastructure are the two highest priority measures for the City of Belgrade.

Next in order are high priority measures in different areas:

- establishment and improvement of early warning systems, dissemination of information and awareness raising, as well as other institutional and organizational measures,
- urban planning for flood protection,
- construction of retention basins, drainage, saving and reuse of water,
- establishment and rehabilitation of green areas and streets.

There is a long list of measures, set out in the table above, that the City of Belgrade recognised as necessary to ensure full adaptation to evident climate changes. Although some of them have lower priority than those mentioned above, decision makers in Belgrade have an imperative to use a large number of measures, because one does not exclude the other. The multisectoral approach to the relevant institutions and other participants is necessary to achieve the full effects. Adequate funding must be raised from various sources, because once the damage is done future generations of Belgraders may bear the burden.

MONITORING THE IMPLEMENTATION

The purpose of monitoring the implementation of the Climate Change Adaptation Action Plan is to understand whether the project or activities deliver the planned benefits and to adjust the measures and activities to potentially changing conditions and new knowledge. Furthermore, the findings from the monitoring process should be reflected in a long term adaptation strategy, in new adaption measures and future planning.

Monitoring of the Climate Change Adaptation Plan will be organised as follows:

Step in the monitoring process	Description	Responsibilities
Setting up the monitoring working group (Climate Change Adaptation Working Group – CCAWG)	The Mayor of Belgrade will establish the CCAWG, consisting of representatives of all relevant departments of the city administration. The task of this Working Group will be to collect data and monitor the implementation of the project and activities, analyse critical CCA developments, etc.	City of Belgrade
Setting–up the monitoring process	CCAWG will decide on the monitoring process, in particular: • frequency of monitoring: it is recommended that the CCAWG have yearly meetings. The meetings are prepared by the CCAWG coordinator. • method of monitoring: the CCAWG will adopt joint conclusions, based on the Action Plan implementation checklist, the achievements of the Action Plan, the need to adjust and update actions. Initially, the conclusions will be adopted on the basis of a qualitative (verbal) review, until measurable assessment indicators are created. • Documentation of monitoring results: The results should be documented in writing to allow communication of the results. • Communication of monitoring results: The monitoring results should be communicated in the CCAWG internally and with the superiors of the organizational units and the city management. The monitoring documentation is firstly an internal self-assessment document used to communicate the quality of climate change adaptation and preparedness. It should help improve internal processes with focus on cross-sector communication and cross-sector planning.	CCAWG of the City of Belgrade

Performance criteria	The CCAWG will establish criteria to assess the achievement of the CCA goals. It is recommended that these criteria be based on: • overall contribution to the broader development goals for the City of Belgrade, i.e. to what extent the measure contributes to the overall climate adaptation goals for Belgrade; • functionality goals for the adaptation measures: functionality aspects include issues such as the number of retention basins in rivers, areas under green cover, green roofs etc. The measures should also be assessed based on how successful they are in reducing heat islands and heat wave effects, reducing flood water in the streets or along the rivers, and similar; • economic goals of the adaptation measures; • acceptance/communication goals of adaptation measures.	CCAWG of the City of Belgrade

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ANNEXES

Annex 1: List of participants in the drafting process

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Annex 2. Local vulnerability assessment – past events

Weather event	Weather extreme	Consequences (indirect impacts)	
Heat waves			
Sumer 2013 (16-22 June; 3-9 August)	• The mean, maximum and minimum air above the multi-annual average; • Extended heat wave – high temperatures (above 39 °C) for more than 6 consecutive days; • 52 "tropical" days and 27 "tropical" nights (minimum air temperatures exceeding 20 °C); • Extreme lack of precipitation (above 25% compared to the normal);		
August 2012	• Extended heat wave – high temperature (above 39 °C) for more than 6 consecutive days; • 62 "tropical" days and 52 "tropical" nights (minimum air temperatures exceeding 20 °C); • Mean summer temperature 4.9 °C higher than the 1960–1991 average;	• Health effects on vulnerable groups (elderly, children, people with cardiovascular and respiratory diseases and psychiatric illnesses); • During the July 2007 heat wave mortality among the elderly increased by 76% in comparison to the baseline mortality. Female mortality was more than twice higher than male mortality; • Decrease in work productivity, particularly in agriculture, infrastructure and building industry; • Decrease in other economic activities (trade; communal services); • Increased electricity consumption (estimated up to 22%); • Increased water consumption; • Heat stress;	
July/August 2009	• High temperatures (above 40 °C);		
July 2007	• Extreme temperatures for more than 22 consecutive days; • Absolute maximum ever in Belgrade (43.6 °C); • Mean summer temperature between 4 and 5 °C higher than the 1960–1991 average;		
June/July 2006	• 12 tropical days and 9 tropical nights in June (8 days and 8 nights above the 1961–1990 average); • 21 tropical days and 12 tropical nights In July (12 days and 9 nights above the 1961–1990 average), only 35% of the average amount of precipitation;		
June 2003	• only 37% of the average amount of precipitation; • 18 tropical days and 12 tropical nights;		

	Measures introduced	Receptors hit	Location	Comment
	• Heat waves early warning system developed and introduced in National Hydrometeorological Institute (from 1 May 2014) • Ministry of Labour, Employment, Veteran and Social Affairs recommends outdoor work downtime between 11 a.m. and 4 p.m.; • Communal utility companies make public appeals for reductions in energy and water use; • Emergency health services introduce preparedness measures; • Awareness raising by broadcasting advice on how to prepare for heat waves on Belgrade local TV station STUDIO B	• Public health and vulnerable groups; • Communal infrastructure, including green infrastructure; • Communal systems (water and wastewater; electricity); • Transport infrastructure and transport system; • Air and water quality; • Economic sectors (including, but not limited on agriculture, industry, construction, trade); • Social infrastructure;	Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia (2013). Seasonal Bulletin for Serbia.
	• Ministry of Labour, Employment, Veteran and Social Affairs recommends work downtime between 11 a.m. and 4 p.m.; • Communal utility companies make public appeals for reductions in energy and water use; • Emergency health services introduce preparedness measures;	• Public health and vulnerable groups; • Communal infrastructure, including green infrastructure; • Communal systems (water and wastewater; electricity); • Transport infrastructure and transport system; • Air and water quality; • Economic sectors (including, but not limited on agriculture, industry, construction, trade); • Social infrastructure;	Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia
	• Ministry of Labour, Employment, Veteran and Social Affairs recommends work downtime between 11 a.m. and 4 p.m.; • Communal utility companies make public appeals for reductions in energy and water use; • Emergency health services introduce preparedness measures;	• Public health and vulnerable groups; • Communal infrastructure, including green infrastructure; • Communal systems (water and wastewater; electricity); • Transport infrastructure and transport system; • Air and water quality; • Economic sectors (including, but not limited on agriculture, industry, construction, trade); • Social infrastructure;	Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia
	• Government of Serbia declares the emergency; • Ministry of Labour, Employment, Veteran and Social Affairs recommends work downtime between 11 a.m. and 4 p.m.; • Communal utility companies make public appeals for reductions in energy and water use; • Emergency health services introduce preparedness measures;	• Public health and vulnerable groups; • Communal infrastructure, including green infrastructure; • Communal systems (water and wastewater; electricity); • Transport infrastructure and transport system; • Air and water quality; • Economic sectors (including, but not limited on agriculture, industry, construction, trade); • Social infrastructure;	Whole territory of Belgrade	Source: Bogdanović *at al.* (2013). The impact of the July 2007 heat wave on daily mortality in Belgrade, Serbia. Cent Eur J Public Health. 2013 Sep; 21(3): 140–5.
			Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia
			Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia

June/August 2000	• 15tropical days and 7 tropical nights in June (11 days and 6 nights above the 1961–1990 average), only 21% of the average amount of precipitation; • 22 tropical days and 14 tropical nights In August (13 days and 11 nights above the 1961–1990 average), only 15% of the average amount of precipitation;		
June/July 1998	• 13 tropical days and 5 tropical nights in June (9 days and 4 nights above the 1961–1990 average); • 18 tropical days and 10 tropical nights In July (9 days and 7 nights above the 1961–1990 average);		
Droughts			
Summer 2012	• Lack of rainfall from late June to the end of August; • Extreme heat over an extended period (above 35 °C);	• Serious damage in agricultural production in suburban and rural municipalities (for example corn yield dropped by 30–70% in the Lazarevac Municipality; fruits and vegetables yield by 50%; soy up to 80%, etc.); • Water level of the rivers drops to the biological minimum (for example Sava to 80% of biological minimum on August 16th); • Smaller water streams dried up; • Damage to biodiversity, particularly to fish stock and urban wetlands; • Restricted drinking water availability; • Dried grasslands and vegetation, which is less resistant to high temperatures and requires greater quantities of water, overheated pedestrian and car tracks which further increases the air temperature both during the day and at night; • Increased pressure from the citizens on the green spaces, which further devastates green areas already weakened endangered by high temperature;	
August 2000	• Lack of rainfall, only 15% of the average amount of precipitation (7.8 mm);	• Dried grasslands, dry vegetation less resistant to high temperature, which has a greater need for water, overheated pedestrian and car tracks which further increases the air temperature both during the day and at night; • Increased pressure from the citizens on the green spaces, which further devastates green areas already weakened endangered by high temperature;	
Heavy precipitation / Floods			
May 2014	• Heavy rainfalls in Western and Central Serbia (more than 200 mm of rain in a week, i.e. the equivalent of 3 months rain under normal conditions); • Rapid and substantial increase of water levels in the main rivers, partly passing through the territory of Belgrade (Sava, Tamnava, Kolubara); • Discharge of groundwater into surface streams;	• Flash floods in the Sava tributaries (Tamnava and Kolubara watershed); • Widespread flooding of urban and rural areas, particularly in the City Municipality of Obrenovac; • 51 causalities, of which 23 due to drowning (not all of them exclusively in Belgrade); • 25.000 people were evacuated from Obrenovac, from which 5.000 required temporally shelters in camps established in Belgrade; • 114 individual houses were fully destroyed with more than 3000 damaged; • Significant damage on infrastructure in Obrenovac (bridges, roads, embankment) • Health and education facilities sustained damages and had to be temporarily closed, so health care and education activities had to be suspended; • Flood waters and rising groundwater levels covered some industrial zones and power plants and facilities; • Flooded mine disposal facilities threatened environment and public health; • Many small and medium farms suffer. Agricultural land received large amount of sediments and other materials; • Total estimated losses in the manufacturing sector in Obrenovac was 23 Million Euro; • The drinking water was contaminated, which can lead to intestinal infections and diseases; • Pesticides contaminated raw water, as a consequence of agricultural pollution carried by the torrent floods; • Heavy metals accumulated in water wells; • Trees weakened due to large amounts of water in the woody tissue, which resulted in the softening thereof and consequently the breaking of trees, and bending of young trees and seedlings;.	

			Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia
				Source: Republic Hydrometeorological Service of Serbia
	• Water use restrictions; • Prohibition of the use of water for irrigation: • Post-drought measures announced, mainly for agricultural producers (subsidies for farmers; some tax exemptions; etc.);	• Public health and vulnerable groups; • Communal infrastructure, including green infrastructure; • Communal systems (water and wastewater; electricity); • Air and water quality; • Economic sectors (including, but not limited on agriculture, industry, construction, trade); • Social infrastructure;	• Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia
	• The Government declares a state of emergency; • Emergency measures against floods are introduced; • Urgent measures: • Rescue actions, involving civil aid and international support; • Urgent allocation of budget reserve for recovery from natural disasters (EUR 3.2 million); • *Lex specialis* on the reconstruction of destroyed facilities; • International donor support; • Intensified control and monitoring of relevant parameters; • Additional measures for removal of problems detected: increased dose of coagulation and flocculation chemicals in water; active carbon absorption; active disinfection; preparedness for drinking water restrictions, depending on the situation. • Other measures still to be introduced;	• Public health and vulnerable groups; • Communal infrastructure, including green infrastructure; • Communal systems (water and wastewater; electricity); • Communal systems (drinking water distribution system, wastewater) • Ecosystem processes chain, via biotope and biocenosis. • Transport infrastructure and transport system; • Air and water quality; • Economic sectors (including, but not limited on agriculture, industry, construction, trade); • Social infrastructure;	• Whole territory of Belgrade, • Most vulnerable: • Obrenovac • Lazarevac • Ostružnica • Baric • Topčider River watershed • Kumodraž	Source: Republic Hydrometeorological Service of Serbia; Belgrade Waterworks and Sewerage Public Utility Company

April 2006	• Melting snow and heavy rainfalls in the Danube, Sava, Velika Morava and Tisa watersheds in December 2005 and March 2006; • Heavy rainfall in Belgrade (March 104 mm, April 97 mm); • Rapid increase of water levels in Danube and Sava river (up to 1 cm per hour);	• Danube water levels exceeded the historical maximum (783 cm in Zemun); • The Danube spilled over its banks in urban municipalities (Zemun and Novi Beograd) and in the suburban area of Veliko Selo; • Sava spilled over its banks in urban areas (Novi Beograd wharf; Beogradski sajam; Kula Nebojša – Kalemegdan; City Municipality of Čukarica; Ostružnica); • 1,000 people were evacuated in the Municipality of Grocka; • Wastewater spilled into the river flood in the lower urban areas, Vojvode Mišića Boulevard and Karađorđeva Street.	
April/June/September 2001	• Record-breaking amount of precipitation for April(157.9 mm) • Record-breaking amount of precipitation for September (183.7 mm) • 17 wet days in June		
July 1999	• Record-breaking amount of precipitation for July (262.5 mm)		
Extreme cold			
27 January–21 February 2012	• Extremely low temperatures (average daily ambient temperature from 30 January to 11 February ranging between -6,6 °C and -12 °C) • 17 consecutive "icy days" (from 29 January to 14 February); • Temperature extreme: -5.5 °C (10 February); • High snowfalls (52cm);	• Health effects on vulnerable groups (elderly, children, people with cardiovascular and respiratory deceases); • Transport problems due to snow cover; • Formation of ice cover on the Danube and Sava rivers; • Shutdown of schools; • Higher level of electricity consumption and stress on the energy system;	
Winter 2008/2009 (26 December-14 January)	• 20 consecutive ice days		
Winter 2007/2008 (19 December-2 January)	• 15 consecutive ice days		
21-28 March, 23-31 December 1998	• 14 frost days in March (8 days above 1961–1990 average); • 12 ice days In December (7 days above the 1961–1990 average), 18 days with snow cover (7 days above the 1961–1990 average);		
Storms			
Usually in the summer during the last 4–5 years.	Intensity and frequency of storms has increased.	Damages to transport infrastructure; Damages to green infrastructure, falling trees and branches.	

	• The Government declared a state of emergency, that lasted for 52 days; • Emergency response to floods on the Danube banks (36 days) and Sava banks (37 days); • Emergency response to floods on the streets by Belgrade Waterworks and Sewerage emergency teams; • After the flooding, the embankments on the Sava river near Ada Ciganlija was reconstructed and upgraded to protect against centennial waters. The aim was to protect the Makiš field. drinking water facilities in Makiš and the future Belgrade–South Adriatic highway; • After the flood, the embankment on the Danube in Zemun was reconstructed and upgraded;	• Public health of vulnerable groups; • Communal infrastructure, including green infrastructure; • Communal systems (water and wastewater; electricity); • Transport infrastructure and transport system, specifically public transport; • Air and water quality; • Economic sectors (including, but not limited on agriculture, industry, construction, trade); • Social infrastructure;	• Embankments on the Danube and Sava Rivers in Belgrade (particularly the lower plateaus in the Stari Grad municipality – from Beogradski sajam to the Sava estuary; Ada Ciganlija; Zemun) • Pančevački Rit; Veliko Selo); • Watersheds of the Topčider and Barič river; • Lower areas of the municipalities of Savski Venac and Čukarica;	Source: Republic Hydrometeorological Service of Serbia; Belgrade Waterworks and Sewerage Public Utility Company
			• Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia
			• Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia
	• The Government of Serbia declared a state of emergency that lasted from February 5th to February 24th in Belgrade; • Flood protection measures were introduced due to ice on the Sava and Danube; • School activities were suspended; • The City of Belgrade called up public works to remove the snow;	• Public health of vulnerable groups; • Communal systems (water and wastewater; electricity); • Transport infrastructure and transport system; • Social infrastructure;	• Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia
			Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia
			Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia
			Whole territory of Belgrade	Source: Republic Hydrometeorological Service of Serbia
		• Communal infrastructure, including green infrastructure; • Communal systems (water and wastewater; electricity); • Transport infrastructure and transport system;	Whole territory of Belgrade	

Annex 3. Assessment of current vulnerability in Belgrade

	Receptors	General weather sensitivity of receptor		Who/what is affected	Sensitivity/ exposure	Capacity to adapt	Vulnerability
		Extreme event	Potential effects				
Population	Public health/vulnerable groups	Heat wave	– Deaths, mainly due to cardiovascular diseases – Spread of vector-borne and infectious diseases – Altered allergy patterns – Heat stress	Vulnerable categories of the population: the chronically ill, the elderly, babies, children, especially vulnerable persons, workers exposed to heat (outdoor work), people with mobility impairments, athletes, homeless, etc.; central urban municipalities, i.e. the urban territory of the administrative area of Belgrade are especially sensitive.	High	Low	High
		Extreme cold	– Casualties and fatalities – Spread of respiratory and infectious diseases – Deterioration of the state of cardiovascular patients	Vulnerable categories of the population: the chronically ill, the elderly, highly vulnerable persons, workers exposed to the cold (outdoor work), people with mobility impairments, homeless.	High	Low	High
		Drought	– Effects on the air - hygienic conditions – Leads to accumulation of trace elements – Diseases caused by consuming poor quality water and food	All persons living or working in affected areas, especially vulnerable categories of the population: the chronically ill, the elderly, babies, children, workers exposed to heat or cold (outdoor work), people with mobility impairments, athletes, the homeless.	Medium	Medium	Medium
		Heavy precipi-ta-tion/ Flood	– Casualties and fatalities – Spread of infectious diseases due to contaminated water – Deterioration of state of chronic patients due to difficulty in providing of lack of medical assistance (diabetes, dialysis etc.)	All persons living or working in affected areas, especially vulnerable categories of the population: the chronically ill, the elderly, babies, children, especially vulnerable people, homeless. Particularly sensitive inhabitants of the municipalities in the vicinity of rivers Obrenovac, Lazarevac, Zemun, Novi Beograd, Rakovica, Zemun, Čukarica, Palilula, Savski Venac.	High	Low	High
		Storm	– Casualties and fatalities	All persons living or working in affected areas, particularly vulnerable population: the elderly, babies, children, the homeless, outdoor workers, etc.	Medium	Medium	Medium
Infrastructure	Transport	Heat wave	– Damages – Changes in behaviour pattern/ demand – Air quality problems – Higher maintenance costs	Roads, railroads, etc., Public transport, mobility of people; Waterways, water management; All vehicles, public transport, mobility, infrastructure in the affected areas; In particular: burdened roads and streets (highway E70 – part of Corridor 10 – passing through the inner city; Radnička, Savska and Karađorđeva street along the Sava River to the mouth and subsequently to the Pančevo bridge, in the direction of New Belgrade across Branko's Bridge, the Terazije tunnel, Despot Stefan Boulevard to the Pančevo bridge, Knez Miloš Street, Takovska) and the main traffic intersection (near the main railway station in the Sava amphitheatre, Slavija Square, Republika Square, Mostar interchange, etc.).	Medium	Medium	Medium
		Extreme cold	– Damages – Changes in behaviour pattern/ demand – Higher maintenance costs		High	Medium	High
		Drought	– Difficult transport of bulk material		Low	Medium	Low
		Heavy precipi-ta-tion/ flood	– Damages – Hindered traffic flow		High	Medium	High
		Storm	– Damages – Hindered traffic flow		Medium	Medium	Medium

Infrastructure	Electricity and heating services	Heat wave	– Damages – Altered load peaks/demand – Efficiency changes – Cooling problems – Higher maintenance costs, mainly own consumption	The production and distribution capacities of the Nikola Tesla A and B power plant in Obrenovac and Kolubara A in Veliki Crljeni, as well as the entire electrical grid.	High	High	Medium
		Extreme cold	– Damages – Altered load peaks/demand – Heating system failures – Interruption of power supply	The production and distribution capacities of the Nikola Tesla A and B power plant in Obrenovac and Kolubara A in Veliki Crljeni, as well as the entire electrical grid; the complete district heating system in Belgrade – all heating and boiler rooms, as well as pipelines.	High	Medium	High
		Drought	– Cooling problems – Higher maintenance costs, e.g. environmental requirements – Lower electricity production	Power plants and heating plants.	Medium	Medium	Medium
		Heavy precipi-ta-tion/ flood	– Damages/failures – Interruption of power supply	The Nikola Tesla A and B power plants in Obrenovac and the Kolubara A power plant in Veliki Crljeni, as well as Novi Beograd and Dunav heating plants.	High	Low	High
		Storm	– Damages/failures	Power plants heating plants and electrical grid.	High	Low	High
	Water supply and sanitation services	Heat wave	– Higher water demand – Water quality problems – Higher maintenance costs	Public health, technical infrastructure, public budget through higher maintenance costs, water supply utilities. In particular: installations for water supply in Makiš and facilities for water supply using well water; Sewerage infrastructure: open retention basins for collecting storm water are at risk: KCS Galovica, Agostin Net Street; KCS Gazela, Milentije Popović Street; somewhat less at risk the indoor retention basin KCS Retenzija, John Kennedy Street 9b are the most critical parts of the central zone in the old part of the city (the Lower Danube zone, which covers parts of Dorćol between the Danube and Car Dušan Street), where there is no storm sewer; Parts of Dedinje, Kaluđerica and Banovo Brdo, as well as parts of the Municipality of Lazarevac, have built storm sewers (and some parts have no sewage system). Almost 25% of households are not connected to the sewage network, including some parts of the central zone of the municipalities of Vračar, Savski Venac, Palilula, Voždovac, Zvezdara, Stari Grad, Novi Beograd, and Čukarica. A particular problem are the suburbs of Mali Mokri Lug, Kaluđerica, most of Kumodraž, Jajinci, most of Batajnica, Krnjača, Ovča, Vinča and Leštane.	High	Medium	High
		Extreme cold	– Damages e.g. to infrastructure – Water quality problems – Higher maintenance costs		Medium	Medium	Medium
		Drought	– Water scarcity – Water quality problems – Higher maintenance costs		High	Low	High
		Heavy precipi-ta-tion/ flood	– Damages – Higher maintenance costs – Water quality problems – Pollution of soil and water from leakage of sewage		High	Medium	High
		Storm	– Damages – Water quality problems		High	Medi-um	High

Infrastructure	Social infrastructure	Heat wave	– Changes in behaviour patterns, e.g. living outdoors – Altered demand, e.g. for cooling – Higher crime rates (conflicts, accidents…) – More patients in hospitals – Higher maintenance costs for public spaces (waste disposal, watering of parks etc.)	Hospitals, homes for the elderly, kindergartens, schools, public spaces, sports complexes, the City Assembly. In particular: Clinical Centre of Serbia, six major clinical hospital centres – KBC Zemun, Bežanijska Kosa, Zvezdara, Military Medical Academy, and Dedinje, as well as a number of specialised hospitals and institutes, school and kindergarten zones.	Medium	Medium	Medium
		Extreme cold	– More patients in hospitals – Higher maintenance costs, e.g. for heating		Medium	Medium	Medium
		Drought	– Altered demands, e.g. for water supply		High	Medium	High
		Heavy precipi-ta-tion/ floods	– Damages – Emergency management needed – More patients in hospitals – Higher maintenance costs		Medium	High	Low
		Storm	– Damages – Emergency management needed – More patients in hospitals – Higher maintenance costs		Low	High	Low
Built environment	Building stock and materials	Heat wave	– Damages e.g. to asphalt – Higher cooling demand – Higher maintenance costs – Heat island effect	Buildings, technical and urban infrastructure, especially in densely built-up areas, roads and railroads, all the buildings in the affected areas, paved surfaces.	High	Medium	High
		Extreme cold	– Damages, e.g. to asphalt – Higher heating demand – Higher maintenance costs		High	Medium	High
		Drought	– Higher water demand – Dikes may collapse		Medium	Medium	Medium
		Heavy precipi-ta-tion/ floods	– Damages – Surface runoff, increase of flooding – Torrential streams		High	Low	High
		Storm	– Damages, demolition and failures		Medium	Medium	Medium
Economy	Tourism	Heat wave	– Altered high/low seasons – Image changes – Increasing costs, e.g. for cooling	Monuments and other tourist facilities, public budget, hoteliers and restaurateurs - fewer visitors.	Low	High	Low
		Extreme cold	– Altered high/low seasons – Image changes – Increasing costs, e.g. for heating	Public budget, hoteliers and restaurateurs - fewer visitors.	Medium	Medium	Medium
		Drought	– Altered high/low seasons – Image changes – Increasing costs, e.g. for water supply – Higher water demand	Public budget	Medium	Medium	Medium
		Heavy precipi-ta-tion/ floods	– Damages to tourism infrastructure – Higher costs for maintenance and repair	Monuments and other tourist facilities, public budget, hoteliers and restaurateurs - fewer visitors.	Medium	High	Low
		Storm	– Damages to tourism infrastructure – Higher costs for maintenance and repair	Monuments and other tourist facilities, public budget, hoteliers and restaurateurs	Medium	High	Low

Economy	Industry	Heat wave	– Lower efficiency – Cooling problems and higher costs – Shortfall of workers	Consumers, industries with the need for cooling, workers , especially in the Kolubara mine.	High	High	Medium
		Extreme cold	– Damages – Increasing costs, e.g. for heating – Efficiency changes	Consumers, industries with high electricity consumption, workers, especially in the Kolubara mine.	High	Medium	High
		Drought	– Water scarcity / cooling problems – Supply problems due to limited bulk transport	Consumers, industries with high water consumption, workers.	High	High	Medium
		Heavy precipi-ta-tion/ floods	– Damages/failures	Industrial complexes near rivers (Prva Iskra Barič, Avala Ada, etc.), or industries that depend on bridges and other infrastructure affected by floods – Pančevo-Zrenjanin-Novi Sad road.	High	Medium	High
		Storm	– Damages/failures	Consumers, industrial complexes in the whole city.	Medium	High	Low
	Retail	Heat wave	– Changes in buying behaviour – Sales boost/shortfall	Consumers (access and price level), shop owners, stores in the affected areas.	Medium	Medium	Medium
		Extreme cold	– Changes in buying behaviour – Sales boost/shortfall		Medium	Medium	Medium
		Drought	– Changes in buying behaviour – Sales boost/shortfall		Low	Me-dium	Low
		Heavy precipi-ta-tion/ floods	– Damages/failures – Sales shortfall		Low	Low	Low
		Storm	– Damages / failures		Low	Low	Low
Natural resources	Green spaces	Heat wave	– Dying of plants – Altered behaviour pattern/ demand – Higher maintenance costs due to extensive use/water use etc.	Ecosystem, state and appearance of parks, sensitive flora and fauna, the public budget; Special: urban green areas, especially core green areas : Kalemegdan, Friendship Park and parts of green areas along the right riverbank of the Danube and the right and left riverbanks of the Sava, the Great War Island, parts of the forests in the foreland of left bank of the Danube (the Zemun new bridge – Borča to Branko's Bridge). The inner green ring may also be vulnerable: the City Park in Zemun, the park close to SIV, green open spaces within the city block in New Belgrade, Braće Jerković, Medaković, Konjarnik, Mirijevo, Višnjička Banja and Bežanijska Kosa, the New Cemetery and Bežanija Cemetery, as well as other smaller parks, squares and avenues.	High	Medium	High
		Extreme cold	– Damages, dying of plants		High	Medium	High
		Drought	– Dying of plants – Higher maintenance costs, mainly watering – Risk of wildfires		High	Low	High
		Heavy precipi-ta-tion/ floods	– Damages to infrastructure and plants		Medium	Medium	Medium
		Storm	– Damages to infrastructure and plants		High	Medium	High

Natural resources	Water resources and quality	Heat wave	– Higher evaporation/higher water uptake by the ecosystem/lower water flows – Spread of algae, bacteria – Altered fauna – Lower groundwater recharge	Whole ecosystem, fauna, flora, human health, ground water recharge, water industry.	High	Low	High
		Extreme cold	n/a	n/a			
		Drought	– Lower water flows/lower groundwater recharge – Dikes may collapse	Whole ecosystem, fauna, flora, human health, ground water recharge, water industry.	High	Medium	High
		Heavy precipi-ta-tion/ floods	– Water quality problems		High	High	Medium
		Storm	– Storm floods/waves		Medium	Medium	Medium
	Air quality	Heat wave	– Spread of diseases – Smog / higher concentration of air pollutants and allergens	Human health, ecosystem, flora and fauna, particularly the inner city on sites that are considered most vulnerable (Knez Miloš Street and Bulevar kralja Aleksandra; Savska Street around the railway station, Despot Stefan Boulevard; the Karađorđe Park.	High	Low	High
		Extreme cold	– Smog/higher concentration of air pollutants	Human health, ecosystem, flora and fauna.	High	Low	High
		Drought	– Smog/higher concentration of air pollutants and allergens		Medium	Medium	Medium
		Heavy precipi-ta-tion/ floods	– Spread of diseases		Medium	Low	High
		Storm	n/a				
	Agriculture	Heat wave	– Changes in growth cycle – Thrive / decline of species	Farmers, consumers, the food industry, municipal gardens. Almost all suburban and urban municipalities where crop plants are grown. Surrounding municipalities in the Šumadija area (Sopot, Barajevo and Obrenovac), and in particular the Municipality of Grocka (slope towards the Danube, Vinča, Vrčin, Ritopek and Begaljica) will be increasingly vulnerability to the effects of erosion.	High	Low	High
		Extreme cold	– Loss of livestock and harvest		High	Low	High
		Drought	– Damages/loss of harvest		High	Low	High
		Heavy precipi-ta-tion/ floods	– Damages/loss of harvest Torrential streams		High	Low	High
		Storm	– Damages / loss of harvest		High	Low	High
	Forestry	Heat wave	– Changes in the growth cycle (decrease in growth or drying of wood) – Wildfires	Forest ecosystems, wood industry, consumers, land. Forests in the inner ring of green areas (Makiš forest, Košutnjak and Topčider, Monastery Forest, Banjica Forest, Zvezdara forest), forests in the flooded area of Danube (especially on its left bank in the Banat part), forests in the Pančevački Rit, as part of the forests in the outer ring (Miljakovačka and Lipovička forests, etc.).	High	Low	High
		Extreme cold	– Mortality of trees		High	Low	High
		Drought	– Damages / dying of trees		High	Medi-um	High

Natural resources	Forestry	Heavy precipi-ta-tion/ floods	– Damages/dying of trees – Deterioration of water bodies and soil quality – Damage to the root system – Erosion of forest land		Medium	Medium	Medium
		Storm	– Damages / dying of trees		High	Low	High
	Bio-diversity / eco-systems	Heat wave	– Altered flora and fauna, new & inva-sive species – Loss of species – Mortality of flora and fauna – Migrations	All the flora and fauna with low adaptive capacity, ecosystem.	High	Low	High
		Extreme cold	– Reduced food sources for animals		Medium	Medium	Medium
		Drought	– Altered flora and fauna, new & inva-sive species – Loss of species – Mortality of flora and fauna – Migrations		High	Low	High
		Heavy precipi-ta-tion/ flood	– Altered flora and fauna, new & inva-sive species – Loss of species – Torrential streams		Medium	Medium	Medium
		Storm	– Loss of natural resources.		Low	Low	Low

Annex 4. Assessment of future risks and opportunities due to climate change in Belgrade

		Weather sensitivity	Current vulnerability	CC impact – Spring/ Summer*	CC impact – Autumn/ Winter*	Future risk (exemplary)	Future risk – Summer	Future risk – Winter	Future opportunity (exemplary)
Population	Public health / vulnerable groups	Heat wave	High	Heat waves – reinforcing in summer	n/a	Reinforcement of heat stress and increasing number of deaths during heat waves; Altered allergy patterns and increasing spread of new vector-borne and infectious diseases; Increased incidence of heart attacks and strokes;	very high	-	
		Extreme cold	High	n/a	Extreme cold – balancing in winter		-	medium	Decreased incidence of typical winter illnesses because of the warmer temperatures; Lower incidence of respiratory and infectious diseases; Fewer injuries, bone fractures and frostbites:
		Drought	Medium	Drought – reinforcing in summer	Drought – indifferent in autumn and winter	Decreased air quality, accompanied by more respiratory troubles; Increased allergic reactions through pollen flight and other allergens; Lower quality of water and food, especially milk products;	high	medium	
		Heavy precipi–tation/ Floods	High	Heavy precipitation/ Floods – reinforcing in summer	Heavy precipitation/ Floods – indifferent in winter	Growing spread of diseases due to contaminated water; Increasing damages and injuries during and after floods; Increasing utilisation of health care system; Increasing levels of mental stress;	very high	high	
		Storm	Medium	Storm – reinforcing in summer	Storm – indifferent in winter	Increasing number of casualties and fatalities; Increasing level of mental stress;	high	medium	
Infrastructure	Transport	Heat wave	Medium	Heat waves – reinforcing in summer	n/a	Increase of damages; Higher maintenance and fuel costs, high rebuilding costs; Less mobility;	high	-	
		Extreme cold	High	n/a	Extreme cold – balancing in winter		-	medium	Reduction of frost and ice days lead to fewer damages and limitations in all sectors of transport (road, rail, ship) Fewer problems because of less snowfall; Decrease of damages due to increasing freeze-thaw cycle; Decreasing costs for maintenance and fuel;
		Drought	Low	Drought – reinforcing in summer	Drought – indifferent in autumn and winter	Inland navigation on rivers might be difficult or impossible (Čukarički Rukavac, Dunav, etc.)	medium	low	
		Heavy precipi–tation/ floods	High	Heavy precipitation / Floods – reinforcing in summer	Heavy precipitation / Floods – indifferent in winter	Increase of damages; Higher maintenance and rebuilding costs; Less mobility	very high	high	
		Storm	Medium	Storm – reinforcing in summer	Storm – indifferent in winter	Increase of damages; Higher maintenance and rebuilding costs; Less mobility;	high	medium	

		Weather sensitivity	Current vulnerability	CC impact – Spring/ Summer*	CC impact – Autumn/ Winter*	Future risk (exemplary)	Future risk – Summer	Future risk – Winter	Future opportunity (exemplary)
Infrastructure	Electricity and heating services	Heat wave	Medium	Heat waves – reinforcing in summer	n/a	Increased damages; Less electricity production; Problems in distribution; Higher maintenance costs; Interruption of electricity supply due to excessive use of cooling;	high	-	
		Extreme cold	High	n/a	Extreme cold – balancing in winter		-	medium	Lower costs for heating and natural gas supply; Less electricity consumption in winter;
		Drought	Medium	Drought – reinforcing in summer	Drought – indifferent in autumn and winter	Increase of cooling problems; Hydropower potential may be reduced; Less electricity production	high	medium	Increased capacity for solar energy production;
		Heavy precipi–tation/ floods	High	Heavy pre-cipitation/ floods – re-inforcing in summer	Heavy pre-cipitation/ floods – in-different in winter	Increased damages or failures on production and distribution facilities (Open pit Kolubara, Power plant "TENT", etc.); Less electricity production; Problems in distribution; Higher maintenance costs	very high	high	
		Storm	High	Storm – re-inforcing in summer	Storm – in-different in winter	Increased damages; Less electricity production; Problems in distribution, including the interruption of electricity supply; Higher maintenance costs;	very high	high	Increased capacity for wind energy production;
Infrastructure	Water supply and sanitation services	Heat wave	High	Heat waves – reinforcing in summer	n/a	Water availability may be significantly reduced due to higher water demand; Problems in distribution; Water quality deterioration; Higher maintenance costs;	very high	-	
		Extreme cold	Medium	n/a	Extreme cold – balancing in winter		-	low	
		Drought	High	Drought – reinforcing in summer	Drought – indifferent in autumn and winter	Water availability may be significantly reduced due to higher water demand; Problems in distribution; Water quality deterioration; Higher maintenance costs;	very high	high	
		Heavy precipi–tation/ floods	High	Heavy pre-cipitation / Floods – re-inforcing in summer	Heavy pre-cipitation / Floods – in-different in winter	Damages to water and sanitation infra-structure; Pressure on the sewage network, lea-ding to leakage;	very high	high	
		Storm	High	Storm – re-inforcing in summer	Storm – in-different in winter	Damages to water and sanitation infra-structure;	very high	high	

		Weather sensitivity	Current vulnerability	CC impact – Spring/ Summer*	CC impact – Autumn/ Winter*	Future risk (exemplary)	Future risk – Summer	Future risk – Winter	Future opportunity (exemplary)
Infrastructure	Social infrastructure	Heat wave	Medium	Heat waves – reinforcing in summer	n/a	Problems in water supply for health care facilities; Higher pressure on social infrastructure institutions; Increased use of cooling may cause higher costs and pressure to electricity system;	high	-	
		Extreme cold	Medium	n/a	Extreme cold – balancing in winter		-	low	
		Drought	High	Heat waves – reinforcing in summer	Drought – indifferent in autumn and winter	Problems in water supply for health care facilities; Higher pressure on social infrastructure institutions; Increased use of cooling may cause higher costs and pressure to electricity system;	very high	high	
		Heavy precipi–tation/ Floods	Low	Heavy precipitation / Floods – reinforcing in summer	Heavy precipitation / Floods – indifferent in winter	Damages on social infrastructure facilities (health care, education, social services, cultural); Increasing maintenance costs on health care facilities, educational facilities and social system facilities;	medium	low	
		Storm	Low	Storm – reinforcing in summer	Storm – indifferent in winter	Damages on social infrastructure facilities (health care, education, social services, cultural); Increasing maintenance costs on health care facilities, educational facilities and social system facilities;	medium	low	
Built environment	Building stock and materials	Heat wave	High	Heat waves – reinforcing in summer	n/a	Increased damages to the existing building stock;	very high	-	
		Extreme cold	High	n/a	Extreme cold – balancing in winter		-	medium	Decreasing number of damages; Reduced need for winter road clearance; Decreasing maintenance costs;
		Drought	Medium	Drought – reinforcing in summer	Drought – indifferent in autumn and winter	Increased damages of the existing building stock;	high	medium	
		Heavy precipi–tation/ Floods	High	Heavy precipitation / Floods – reinforcing in summer	Heavy precipitation / Floods – indifferent in winter	Increased damages of the existing building stock;	very high	high	
		Storm	Medium	Storm – reinforcing in summer	Storm – indifferent in winter	Increased damages of the existing building stock;	high	medium	

		Weather sensitivity	Current vulnerability	CC impact – Spring/ Summer*	CC impact – Autumn/ Winter*	Future risk (exemplary)	Future risk – Summer	Future risk – Winter	Future opportunity (exemplary)
Economy	Tourism	Heat wave	Low	Heat waves – reinforcing in summer	n/a	Altered seasons; Increasing damages of cultural monuments and institutions;	medium	-	
		Extreme cold	Medium	n/a	Extreme cold – balancing in winter		-	low	Decreasing damages to tourism infrastructure; Decreasing maintenance costs of tourism infrastructure;
		Drought	Medium	Drought – reinforcing in summer	Drought – indifferent in autumn and winter	Increasing costs for water supply; Deterioration of water quality on public beaches (Ada Ciganlija, Lido, etc.);	high	medium	
		Heavy precipitation/ floods	Low	Heavy precipitation/ floods – reinforcing in summer	Heavy precipitation/ floods – indifferent in winter	Increasing damages; Increasing costs for protection and repairs; Decrease of heritage and leisure tourism;	medium	low	
		Storm	Low	Storm – reinforcing in summer	Storm – indifferent in winter	Increasing damages; Increasing costs for protection and repairs;	medium	low	
Economy	Industry	Heat wave	Medium	Heat waves – reinforcing in summer	n/a	Increasing costs for water supply; Lower efficiency and loss of business continuity; More problems in outdoor construction works, including temporary termination; Increasing costs for wastewater treatment;	high	-	New opportunities for climate adaptation based economic activities; Demand for product and services to face and adapt to climate change;
		Extreme cold	High	n/a	Extreme cold – balancing in winter	More problems in outdoor construction works, including temporary termination of works;	-	medium	New market opportunities, such as food production;
		Drought	Medium	Drought – reinforcing in summer	Drought – indifferent in autumn and winter	Increasing costs for water supply; Loss of business continuity;	high	medium	
		Heavy precipitation/ Floods	High	Heavy precipitation / Floods – reinforcing in summer	Heavy precipitation / Floods – indifferent in winter	Greater damage to stock or equipment; Loss of business continuity;	very high	high	New opportunities for climate adaptation based economic activities; Demand for products and services to adapt to climate change;
		Storm	Low	Storm – reinforcing in summer	Storm – indifferent in winter	Greater damage to stock or equipment; Loss of business continuity;	medium	low	

		Weather sensitivity	Current vulnerability	CC impact – Spring/ Summer*	CC impact – Autumn/ Winter*	Future risk (exemplary)	Future risk – Summer	Future risk – Winter	Future opportunity (exemplary)
Economy	Retail	Heat wave	Medium	Heat waves – reinforcing in summer	n/a	Increasing problems with transportation of goods; Changes in buying behaviour;	high	-	
		Extreme cold	Medium	Heat waves – reinforcing in summer	Extreme cold – balancing in winter		-	low	
		Drought	Low	Drought – reinforcing in summer	Drought – indifferent in autumn and winter	Changes in buying behaviour;	medium	low	
		Heavy precipi–tation/ Floods	Low	Heavy precipitation / Floods – reinforcing in summer	Heavy precipitation / Floods – indifferent in winter	Greater damage to retail infrastructure; Increasing problems with transportation of goods;	medium	low	
		Storm	Low	Storm – reinforcing in summer	Storm – indifferent in winter	Greater damage to retail infrastructure; Increasing problems with transportation of goods;	medium	low	
Natural resources	Green spaces	Heat wave	High	Heat waves – reinforcing in summer	n/a	Increasing number of dying plants; Increasing maintenance costs (mainly watering) ; High risk of fire;	very high	-	
		Extreme cold	High	n/a	Extreme cold – balancing in winter		-	medium	Less damage from frost; Lesser need for winter road clearance;
		Drought	High		Drought – indifferent in autumn and winter	Increasing number of dying plants; Increasing maintenance costs (mainly watering) ; High risk of wildfires;	very high	high	
		Heavy precipi–tation/ Floods	Medium	Heavy precipitation / Floods – reinforcing in summer	Heavy precipitation / Floods – indifferent in winter	Increasing number of damages to infrastructure and plants;	high	medium	
		Storm	High	Storm – reinforcing in summer	Storm – indifferent in winter	Increasing number of damages to infrastructure and plants;	very high	high	
Natural resources	Water resources and quality	Heat wave	High	Heat waves – reinforcing in summer	n/a	Problems with water supply, due to lower water recharge;	very high	-	
		Extreme cold	0	n/a	Extreme cold – balancing in winter		-	-	
		Drought	High	Drought – reinforcing in summer	Drought – indifferent in autumn and winter	Problems with water supply, due to lower water recharge; Deterioration of water quality in open water flows;	very high	high	
		Heavy precipi–tation/ Floods	Medium	Heavy precipitation/ floods – reinforcing in summer	Heavy precipitation/ floods – indifferent in winter	Deterioration of groundwater quality and water quality in open water flows;	high	medium	
		Storm	Medium	Storm – reinforcing in summer	Storm – indifferent in winter	Deterioration of water quality in open water flows; Increasing risk of torrential floods and erosion;	high	medium	

		Weather sensitivity	Current vulnerability	CC impact – Spring/ Summer*	CC impact – Autumn/ Winter*	Future risk (exemplary)	Future risk – Summer	Future risk – Winter	Future opportunity (exemplary)
Natural resources	Air quality	Heat wave	High	Heat waves – reinforcing in summer	n/a	Increasing spread of diseases; Reinforcement of smog; Increasing concentration of air pollutants and allergens;	very high	-	
		Extreme cold	High	n/a	Extreme cold – balancing in winter		-	medium	Decreasing air pollution due to slower combustion of hydrocarbons;
		Drought	Medium	Drought – reinforcing in summer	Drought – indifferent in autumn and winter	Increasing spread of diseases; Increasing concentration of air pollutants and allergens;	high	medium	
		Heavy precipi–tation/ Floods	High	Heavy precipitation / Floods – reinforcing in summer	Heavy precipitation / Floods – indifferent in winter	Increasing concentration of air pollutants;	very high	high	
		Storm	-	Storm – reinforcing in summer	Storm – indifferent in winter		-	-	
Natural resources	Agriculture	Heat wave	High	Heat waves – reinforcing in summer	n/a	Changes in growth cycle; Decreasing diversity of species; Increasing number of pest infestations; Growing need of irrigation; Loss of harvest; Increasing damages / dying of plants; Increasing risk of fire;	very high	-	
		Extreme cold	High	n/a	Extreme cold – balancing in winter		-	medium	Better conditions for species that thrive in a warmer climate;
		Drought	High	Drought – reinforcing in summer	Drought – indifferent in autumn and winter	Changes in growth cycle; Decreasing diversity of species; Increasing number of pest infestations; Growing need for irrigation; Loss of harvest; Increasing damages to/dying of plants; Increasing risk of wildfires;	very high	high	
		Heavy precipi–tation/ Floods	High	Heavy precipitation / Floods – reinforcing in summer	Heavy precipitation / Floods – indifferent in winter	Loss of harvest; Increasing damage to/dying of plants; Erosion;	very high	high	
		Storm	High	Storm – reinforcing in summer	Storm – indifferent in winter	Loss of harvest; Increasing damage to plants; Erosion;	very high	high	

		Weather sensitivity	Current vulnerability	CC impact – Spring/ Summer*	CC impact – Autumn/ Winter*	Future risk (exemplary)	Future risk – Summer	Future risk – Winter	Future opportunity (exemplary)
Natural resources	Forestry	Heat wave	High	Heat waves – reinforcing in summer	n/a	Changes in growth cycle; Damage to and dying of trees; Forest fires;	very high	-	Better conditions for species that thrive in an arid climate;
		Extreme cold	High	n/a	Extreme cold – balancing in winter		-	medium	Better conditions for plants that thrive in a warmer climate;
		Drought	High	Heat waves – reinforcing in summer	Drought – indifferent in autumn and winter	Changes in growth cycle, Damages to and dying of trees; Forest fires;	very high	high	
		Heavy precipi–tation/ Floods	Medium	Heavy pre-cipitation / Floods – re-inforcing in summer	Heavy pre-cipitation / Floods – in-different in winter	Soil erosion; Serious damage to forest flora; Uprooting of trees;	high	medium	
		Storm	High	Storm – re-inforcing in summer	Storm – in-different in winter	Soil erosion; Serious damage to forest flora;	very high	high	
Natural resources	Bio–diversity / eco–systems	Heat wave	High	Heat waves – reinforcing in summer	n/a	Some species may be lost; Occurrence of new and invasive spe-cies;	very high	-	
		Extreme cold	Medium	n/a	Extreme cold – balancing in winter		-	low	
		Drought	High	Drought – reinforcing in summer	Drought – indifferent in autumn and winter	Some species may be lost; Occurrence of new and invasive spe-cies;	very high	high	
		Heavy precipi–tation/ Floods	Low	Heavy pre-cipitation/ floods – re-inforcing in summer	Heavy pre-cipitation/ loods – in-different in winter	Damages to existing habitat and ecosystem; Increasing loss of some species; Increasing reduction of diversity of species; Increasing loss of habitats;	high	medium	
		Storm	Low	Storm – re-inforcing in summer	Storm – in-different in winter	Damages to existing habitat and ecosystem.	medium	low	

CITY OF BELGRADE

SECRETARIAT FOR ENVIRONMENTAL PROTECTION