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The perception of decision-makers to climate change adaptation in urban and peri-urban forests of Belgrade

EUROPEAN FOREST INSTITUTE
CENTRAL-EAST EUROPEAN REGIONAL OFFICE – EFICEEC

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Written by

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TABLE OF CONTENTS

Abstract

Climate change has been recognized as one of the most serious challenges facing the world. Human influence on the change of climate has become more apparent during recent years, mainly through population growth, urbanization processes, technological development, and increased consumption levels. All those changes have enlarged the pressure on the world's natural resources and ecosystems. Especially urban areas will become highly vulnerable to future threats. Protection and adaptation of all natural resources in cities, including urban and peri-urban forests (UPF), are an urgent need.

The main objective of this master thesis is to analyze the integration of climate change adaptation issues in UPF policies and management plans in Serbia and particularly in Belgrade.

Serbia has experienced major political and social changes in recent decades. After a period of great unrest during the Yugoslav Wars, a political change in the year 2000 was the starting point for a period of gradual recovery and stabilization. This was the reason why national policies in many domains were lacking. Forestry and urban forestry are at an initial stage of this process and climate change has recently been recognized as a multi-sectoral issue, which also needs to be included in sectoral and national development strategies. One of the needs for long-term development of the urban forestry sector is to incorporate adaptation strategies in national urban forestry legislation and management plans as a starting point for adaptation processes.

Utilization of the DAYMET model, for interpolation of climate data, shows that an increase of annual mean temperature and precipitation is present over the territory of Belgrade. This is the base and justification for understanding the state-of-the-art and possibilities regarding climate change adaptation in UPF, focusing on the integration of these aspects in policy and management. An analysis of urban forestry related documents shows a very weak integration of climate change issues in general. It can be noted that comprehensive and systematic approach to climate change adaptation does not exist. In 2011, the assembly of the city of Belgrade adopted the "Afforestation Strategy for Belgrade", which is seen as one of the main actions in respect to climate change. However, climate change adaptation issues are only indirectly tackled in this document. Conducted expert interviews (in-depth and Q-methodology) reveal the current understanding of climate change adaptation issue in UPF management. Awareness of managers towards climate change adaptation is varying but present to a certain extent. It is largely influenced by many assumptions and uncertainties, caused by a lack of knowledge and information, especially about local conditions in regards to climate change. The presence of actors that holds a skeptic view towards the issue is also revealed. In this respect, institutional and human capacities are seen as the most important factors to be developed and strengthened in the future. The lack of political will and legislation regarding climate change, lack of systematic data collection and integrated databases, still weaken the structure of the urban forestry sector. Furthermore, lacking financial and technological capacities are challenges that need to be faced in the process of adaptation to climate change in UPF.

Key words: urban forest management, climate change, adaptation strategies, awareness, institutional and human capacity

1 Introduction

Climate change has become a main driver of environmental change and it is recognized as one of the most serious challenges facing the world (Bolte et al., 2009). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change presents the evidences that the climate is changing, and that anthropogenic influence on this change is significant (IPCC, 2007b). Population growth, together with urbanization, technological development and increase consumption levels, has increased the pressures on the world's natural resources and ecological systems (Satterthwaite, 2011a). Cities are therefore seen as part of the problem, but also as part of solution to climate change (Corfee-Morlot et al., 2011). Furthermore, hundreds of millions of people living in urban areas are potentially affected by climate change impacts (Satterthwaite et al., 2007). According to UNDESA (2010), currently around 73% of the European population lives in cities and rising trend of population growth and urbanization is expected to continue. By 2050, the proportion of European population living in urban areas will reach 84%. Urgent actions are needed in order to address current urban centres vulnerabilities to climate change (CC), but also to build and adopt new strategies for future changes (Satterthwaite et al., 2007). Blue (i.e. water) and green (i.e. forests, parks, green corridors) infrastructure are becoming increasingly valuable and important in regulating problems posed by climate change in cities (e.g. regulate water floods, mitigate urban heat, improve air quality, provide pleasant places for citizens). These city recourses are highly threatened by climate change (Ecologic Institute et al., 2011).

Urban and peri-urban forests (UPF) are defined as "all the trees and woodlands in and around urban areas" (Lawrence et al., 2011). UPF are one of the natural resources in urban areas that are under negative influence of climate change, which together with effects of urbanization and industrialization are causing the permanent decrease of areas covered with forests in cities. "Urban sites are often harsh, characterized by many pressures and threats, from limited growing space to adverse climatic conditions and air pollution" (Konijnendijk et al., 2006, p.93).

Urban and peri-urban forests have a very obvious and recognized role in urban climate change mitigation (Lawrence et al., 2011), while the adaptation of UPF to climate change is less studied and approaches are less applied (Ordóñez et al., 2010). Nowadays urban forests are changing role due to the change in everyday life of citizens, and are subjected to fulfilment of various needs and demands (Bengston, 1994). Urban green areas are the most popular outdoor recreation environments in Europe, which can serve for recreation and improvement of physical and mental human health (Konijnendijk, 2003). Urban trees and other vegetation intercept particles and gaseous pollutants and act as carbon sink. In time of global warming, those aspects become increasingly important. Furthermore, they reduce storm water runoff and have a role in protecting drinking water resources and soils, moderating harsh urban climates, e.g. by cooling the air, reducing wind speeds and shading. The level of biodiversity in urban green areas is often surprisingly high (Konijnendijk, 2003). All of those aspects illustrate that benefits provided by urban forests to cities and societies are important.

Urban forest system vulnerability can be seen in three dimensions: (i) environmental (e.g. related to structure of urban forests, and stress to which urban trees are subjected), (ii) social (e.g. existence of urban forestry institutions, the skills of forestry officials), and (iii) economic (e.g. budget, valuation of forests).

Assessing the vulnerabilities of urban forest system is essential for adaptation process, and is matter of local importance (Nowak, 2000; Ordóñez et al., 2010). Adaptation responses in urban forests system are mainly focused on reducing system's climate vulnerability and increasing its climate adaptive capacity (Adger et al., 2007). They are having two parts: (i) adapting the urban forests to change, and (ii) using urban forests to help cities adapt to changes. Adaptation also assumes adaptation of society, therefore in urban forests policy and management it needs to be considered in relation to

wider forest community, people and infrastructure (Ordóñez et al., 2010). Adaptation actions, especially in urban context, represent the multitude of decisions and actors that need to be combined in order to get collective response to climate change (Corfee-Morlot et al., 2011). In this respect, the perception of climate risk of various stakeholders or actors needs to be understood (Adger et al., 2007).

The study of Ecologic Institute et al. (2011) confirms that European cities are facing or are expected to face several challenges from direct climate change impact. Some of the cities have adopted the approach of pursuing comprehensive adaptation strategies (e.g. Vienna, London, Copenhagen). In terms of urban forest adaptation strategies the most advanced are cities like e.g. Melbourne (Australia), Vancouver and Toronto (Canada), which have developed comprehensive strategies in this respect.

This research focus on adaptation processes to climate change in urban and peri-urban forests of Belgrade. The focus is on perception and attitude towards climate change adaptation within urban forestry actors and current state-of-the-art of urban forestry management in this respect. Under UPF are assumed all forest resources and other types of green areas (e.g. parks, park-forest, alleys) that are situated within the administrative border of city of Belgrade. There are in total 35,980.00 ha of UPF in the Belgrade administrative area, which represent 12% of total city area. The current need is to protect existing and plan new UPF areas. Climate change poses one of the greatest challenges for UPF management and its long-term development. Therefore, adaptation of urban forests to climate change needs to be adequately planned.

For understanding the case of Belgrade, the country context needs to be understood as well. Serbia has experienced major political and social changes in recent decades. After a period of great unrest during the Yugoslav Wars, a political change in the year 2000 was the starting point for a period of gradual recovery and stabilization. This was the reason why in many domains national policies are lacking. Climate change has only been recognized in the past few years as a multi-sectoral issue, which needs to be included in sector strategies and national development strategies in general. Forestry, and therefore urban forestry, is in its initial stage of this process. Those aspects are addressed in the Initial National Communication to UNFCCC. Both mitigation and adaptation to climate change are seen as important measures, while the mitigation has been better understood and more studied so far on the level of UPF management. Therefore, the purpose of this thesis is to give insight into the state-of-the-art regarding adaptation aspects of UPF management, focusing on the integration of climate change adaptation aspects in UPF policies and management plans in Belgrade.

1.1 Problem statement and objectives

The main objective of the master thesis is to analyze the integration of climate change adaptation issues in urban and peri-urban forest (UPF) policies and management plans in Belgrade, Serbia.

As specific objectives of master thesis are identified:

1. To explore climate development in the city of Belgrade (analysis of the gathered climate data using DAYMET model)
2. To analyze UPF management and policy documents, with emphasis on integration of climate change aspects (existing data on CC, impact of CC and measures of adaptation)
3. a) To reveal and analyze the structure of UPF actors' believes and opinions about CC adaptation in UPF of Belgrade (awareness/social perspectives) (Q methodology)

b) To determine past actions and future plans regarding climate change adaptation in UPF of Belgrade (expert interviews with managers of UPF)

4. To determine the role of ecosystem services in management plans for UPF in connection to climate change (expert interviews with managers of UPF)

Each of objectives is followed by research questions, which address specific climate change adaptation issues within UPF of Belgrade. In total five questions are posed:

1. What is the current trend of climate parameters in Serbia and Belgrade? (DAYMET model)
2. To which degree do policy and management instruments reflect on CC aspects for UPF?

a) How and why do policy documents in the context of UPF take climate change in consideration?

b) How adaptive towards climate change are UPF management plans? (aspects/elements)

3. What are the believes, opinions and awareness of UPF actors on CC adaptation aspects in UPF of Belgrade?

4. Which environmental goods and services from UPF are provided, and what is their relation to future CC adaptation?

Figure 1 illustrates the research framework. General focus is on the climate change adaptation issues, which are either detectable by adaptations within forests and adaptation in urban areas. As a combination of these two, further focusing of the topic was on the adaptation of society.

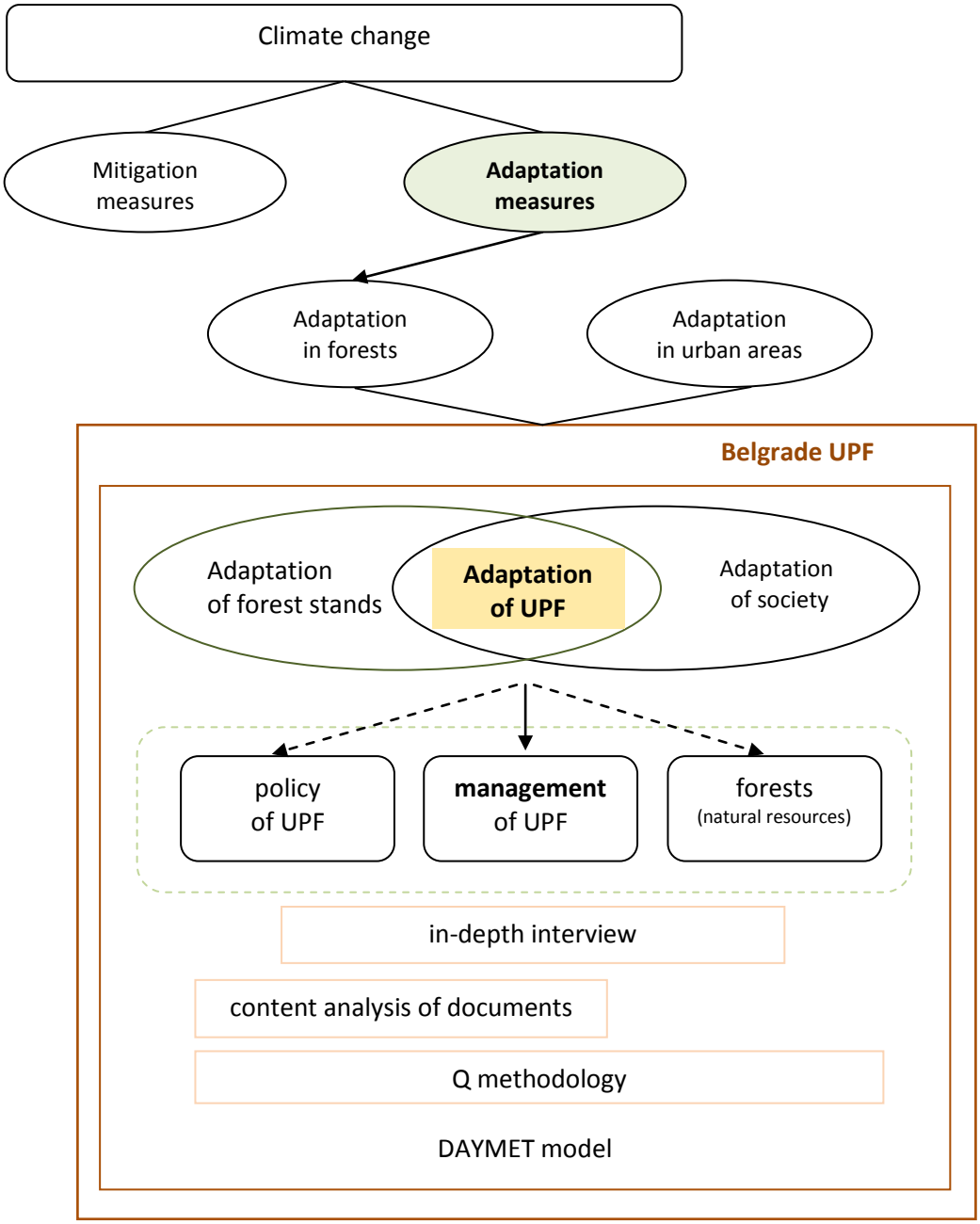

Figure 1 Framework of the research

Since the focus of the thesis is on adaptations to climate change in urban and peri-urban forests (UPF) management and policy documents in Belgrade, the starting point was application of the DAYMET method. It provided research with interpolated weather data that served for understanding in how far climate have been change on the territory of Belgrade, and gave the justification for conducting the research. Aspect of climate change adaptation in management of UPF is approached through application of few methods: content analysis of management plans of UPFs, in-depth interviews with managers and expert interviews by application of Q-methodology. For better understanding of management issue, the policy issue of urban forestry sector and state of UPF resources was described, mainly through literature research, fulfilled with information obtained by in-depth interviews and content analysis of UPF policy documents. In the conclusion main weaknesses and constrains regarding the climate change adaptation in UPF in Belgrade were addressed.

1.2 Thesis structure

Thesis starts with the introduction and addresses the problems, objectives of research and research questions. This is flowed by literature review where all concepts related to the topic will be discussed (climate change adaptation, urban forest governance, adaptive forest management and ecosystem services). The description of urban and peri-urban forests/forestry in Belgrade are presented, next to providing an understanding of the overall background in managing these natural resources.

In the result/analysis chapter all addressed topics of climate change adaptation in UPF are presented: (i) climate interpolation for Serbia and Belgrade (by utilizing DAYMET model), (ii) climate change integration in UPF management and policy documents (through content analysis of relevant documents), (iii) perception of decision-makers to climate change and adaptation strategies in UPF of Belgrade (by conducting experts interviews (in-depth and Q methodology)). The discussion and conclusion chapters summarize the work and demonstrate the strengths and weaknesses of the current state of the UPF management and policies regarding to climate change adaptation.

2 Methodological approach

The research builds on four main concepts: Climate Change Adaptation, Urban Forest Governance, Adaptive Forest Management and Ecosystem Services, and it defines how these concepts can be interlinked in the context of UPF.

The method of research is explorative, descriptive and explanatory, based on case study approach dealing with a specific situation at a given period. The case study and object of the study are the urban and peri-urban forests (UPF) of the city of Belgrade. For the purpose of this research, 'primary' and 'secondary' data have been collected.

Primary data are obtained from the National Hydrometeorological Service of Serbia (RHMZ), by conducting expert interviews (in-depth interviews and Q-methodology) with urban forestry actors and by content analysis of management and policy documents related to UPF in Belgrade. These various types of methods that have been applied in this study are used for final triangulation of results.

Secondary data are obtained by literature review of scientific papers, books, previous research and sources related to the topic.

2.1 Literature review

Literature review was part of the initial stage of the research. Scientific papers, books, previous research and sources related to the main concepts (climate change, climate change adaptation, urban forest governance, adaptive forest management and ecosystem services) of research were explored. Based on those findings, the overall research design was developed, as well the design of expert interviews (in-depth and Q methodology). The literature review represents the summary of the main aspects of the concepts that were part of literature review process.

2.2 DAYMET model

DAYMET model was developed by the Numerical Terradynamic Simulation Group (NTSG) at the University of Montana, Missoula. It interpolates daily minimal (T_{min}) and maximal (T_{max}) air temperatures, and precipitation for a given point using observations of surrounding stations and estimates the daily solar radiation and vapour pressure deficit for the location of interest. The interpolation procedure is based on a reduced Gaussian filter that uses a certain number of stations located near a given point (Hasenauer *et al.*, 2003). For the calculation of solar radiation and vapour pressure deficit interpolation results of T_{min}, T_{max} and precipitation as well as elevation and angel to the horizon in the east and west are required. In DAYMET, the interpolation can be done for a list of points or for an area on a grid base. The routines of calculation are same in both cases, while the input and output formats are differing. In case of grid interpolation, a digital elevation model (DEM) is needed for the application of this model.

The target number of stations is 25 for temperature and 15 for precipitation. Stations can only be included in the calculations if the number of measurement days exceeds 330. The stations are weighted with a three-dimensional Gaussian filter. The weighted values of maximum and minimum temperature from surrounding stations are used for estimation of temperature for the specified point by application of multiple linear regressions. This interpolation procedure results in a dynamic lapse rate. Regarding the precipitation, the probability of precipitation for specified point is predetermined with an analogue (with regard to the daily occurrence and daily total precipitation). When the probability of precipitation is greater than 0.5, the precipitation is estimated from the stations with measured rainfall (Hasenauer *et al.*, 2003).

The calculation of daily solar radiation is based on the day length at a specific point that is derived from the Sun-Earth Geometry (Monteith and Unsworth, 1990). Radiation is then calculated in ten-minute intervals and added up for a day total. Potential incoming radiation derived from the solar constant and the solar angle is reduced via the transmission coefficient for the permeability of the atmosphere (Bristow and Campbell, 1984). Both direct and diffuse solar radiations are considered in model. The

water vapour pressure is calculated according to Abbott and Tabony (1985).

For the application of DAYMET model for the territory of Serbia, data obtained from the National Hydrometeorological Service of Serbia were utilized. The interpolation is done for the area of Serbia and Belgrade on the grid base.

The Serbian version of DAYMET uses the original daily weather data from the years 1961 to 2010, from 80 measurement stations all over Serbia (Figure 2).

For 31 stations all required data were provided (Tmin, Tmax, daily precipitation, daily solar radiation and vapour pressure), while from 49 stations, only Tmin, Tmax and daily precipitation could be obtained. In addition, latitude, longitude and elevation of climate stations were obtained. Climate data from surrounding countries could potentially eliminate edge effects (Hasenauer et al., 2003). However, in the framework of this study this data were not included, due to the lack of time and financial resources.

Figure 2 Digital Elevation Model (DEM) of Serbia with climate station locations

The number of weather stations on the territory of Serbia has changed over the years, some stations have been added or taken out of operation. Twenty stations have been working during the entire analyzed period. The average length of the stations work is 39 years. The measurements from the stations that are located on the territory of province Kosovo are missing since the year 1997 (10 stations).

The station density was enough for running the model, i.e. for each year the required number of stations could be provided. However, a greater density would improve the interpolation results. The special lack of data is observed from higher elevations, where just 8 stations are present on altitudes higher than 1000 m.a.s.l and just one higher than 1500 m.a.s.l ('Kopaonik' - 1711m).

Data obtained by DAYMET analysis are used in R Statistical Software for further calculations, and maps are produced with the ArcGIS program.

2.3 Analysis of documents

Main documents that are of importance for policy-making and management of UPF are analyzed by a content analysis. The aim was to assess how climate change and climate change adaptation issues are incorporated in the selected documents. Terms1 like "climate change", "climate change mitigation" or "climate change adaptation" were searched for in all documents. Furthermore, the results obtained by the in-depth interview are compared with the results of the content analysis for identifying potential gaps.

Following documents were analyzed:

- Law on Forestry of RS
- Forest Development Strategy of RS
- Afforestation Strategy of Belgrade
- Management Plans of UPFs (4 selected management plans)
- Law on Spatial Plan of the Republic of Serbia 2010-2020
- Regional Spatial Plan for the Administrative Territory of the City of Belgrade
- Master Plan of Belgrade 2021
- National Sustainable Development Strategy 2008-2017
- Development Strategy of the city of Belgrade
- Tourism Development Strategy of Belgrade

The main criteria that were searched in the documents referred to the main aspects of the climate change and climate change adaptation, in general and regarding the urban forests. Those were: (i) (urban forests) contribution to climate change; (ii) vulnerability (of urban forests) to climate change; (iii) climate change impact (on urban forests) and (iv) climate change adaptation actions (that are considered as important for management of urban forests). It is analyzed in which way these issues appear in the documents (directly/indirectly) and how detailed they are presented.

2.4 In-depth expert interviews

In-depth interviewing is a qualitative research method "that involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program, or situation" (Boyce and Neale, 2006). This type of interview is often unstructured and uses a flexible interview approach. An in-depth interview is characterized by the length, depth and structure and seeks to obtain more deep information then a questionnaire-based interview (Veal, 1992).

In-depth expert interviews were addressed to the managers of two main management agencies of UPF in Belgrade. It aimed to understand the current state of UPF resources, management plans and ecosystem services regarding climate change adaptation, as well as current actions undertaken and potential actions for adaptation of urban forest resources to climate change. Furthermore, it aims to understand the perception of managers on climate change in general and its implication for UPF management.

For the purpose of this research, in total 6 in-depth interviews were conducted. Four were done with the representative managers of two management agencies in Belgrade, PE 'Serbia Forests' and PUC 'Greenery Belgrade', and two with the experts involved in the development of management plans (Appendix 2).

Two managers were interviewed from the Forest Estate 'Belgrade' of the PE 'Serbia Forests', as they are involved in the planning process and management of UPF of Belgrade (manager 4 and 5).

[1] Those terms were search in the documents in Serbian language ("klimatske promene", "ublažavanje klimatskih promena", "prilagođavanje na klimatske promene") in their literal expression but also in informal way.

In addition one interview was conducted with the manager from the Department for Project and Planning in Forestry (manager 6), as they are in charge for the development of the management plans for the some forest areas (both state and private properties) on the territory of administrative territory of Belgrade.

In PUC 'Greenery Belgrade', two interviews were conducted, one with the head of the Working Unit for Forests (manager 1) and other, with the manager in charge for the development of plans and projects for green areas of Belgrade (manager 2). In addition, one interview was done with the representative of Faculty of Forestry (manager 3), because it is responsible for the development of the long-term management plans for the forest areas that are managed by the PUC 'Greenery Belgrade'.

The interviews were done in May 2012. The average length of the interview was 45 minutes. During the interviews, main topics regarding the climate change and climate change adaptation were discussed. The interview started with the question how the managers are concerned with climate change in their work. It was followed by the conversation about the issue of the importance of climate change and climate change adaptation (both in general and in regards to the management of UPF) and the issues of communication and policy making regarding the climate change adaptation in UPF. Furthermore, the interview was streamed to the more specific details about climate change adaptation of UPF (urban forests contribution to climate change in management plans; vulnerability of urban forests to climate change; climate change impact on urban forests and climate change adaptation actions (strategies) that are consider as important for management of urban forests). At the end of the interview, main challenges for adaptation process in UPF were stressed (Appendix 1).

2.5 Q methodology

The second type of expert interviews is done by applying the Q-methodology, for examining respondents' perception by ordering the pre-prepared statement (Stephenson, 1935; Brown, 1980; Brown, 1993). It focuses on experts' opinions, believes, perceptions and awareness towards climate change adaptation as an issue (and climate change in general) in UPF in Belgrade. It tries to differentiate which aspects of adaptation process are seen as the most important; as well as which viewpoints towards climate change exists.

"Q methodology provides a foundation for the systematic study of subjectivity, a person's view point, opinion, beliefs, attitude and the like" (Brown, 1980, pp. 3-4). It is a powerful analytical tool that can produce robust and externally valid results with small samples (Niemeyer et al., 2005). Basically, the aim of Q methodology is to analyze subjectivity in a statistically interpretable form (Barry and Proops, 1999). This method does not link persons over statements as common factor analysis does, but conversely links statements over the participants of the study (Kaufmann, 2012).

In Q methodology, study people are presented with a sample of statements related to a topic. The concourse of the statements is called 'Q-set'. Respondents, which are called 'P-set', are asked to rank-order the statements (usually from 'agree' to 'disagree') from their individual perspective, according to their preferences or feelings about the topic. Sorting of Q statements is mostly done by using the score sheet, which follow quasi-normal distribution. The respondents are asked to sort the statements adhering to the distribution (score sheet) provided (Van Exel and de Graaf, 2005). By Q-sorting people give their subjective meaning to the statements, and by doing so reveal their subjective view point. Those individual rankings are then subjected to factor analysis, where correlation between personal profiles indicates similar viewpoints, or segments of subjectivity that exists around certain topics (Brown, 1993). In this methodology persons are correlated instead of tests. If each person sorts the statements in his/her specific likes and dislikes then their profiles will not correlate. On the contrary, if the sorts are similar, significant clusters can appear, which could be factorized, and described as common viewpoints, and individuals could be measured with respect to them (Van Exel and de Graaf, 2005). The main critique of the Q methodology is concerned for the reliability and the possibility of generalization due to small sample. An important notion behind the Q methodology is that only a limited number of distinct viewpoints exist on any topic. These perspectives can

be revealed if the Q statement concourse is well structured and contain the wide range of existing opinions on the certain topic (Brown, 1980).

One of the advantages by using Q Methodology is that it utilizes statistical measurements in order to exclude the researcher from the distinctive ideal discourses and its subjective opinion. However, this advantage is also the risk of the method, and it is represented by believing too strongly in the Q methodology statistics (Kaufmann, 2012): "The numbers cannot tell anything, but help to interpret the conglomeration of all collected data. Statistical results give reasons to conclude one or the other and – first of all – provide replicable data and the possibility to redo the research to then compare the results is much easier than by just using ethnographic methods" (Kaufmann, 2012; p. 33).

In this research, Q-methodology is addressed to managers of UPF of Belgrade (that were also part of the in-depth interview) and other relevant UPF decision-makers (scientists, researchers, university professors, representatives of relevant organizations) (Appendix 6). Initially, existing organisations relevant for UPF in Belgrade were screened and experts were chosen so that they represent wide variety of actors and organizations that exists in urban and peri-urban forestry arena in Belgrade, and reveal as many as possible perspectives on the questioned issue. In total 23 respondents were interviewed.

Organizations from which respondents are chosen are directly or indirectly involved in management of UPF and are of importance for climate change adaptation, both on national, local and regional level. Finally, 14 organizations on national, local and regional level were approached (Table 1) (Appendix 6).

The statements used in the study were drawn based on the in-depth interviews and review of relevant literature. The concourse of statements was organized according to the general attitudes toward the climate change and climate change adaptation, as well as to concrete measures and aspects of climate change adaptation that can be relevant for UPF in Belgrade. Initially, fifty-five statements were developed, and were used in the test phase of Q methodology, where three Q-sortings were done. The statements that did not strongly differentiate between individuals or were misunderstood were excluded or replaced. At the end, a Q-set of forty-eight statements was fixed, which contains a variety of existing relevant aspects related to the topic (Appendix 4).

Table 1 Organizations involved in Q methodology, with the number of conducted interviews

Organizations involved in Q methodology		
National level	**Local level**	**Regional level**
– Public Enterprise 'Serbia Forest' – Forest Estate 'Belgrade' and Biro for Projects and Planning in Forestry (3) – Ministry of Agriculture, Forestry and Water Management - Directorate of Forests (2) – Ministry of Environment, Mining and Spatial Planning - Department for Climate Change (2) – Institute of Architecture and Urban and Spatial Planning of Serbia (IAUS) (1) – Faculty of Forestry (4) – Faculty of Agriculture (1) – Institute of Forestry (2) – Serbian Association of Landscape Architects (1)	– Public Utility Company 'Greenery Belgrade' (2) – Institute of Urbanism Belgrade (1) – Secretariat for Environmental Protection of Belgrade City (1) – Citizen Initiative for Protection of Zvezdara Forest (1)	– South-East European Virtual Climate Change Centre (SEEVCCC) (1) – Regional Environmental Center (REC) (1)

The sorting process was preceded by instructions on how the sorting should be performed (Appendix 3). The process of Q-sorting involved allocating printed cards containing the statements among nine response categories between +4 and -4, referring to how strongly respondents agree or disagree about the statement. Respondents were provided by the score sheet, where each category was subjected to a quota resulting in a final distribution of statements. This process of sorting referred to as a "forced" sorting. The score sheet contained the response categories -4, -3, -2, -1, 0, 1, 2, 3, 4 that were subjected to quotas of 3, 4, 6, 7, 8, 7, 6, 4, 3 (Appendix 5). Forced distribution is used as it improves the quality of the data, because the respondents are required to consider the relative merit of statements to each other. In mathematical terms, forced distribution produce equal means and variance, thereby conforming to assumptions underpinning the factor analysis (Brown, 1980).

Figure 3 Process of Q-sorting by respondents

Most of the Q-interviews (20) were done in person, during June 2012, with average length of 50-60 minutes (Figure 3). Due to the lack of time, some of the Q sorts (3) were obtained through the on-line application of Q methodology, by using Q-Assessor[2] (Appendix 6).

2.6 Summary of methods applied in research

In the Table 2 main methods used in the research have been summarized.

Table 2 Methods applied in research

Methods	
Literature review	Relevant literature have been analysed (covering main concepts)
DAYMET model	Interpolation of daily weather data was done based on the data from 80 measurement stations all over Serbia, for period 1961-2010
Content analysis of documents	In total, 4 management plans and 9 policy documents in relation to UPF were analysed
In-depth interviews	In total 6 interviews were done with managers of UPF
Q-methodology	In total 23 interviews were done with decision-makers from UPF arena (including six managers of UPF, that were part of in-depth interviews)

[2] Q-Assessor is a web application that leverages the best parts of Q Methodology technique to provide a novel, rapid way to identify and quantify opinions, beliefs, and preferences within target populations (available at: http://q-assessor.com/).

3 Literature review

3.1 Urban forests

Changes in socio-economic conditions of today's society lead to re-evaluation of traditional ways of management of natural resources. Urbanization process has imposed high stress on natural ecosystems, especially in urban areas. Therefore, traditional forestry was not seen as appropriate approach for management of forest resources in the cities. The new approaches that recognize and favour the importance of the social, cultural and environmental values over the economic become prioritized. One of the approaches, which emerged during 1960 in Northern America and 1970s in Europe, is concept of urban forests and urban forestry (Konijnendijk, 2003). The definition of 'urban forestry' and 'urban forest/s' has been under the debate, and has slightly different meanings from country to country. Existence of domestic terms ('Stadtwald' (German), 'Skov' (Danish)) that are more commonly used also make the acceptance of term urban forest a bit harder.

Urban forestry is commonly defined as "*the art, science and technology of managing trees and forest resources in and around urban community ecosystems for physiological, sociological, economic and aesthetic benefits tree provide society*" (Konijnendijk, 2003 according to Helms, 1998, p.193). In Europe it took longer that the concept of urban forestry was accepted. Britain was the first European strongholder of urban forestry, by setting up several larger projects on urban forestry (Johnston, 1997; Konijnendijk, 2003). More recently, FAO adopted the term *'urban and peri-urban forestry'* (UPF) that has broader scope within urban green environment (Sangster *et al.*, 2011). Key strengths of urban forestry concept are that it is: (i) integrative (incorporating different elements of urban green structures into a whole), (ii) strategic (oriented on long-term policies and plans, connecting different sectors, actors, agendas and programs), (iii) multidisciplinary, (iv) participatory and (v) aim at delivering multiple benefits (Randrup *et al.*, 2005).

Urban forests refer to all forest and tree resources in and close to urban areas (Figure 4). As this concept is hard to operationalise, and terms *'urban'* and *'forest'* are differently defined in different countries, some other categories appeared, which has same or similar meaning. FAO (2002) used in its forest resource assessment term *'trees outside the forests'* (where parks, gardens and street tree can be categorized). The term of 'green infrastructure' also gain a lot of interests in recent years. It refers to combined structure, position, connectivity and types of green spaces that together enable delivery of multiple good and services.

The lack of inventory data, data on composition and characteristics of urban forests is evident in most of the countries. On the European level, the sole exception to the deficit in comprehensive data of urban/peri-urban forests is the *Trees in Town II* (TTII) national survey of England. This lack of data is conditioned by the different levels of planning and management hierarchy, variety of competent agencies and ownership structures on local level and in relation to the urban tree resources. Furthermore, the lack of definitions, terminology and the practices used in national forest inventories pose a great challenge (Sangster *at al.*, 2011).

Studies that have been conducted so far differ in terms of how they tackle the issue of 'urban forests'. Some were based on administrative units, which may be largely urban but also includes areas of peri-urban or countryside (e.g. peri-urban forests, green belts).

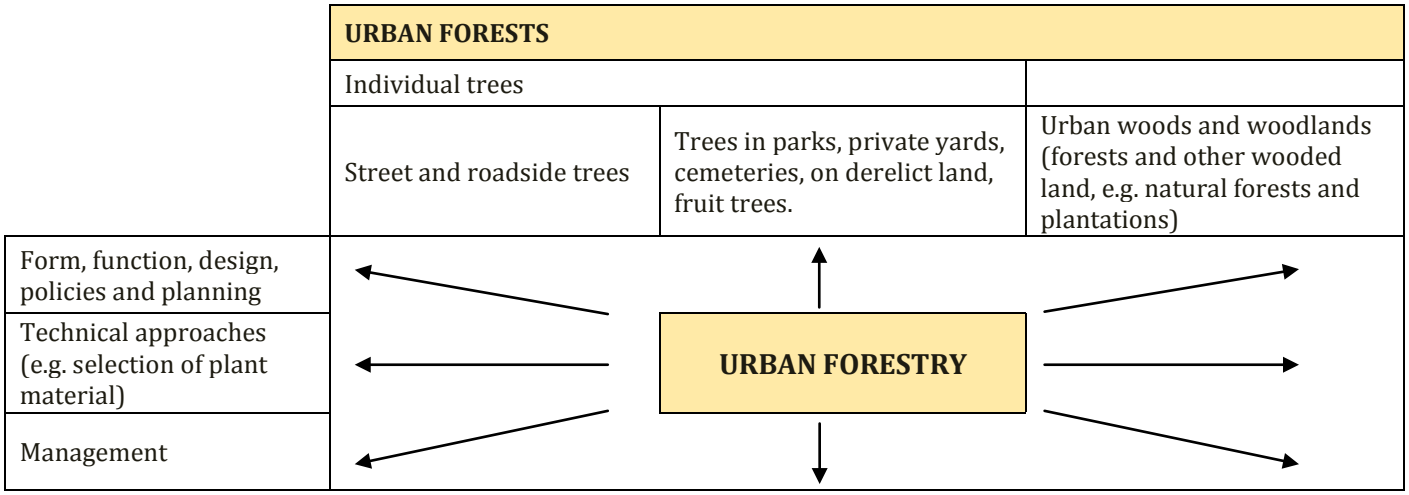

Figure 4 The urban forestry matrix, representing the magnitude and scope of urban forestry (source: Randrup et al., 2005; p.18)

The amount of green spaces in cities can vary from e.g. 4% in Athens to 53% in Budapest. Due to the urbanization process, urban forests are usually very fragmented, and thus harder to be managed. For example, in London, 40% of urban forests have a size between 2 and 5 ha, while in Ljubljana (Slovenia) 79% of them exhibit a size of 1 to 5 ha (Sangster et al., 2011).

3.1.1 Urban forest governance

In most European cities, strategies and polices particularly for urban forests do not exist. Exceptions are European cities with the long history of woodland ownership (e.g. Freiburg, London) (Konijnendijk, 1999).

Urban forest governance refers to "*the structures, rules, partnerships and processes that shape decision about urban forests*" (Lawrence *et al.*, 2011). It includes a wide range of actors (state and non-state organizations) that operate at multiple scales. On the national level this comprises of administration and policies relating to forestry, environmental protection, natural resources, nature conservation, but also transport and urban planning works, and on local scale of local administrations and organizations (e.g. land use planning/zoning, municipality administration) (Van Herzele *et al.*, 2005). All these actors should participate in urban forestry system, as the urban forests are used for a wide range of purposes. Therefore, interest groups and users should play an important role in urban forestry governance (Lawrence *et al.*, 2011) (Figure 5).

Law, policy and planning are three distinct areas that form the legal structure of urban forestry governance. Laws that influence urban forestry are from different sectors (e.g. forestry, nature conservation, building) and are usually of national importance. Many cities also have their own regulations that could particularly relate to urban forests. Other types of policy schemes and incentives are more locally applied, e.g. partnerships are formed to support actions in urban forests. Impact of policies is usually limited, due to many levels, sectors and departments in which urban forests are taken as a part. This fragmentation is one of the greatest challenges in urban forestry, and requires application of integrative approach. Planning in urban forestry has many forms, from day-to-day planning to long-term local and even national planning. Adequate land use planning and environmental planning are of huge importance for functioning of urban forests (Lawrence *et al.*, 2011).

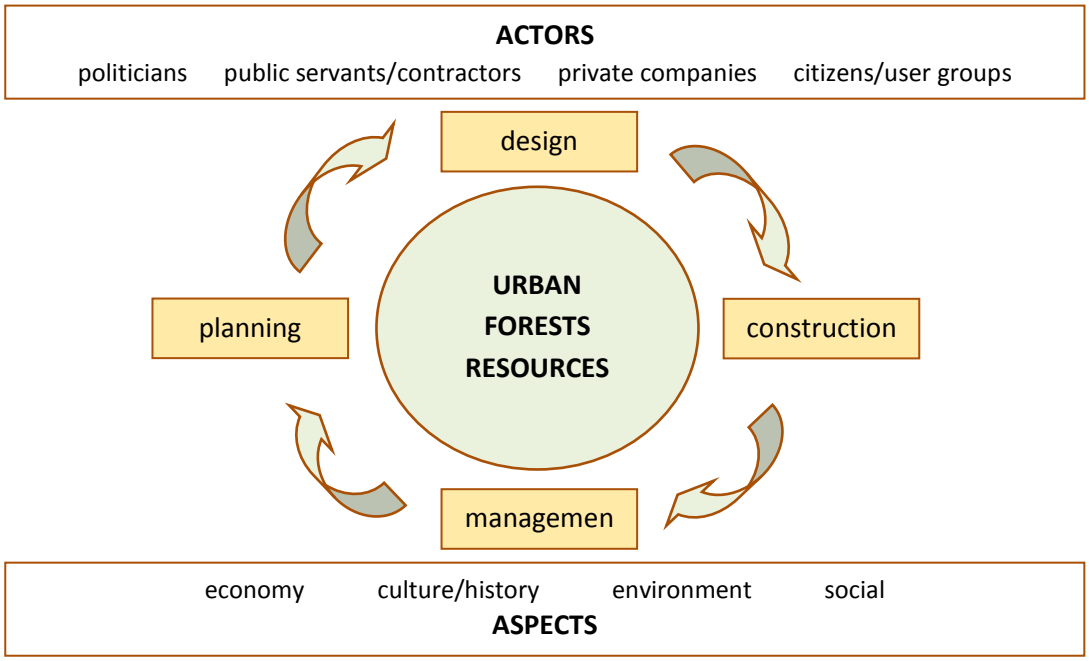

Figure 5 The urban forestry model, representing the actors and main aspects of urban forestry concept (source: Randrup et al., 2005; p.19)

Urban forestry policymaking usually refers to the social bargaining process for the regulation of conflicts related to interests in the utilization and protection of forests and trees (Ottitsch et al., 2005). Conflicts occur between different users, different types of recreation, but also between people and the "authority" of forests. A study of Hunter (2003) showed that different views of forest managers and other users lead to conflicts.

The diversity of ownership forms, resources, fragmented legislation and policies, competitive interest of local administrative bodies make the urban forestry system complex. Therefore, it requires enhanced and strong organizations, a stable budget (Ottitsch et al., 2005) and additional innovative forms of funding (Lawrence et al., 2011). Morover, it needs both a clear orienation toward public goals and the means and strategies to influence users (Ottitsch et al., 2005).

Public participation, and participation in general, is central issue in urban forestry. Urban forestry is more socially inclusive then other forms of natural resouce management. Diversity of actors and diversity of citizen's need towards forests, call for open participatory policy making and management (Lawrence et al., 2011).

3.1.2 Management of urban forests

In Europe, urban woodlands and parks are in many cases managed by municipal organizations, while peri-urban forests are managed by state forest services. Such situation is usually in contrast to forest ownership and management at the national level. For example, in Austria 85% of forests are in private ownership, but the city of Vienna owns 72% of the forests within its municipal boundaries. In Prague 40% of forests is owned by the city, while in the Czech Republic state forest ownership is dominant (70%). In many cities in Eastern Europe the state is the main owner of the forests in the cities (Hunter, 2003).

Management of urban forests have two levels: (i) the 'strategic' level, which is directed towards the development of overall visions for forest management usually for a ten years period, and (ii) the 'operational' level, which focuses more on annual or biannual activities that consists of well-defined tasks. In terms of urban forest management, it refers to a more dynamic and creative concept that embodies maintenance of areas and the development aspect (planning). Long-term strategic planning should have more attention in urban forest management, especially nowadays when the

relationship of a modern society and nature becomes different. Thus, an integrative and multidisciplinary approach for management is seen as important. The relationship between the user's needs, technical aspects, biological processes and time aspects should be stressed in the more integrative way. Furthermore, a profound understanding of ecological maters should be balanced with other services and aspects of urban forest management, e.g. design and aesthetics (Gustavsson et al., 2005).

Management of urban forest is more expensive than regular management of forests. The amount of management costs varies also between different types of green areas (e.g. management of urban parks is much more expensive than management of peri-urban forests) (Hunter, 2003) and is challenging (Gustavsson et al., 2005).

Forest ecosystems provide a wide range of services to the society and are essential for human well-being (Louman et al., 2009). Those services are widely known as ecosystem services and are divided in: supporting, provisioning, regulating and cultural services (Figure 6). In UPFs the benefits that those services provide are numerous, ranging from intangible psychological and aesthetic benefits to amelioration of urban climate and mitigation of air pollution (Tyrväinen et al., 2005).

Urban forests serve multiple purposes. Historically the most important services are: recreation, aesthetic and positive influence on health. Moreover, importance of provisioning services have been high, as it provides people with food, fuel wood, timber for construction, non-timber products. Citizens are usually very connected to their forests because it symbolizes their personal, local or community identity and have a cultural meaning. Other services, like education or providing positive image to the city, should not be overlooked. Some of those services can improve the quality of living/working environment, promote tourism or enhance economic development (Stewart et al., 2011; Tyrväinen et al., 2005).

Consumptive use value of forests, which relates to market-priced products, has been prioritized so far. However, the main values of urban and peri-urban forests have no market price. Therefore, they are sometimes not part of management plans, even if they are important for the human well-being (Tyrväinen et al., 2005).

The use of urban forests, and thus services that are provided, vary between European cities. Nordic countries are famous for recreational use and aesthetic purposes, while protective and climatic uses of tree vegetation is more emphisizen in other countries in Europe. Protective function (e.g. form winds) is more seen in north-western part of Europe, while mitigationg urban microclimate (e.g. shading effects of trees) is seen in Southern part (Tyrväinen et al., 2005).

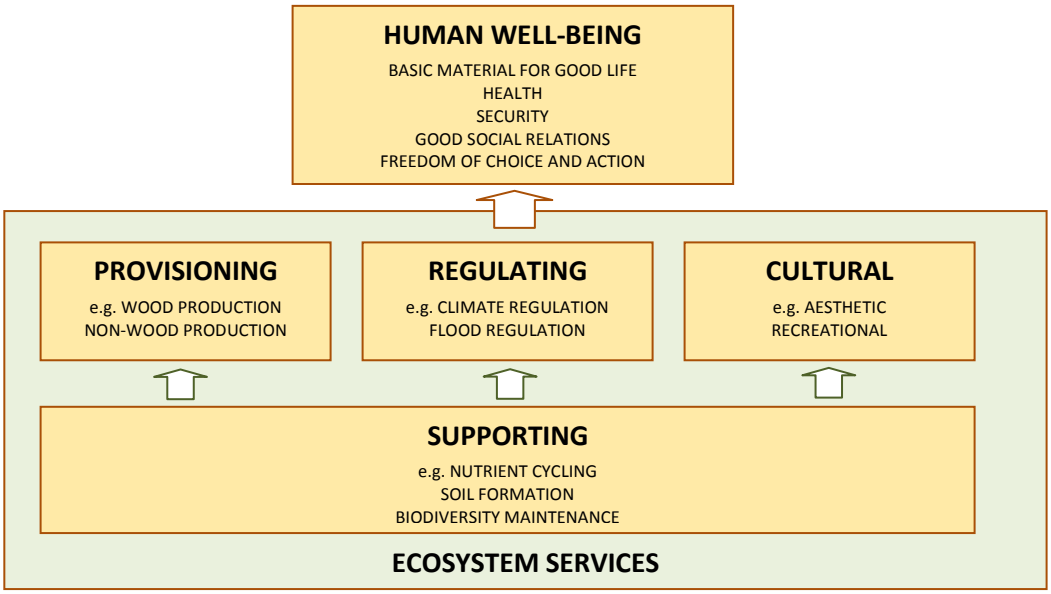

Figure 6 Ecosystem goods and services and their relation to well-being (Louman *et al.*, 2009)

3.2 Climate change

Climate change is recognized as one of the most serious challenges facing the world (Bolte *et al.*, 2009). The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) presents the evidences that anthropogenic influence is significant (IPCC, 2007b). Temperatures are increasing, rainfall patterns are shifting, glaciers are melting, and global mean sea level is rising. Extreme weather events resulting in hazards, such as floods and droughts are expected to become more frequent and intense (Lindner *et al.*, 2010). Thus, climate change has consequences on economic and natural systems and human health (IPCC, 2007b).

Climate change "*refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use*" (IPCC, 2007a, p. 871; Levina and Tirpak, 2006, p. 12). The IPCC takes a broader view on 'climate change', while the United Nations Framework Convention on Climate Change (UNFCCC) makes a distinction between 'climate change' that is attributable to human activities altering the atmospheric composition of the globe and 'climate variability' attributable to natural causes. The UNFCCC defines climate change as "*a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*" (Levina and Tirpak, 2006, p. 12).

Causes of climate change

Energy balance of climate system is altered by changes in atmospheric concentration of GHGs and aerosols, land cover and solar radiation (IPCC, 2007b).

GHGs are emitted through natural processes and human activities that trap heat in the atmosphere. Large amounts of GHGs are released into the atmosphere due to human activities. Increasing the atmospheric concentrations of these gases enhance the greenhouse effect and warming the climate. The main sources of anthropogenic GHG emission are (EEA, 2012a):

- burning of fossil fuels (coal, oil and gas) in electricity generation, transport, industry and households (CO_2);
- agriculture (CH_4) and land use changes like deforestation (CO_2);
- land filling of waste (CH_4); and
- use of industrial fluorinated gases.

GHGs emissions increased for 70% between 1970 and 2004. Global atmospheric concentration of CO_2, methane (CH_4) and nitrous oxide (N_2O) has increased markedly as result of human activities since 1750 (Figure 7).

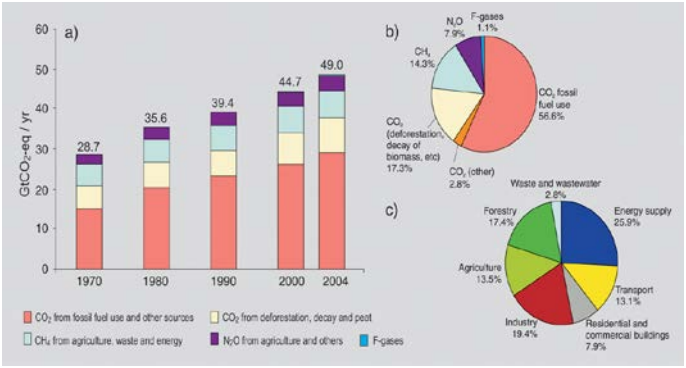

Figure 7 Global anthropogenic GHG emissions (source: IPCC, 2007a, 2007b)

Projected climate change and its impacts

The IPCC has developed scenarios for climate change, based on plausible, quantitatively specified assumption about future demographic, socio-economic, technological and environmental development. All of these factors affect human emission of GHGs and aerosols, and thus enhance climate change. The Special Report on Emission Scenarios (SRES) of IPCC presents 40 scenarios, that are further grouped into four 'families' characterized by common narratives. Following six scenarios are the most often used: A1B, A1F1, A1T, A2, B1, B2 (Fischlin et al., 2009; Nakicenovic et al., 2000). (Figure 8)

In Fischlin et al. (2009) four scenario clusters are explained, which stress commonalities among scenarios in the current trends of emissions and consider possible future differences among pathways in the second half of 21st century. Those clusters are: (i) "unavoidable" which can be used to assess minimal adaptation needs; (ii) "stable", in which GHGs concentrations approach a new equilibrium by 2100; and (iii) "growth", which correspond to business-as-usual emissions, and (iv) "fast growth" that represents development since 2000 that involve unprecedented high emission level (Seppälä et al., 2009a, p. 10). However, it should be noted that uncertainty, which is associated with expected development of human society, climate system response and effects of physical and biotic system, is still present in all these predictions (Seppälä et al., 2009a).

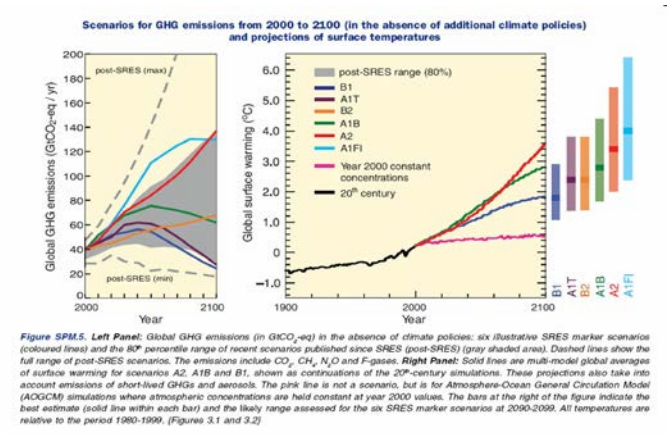

Figure SPM.5. **Left Panel:** Global GHG emissions (in GtCO$_2$-eq) in the absence of climate policies: six illustrative SRES marker scenarios (coloured lines) and the 80th percentile range of recent scenarios published since SRES (post-SRES) (grey shaded area). Dashed lines show the full range of post-SRES scenarios. The emissions include CO$_2$, CH$_4$, N$_2$O and F-gases. **Right Panel:** Solid lines are multi-model global averages of surface warming for scenarios A2, A1B and B1, shown as continuations of the 20th-century simulations. These projections also take into account emissions of short-lived GHGs and aerosols. The pink line is not a scenario, but is for Atmosphere-Ocean General Circulation Model (AOGCM) simulations where atmospheric concentrations are held constant at year 2000 values. The bars at the right of the figure indicate the best estimate (solid line within each bar) and the likely range assessed for the six SRES marker scenarios at 2090-2099. All temperatures are relative to the period 1980-1999. (Figures 3.1 and 3.2)

Figure 8 Scenarios for GHG emissions from 2000 to 2100 and projections of surface temperatures (source: IPCC, 2007a, 2007b)

Impacts and vulnerabilities of climate change differ across regions, territories and economic sectors in Europe. According to IPCC (2007c), in Europe the mean annual temperature has increased by more than 1.1°C compared to preindustrial time. This is higher than global average increase (0.8ºC). Climate change projections suggest that by 2100 temperature will increase between 2°C in Ireland and UK, up to 3°C in central Europe and 4-5°C in northern Europe and Mediterranean regions (Lindner *et al.*, 2010). Atmospheric CO_2 is projected to increase to at least 486 ppm (compared to preindustrial level of 280 ppm) (Nakicenovic *et al.*, 2000).

In Europe the largest temperature increase is expected to be evident in southern Europe. The largest precipitation decrease is in southern Europe in contrast to increased precipitation in north/north-western Europe. Projected increases in intensity and frequency of heat waves and floods and changes in the distribution of some infectious diseases and pollen adversely affect human health. Climate change is an additional pressure on ecosystems, which may lead to northward and uphill shifts of many plant and animal species. However, this change may be too rapid for many species and their potential to migrate. Sectors that are adversely affected by climate change include agriculture, forestry, energy production, tourism and infrastructure in general (EEA, 2012a).

Measures to tackle climate change

Tackling climate change requires the implementation of both mitigation and adaptation measures. They can complement each other and together significantly reduce risks of climate change (IPCC, 2007b).

Mitigation is defined as "*an anthropogenic intervention to reduce the anthropogenic forcing of the climate system; it includes strategies to reduce green-house gas sources and emissions and enhancing greenhouse gas sinks*" (IPCC, 2007a, p. 878).
Mitigation actions are supported by wide range of policies and instruments, which are available for the governments, but are varying depending of national circumstances and sectoral context. Some of those measures include: (i) integration of climate policies into a national/development policies, (ii) regulations and standards, (iii) taxes tradable permits, (iv) financial incentives, (v) voluntary agreement, (vi) information and (vii) research. Achievements of UNFCCC and Kyoto Protocol regarding the mitigation action are evident, from which carbon market and new institutional mechanisms for future mitigation efforts are the most important (IPCC, 2007b).

Adaptation is defined as "*adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities*" (IPCC, 2007a, p. 869).

Mitigation and adaptation measures should be incorporated in overall sustainable development

concepts and policies. Thus, synergies can be realized and conflicts avoided in many sectors. Macroeconomic and non-climate policies should be harmonized with climate policies, as on contrary they can significantly affect emissions, adaptive capacity and vulnerability (IPCC, 2007b). Besides climate protection, all these measures need to assure socio-economic development simultaneously (Corfee-Morlot *et al.*, 2011).

Climate change policies

UNFCCC addresses the global threat of climate change. According to UNFCCC and IPCC, it is necessary to keep global warming below 2°C, which require that emissions of carbon dioxide (CO_2) and other GHGs must be half of the current numbers by 2050 (compared with 1990 level) (EEA, 2012b).

In 1997, the UNFCCC's Kyoto Protocol was adopted with the aim to achieve more substantial global emission reductions. It sets binding emission targets for developed countries that have ratified the agreement, such as the EU Member States, and limits the emission increases of the remaining countries for the first commitment period from 2008 to 2012[3].

The Cancún Agreements was adopted at the UN Climate Conference in Mexico (in 2010). It includes a comprehensive finance, technology and capacity-building support package to help developing nations adapt to climate change and adopt sustainable paths to low-emission economies.

In 2011, The 'Durban Platform for Enhanced Action' was adopted at the UN conference in South Africa and it agreed a roadmap towards a new legal framework by 2015, applicable to all Parties to the UN climate convention. Furthermore, it foresees a second commitment period of the Kyoto Protocol, starting in 2013. Agreement was also reached on the design and governance arrangements for the new Green Climate Fund (Tadesse, 2011).

When it comes to activities undertaken towards reduction of GHGs emission, and in overall mitigation of climate change, it can be noted that many European countries have adopted national program aimed at reducing emissions. Some of EU-level policies and measures include: (i) increased use of renewable energy (wind, solar, biomass) and combined heat and power installations; (ii) improved energy efficiency in buildings, industry, household appliances; (iii) reduction of CO_2 emissions from new passenger cars; (iv) abatement measures in the manufacturing industry; and (v) measures to reduce emissions from landfills (EEA, 2012b).

Adaptation measures refer to anticipating the effects of climate change and taking appropriate action to prevent or minimize the damage they can cause or exploit opportunities. Those measures affect most economic sectors and involve many levels of decision-making. Therefore, adaptation measures should be integrated in numerous policy areas: agriculture and rural development, disaster risk reduction, health services, spatial planning, forestry, ecosystems and water management.

The European Commission (EC) published a green paper in 2007 ("*Adapting to climate change in Europe — options for EU action*") and a white paper in 2009 ("*Adapting to climate change: Towards a European framework for action*"). The white paper emphasized the need to mainstream adaptation in all key EU policies, to develop a knowledge base through further research, to support developing countries to improve their resilience and capacity to adapt to climate change (e.g. within the UNFCCC) and to implement a web platform for sharing information. A comprehensive EU adaptation strategy is expected to be developed by 2013 (Ecologic Institute, 2011; EEA, 2012b).

In March 2012, the European Climate Adaptation Platform (Climate-ADAPT[4]) was launched. It aims at various governmental levels to support development of adaptation strategies and actions. A Global Monitoring for Environment and Security (GMES) initial operational climate service is being proposed, complementary to existing GMES initial services (EEA, 2012b).

3 Countries are expected to meet their target mainly through domestic policies and measures. They may meet part of their emission reduction targets by investing in emission-reducing projects in developing countries (the Clean Development Mechanism (CDM)) or in developed ones (Joint Implementation (JI)).

4 http://climate-adapt.eea.europa.eu/

3.2.1 *Climate change adaptation*

As it was previously mention, **adaptation** refers to *"adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities*" (IPCC, 2007a, p. 869). Distinction can be made between anticipatory, autonomous and planned adaptation.

- **Anticipatory adaptation** – it takes place before impacts of climate change are observed, and is also known as *proactive adaptation*.
- **Autonomous adaptation** – adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems, which is also known as *spontaneous adaptation*.
- **Planned adaptation** – is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state (IPCC, 2007a, p. 869).

Up to now adaptation has been a lesser part to climate change debates (Dovers and Hezri, 2010), but it is becoming highly important on global and national policy agendas (Ecologic Institute, 2011). Even though many adaptation options have emerged, adaptation that is more extensive is needed if vulnerability to climate change is to be reduced. Adaptation can reduce vulnerability, especially if it is part of broader sectoral initiatives. Some of the factors that can exacerbate vulnerability to climate change are: poverty, unequal access to resources, food insecurity, globalization, and conflicts (IPCC, 2007b).

In relation to climate change impacts, IPCC (2007a, p. 869) defines **adaptive capacity** as "*ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences*". Adaptive capacity is connected to social and economic development, and is unevenly distributed across and within societies (IPCC, 2007b). In any adaptation policy it is important to know that there is no 'one size fits all' solution.

The United Nations Development Programme - Global Environment Facility has developed an Adaptation Policy Framework (APF), which has four basic principles with key feature of flexibility (Lim and Spanger-Siegfried, 2005):

- Adaptation to short-term climate variability and extreme events is included as a basis for reducing vulnerability to long-term climate change.
- Adaptation policy and measures are assessed in context of development.
- Adaptation occurs at different levels in society including the local level.
- Both the strategy and the process by which adaptation is implemented are equally important (Lim and Spanger-Siegfried, 2005).

3.3 Climate change adaptation in urban areas

In last century urban population has grown rapidly, from 260 million in 1900 to over 3.4 billion today. This growth, together with urbanization, technological development and increase consumption levels, has increased the pressures on the world's natural resources and ecological systems (Satterthwaite, 2011a). Cities are therefore seen as part of the problem, but also as part of solution to climate change (Corfee-Morlot *et al.*, 2011).
Cities are facing various challenges and will be in many ways affected by climate change. They are focal points of vulnerability, as they rely on complex infrastructure in order to function, which is at high risk from climate change. Blue (i.e. water) and green (i.e. forests, parks, green corridors) infrastructure are becoming increasingly valuable and important in regulating problems posed by climate change (e.g. regulate water floods, mitigate urban heat, improve air quality, provide pleasant places for citizens). At the same time, these city recourses are also becoming highly threatened by climate change (Ecologic Institute, 2011).

The Fourth Assessment Report of IPCC has acknowledged the role of cities in design and delivery of climate responses. However their role is still marginally studied to the full perspectives of climate change issues (IPCC, 2007a).

The White Paper (released in 2009 by EC) proposes a framework for action to reduce vulnerability and adapt to climate change. It stresses the importance of: (i) integration of all regional and municipal development areas (e.g. agriculture, forestry, energy) as parts of climate adaptation strategy, and (ii) crucial role that local and regional authorities must have in adaptation process (Ecologic Institute, 2011).

In cities, adaptation involves changes in policy practices within many parts of local government. So far, only a small number of countries have considered climate change adaptation as part of development plans (e.g. Hungary, Romania) (CLIMATE-ADAPT, 2012). Usually, lack of relevant local knowledge and data on the local impact is present. Large overlap exists between most of the measures needed for adaptation and local development, as well between climate change adaptation and building resilience to extreme weather/disasters (Satterthwaite, 2011b). Therefore, integrated urban planning should be crucial to both adaptation and mitigation processes on city level (Corfee-Morlot *et al.*, 2011).

In cities where effective development plans or strategies exist, and where environmental issues are taken seriously, it is much easier to introduce adaptation strategies (e.g. London). Local planning, regulatory and financial framework need to be first adjusted, in order to encourage and support adaptation by households, community organisations, nongovernmental organizations (NGOs), private sector and individuals. The second need is bottom-up initiatives from local governments that would address specific local risks of climate change. This approach also enables forming of public-private partnerships on local level that can be very effective in process of adaptation (Satterthwaite, 2011b). National policies should assist and empower local governments to become more effective as actors in talking climate change (Corfee-Morlot *et al.*, 2011).
Adaptation actions, especially in urban context, represent the multitude of decisions and actors that need to be combined in order to get collective response to climate change (Corfee-Morlot *et al.*, 2011). Key actors in the policy process are typically grouped in four key categories: (i) state actors (governments (national/local) or related institutions), (ii) market actors (business institutions), (iii) scientific actors and (iv) civil society. Particularly important for raising awareness about importance of adaptation to climate change are expert community and media (Corfee-Morlot *et al.*, 2011).

Urban areas, with its multiple needs and demands, are facing various barriers in relation to climate change adaptation (Table 3). The most obvious conflict is between expected short-term economic and social benefits and the long-term benefits that will be obtained by sustainable development (Ecologic Institute, 2011). Developing capacities to address these barriers is crucial for moving local climate policy through all sectors.

A possible solution to climate change is to undergo both mitigation and adaptation measures in all city sectors. This requires that the following issues are identified: (i) need for strong leadership, (ii) involvement of a wide range of stakeholders, (iii) provision of relevant information and up-to-date knowledge, (iv) making decisions through innovative and new issues ('adaptation as learning') and (v) the provision of guidelines and tools useful for decision makers (Ecologic Institute, 2011).

Table 3 Key obstacle/barriers to local adaptation actions (Corfee-Morlot et al., 2011, p.178).

Key obstacle to local adaptation actions	
Jurisdictional and institutional	• Lack of mandate to address climate issues • National legislation that lead to mal-adaptation to increase vulnerability over time • Ill-adapted institutional design to convene or coordinate across relevant issues (vertical and/or horizontal)
Political	• Local authorities faced with many different interests • Pressures of short-term electoral cycles on effective risk management and long time lag to reap full adaptation benefits • Lack of willingness to accept costs and behavioural change • Pressure to maintain business as usual development pathways
Economic and budgetary	• Distribution of perceived and real costs and benefits • Lack of resources or funding to address the problems identified
Technical or scientific	• Scientific uncertainty • Inadequate understanding or ignorance of climate change risk • Lack of technical capacity or access to expertise • Lack of scale relevant scientific or technical information

3.4 Climate change adaptation in urban and peri-urban forests

The fact that forests cover about a third of the Earth's land, store about half of all carbon and are valuable sources of biodiversity reminds us that forest ecosystems have a valuable role in tackling climate change (Seppälä *et al.*, 2009b). Adaptation and mitigation measures in forestry are very important steps in this process. The proper time scale for effective implementation of those measures is very crucial in the context of forests. Forests respond more slowly to external forcing than many other ecosystems (e.g. forest succession or soil formation can last for centuries) (Louman *et al.*, 2009). Even though the natural mechanism and inherent adaptive capacity of forests is diverse and will support adaptation of forests to climate change, those natural processes are too slow if the projected climate change is taken into account. Therefore, additional adaptation measures are necessary to be applied (Lindner *et al.*, 2010).

Forests and forestry practices are mainly characterized by reactive and autonomous adaptations (Louman *et al.*, 2009). According to Adger *et al.* (2007), adaptation strategies are focused on reducing vulnerabilities. They can include: (i) altering the exposure of a system (e.g. use of early-warning system, preparedness), (ii) reducing the sensitivity of the system (e.g. application of concrete measures- planting hardy species, improving infrastructure) and (iii) increasing the resilience of the system (e.g. special measures that enable system to recover from loss). All these measures can be implemented as a part of sustainable forest management (SFM), which refers to forest practices that ensure the long-term continuity in the availability and development of forest goods and services along with fulfilment of nowadays society needs. It is seen that SFM as concept was insufficiently adopted, especially in developing countries. Much more efforts are required nationally and internationally to ensure the more responsible management of the forests. Such situation is likely to limit the ability of forests/forestry to adapt to climate change. Therefore, the reinforcement of SFM concept is needed for appropriate climate change adaptation in forests (Seppälä *et al.*, 2009b).

Climate change can lead to significant changes in the delivery of ecosystem services, which is even more apparent if it is combined with other socioeconomic processes (e.g. deforestation, forest fragmentation, population growth, urbanization) (Seppälä *et al.*, 2009a). Over the past 50 years, climate change has affected many aspects of forest ecosystems, like forest growth and dieback, the distribution of indigenous species, the proliferation of invasive species, seasonal patterns in ecosystem processes. Other non-climatic factors (e.g. land-use practices,

energy demand, changed ownership structure) are in interaction with climate effects, and affect forests and forest management (Osman-Elasha and Parrotta, 2009; Seppälä *et al.*, 2009b). Therefore, it is hard to quantify the impact of climate change on forest ecosystems (Lindner *et al.*, 2010).

Climate change is expected to affect the distribution of forest types and tree species, which is predicted with all scenarios that are developed so far (Seppälä *et al.*, 2009b). The consequences of climate change will alter biotic (pests and diseases) and abiotic (fire occurrence, windstorms, flooding, drought) disturbances (Lindner *et al.*, 2010; Seidl, 2008). Depending on the regional situation and the specific changes in climate, it will depend in how far impact on forest goods and services will be present. In Europe, every bioclimatic zone is characterized by its limitations for forest production (Figure 9). Therefore, vulnerability towards climate change is dependent on ability of trees/forests (inherent adaptive capacity) and socio-economic factors to cope with various impacts (Lindner *et al.*, 2010; Schröter *et al.*, 2005).

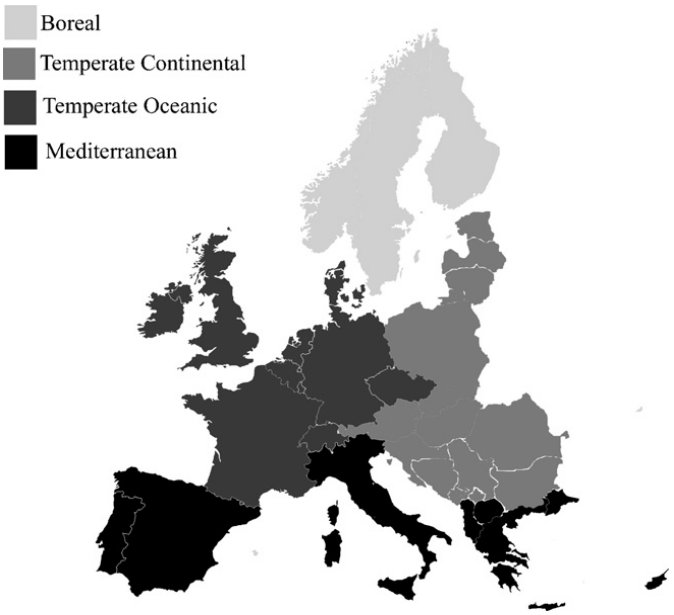

Figure 9 Principle allocation of European countries to bioclimatic zones (Lindner *et al.*, 2010)

According to scenarios of IPCC (2007a) it is expected that forest productivity will increase in some regions (e.g. Boreal region), which represent the opportunity for forest industries and forest-dependent communities. On the other side, drought risk towards forests is very high in Temperate continental and the Mediterranean regions (Lindner *et al.*, 2010). Even though in short-term both positive and negative impacts will be present in Europe, more drastic changes in climate that are expected at the end of century will cause more negative impacts in most European regions (Lindner *et al.*, 2010).

In the Temperate continental zone forest productivity will be mainly constrained by water availability and decreasing annual precipitation. Impact on individual species will vary, e.g. *Fagus silvatica* L. will face severe problems under increasing temperature (Lindner *et al.*, 2010). In addition, net primary production of conifers is likely to decrease in continental and central Europe (Lexer *et al.*, 2002). Exothermic organisms will be enhanced with increasing temperatures, while most of the pests will be triggered by them (e.g. *Ips typographus* L.) (Seidl *et al.*, 2008). Differences in socio-economic conditions within forestry sectors are significant, which is also transferred to its capacity to cope with climate change. In Temperate continental and Mediterranean regions, adaptive capacity is constrained with socio-economic factors, e.g. in southeastern Europe with the lack of economic activities, as well with traditional top-down management of forests (Lindner *et al.*, 2010).

3.4.1 Management for adaptation

Adaptive measures to climate change should be part of sustainability approaches in forest management planning (Table 4), which not necessarily require large financial investments. Effective forest management for climate change must be responsive to wide variety of economic, social, political and environmental circumstances (Spittlehouse and Stewart, 2003).

Perception of climate risk of various stakeholders or actors (individuals, communities, governments, private institutions and organizations) need to be adjusted (Adger *et al.*, 2007). Climate change adaptation strategies take into account precautionary principle that allows implementing some measures that are useful now, but also reduce the risk of unacceptable losses in future. They can be

seen as a risk management component of SFM plans (Spittlehouse and Stewart, 2003).

According to Innes *et al*. (2009) many actions that managers might take, involve substantial amount of uncertainty. FAO (2010) suggests adaptive forest management as essential to addressing arising challenges and reducing forest vulnerability to climate change. It combines management, research, monitoring and opportunity to change practices, as response to gained information (Innes *et al.*, 2009). In adaptive management various measures can be included: selection of pest-resistant or drought-tolerant species, use of stock from a range of provenances, assisting to natural regeneration of functional species. All of those measures need to be adapted to forest condition and the specific site (FAO, 2010). Including adaptation in forest management needs integrative approach, involving all parts of forestry sector, and dealing with forests on landscape-level scale. Developing a dialogue within the forest management community is essential, and will increase the range of options and aid evaluation of the cost-effectiveness of planned/proposed actions (Spittlehouse and Stewart, 2003).

As proposed by Spittlehouse and Stewart (2003, p. 3) adaptation to climate change for forest management requires to:

- Establish objectives for future forest under climate change,
- Increase awareness and education within forestry community about adaptation to climate change,
- Determine the vulnerability of forest ecosystems, forest communities and society,
- Develop present and future cost-effective adaptive actions,
- Manage the forest to reduce vulnerability and enhance recovery
- Monitor to determine the state of the forest and identify when critical thresholds are reached
- Manage to reduce the impact when it occurs, speed recovery, and reduce vulnerability to further climate change.

3.4.2 Governance, Policies and Instruments for adaptation

Forest management measures and strategies to adapt to climate change can be supported by proper policy means. It is necessary that forest managers ensure flexibility so they are able to respond to specific local conditions of forest site and to consider the needs of local people. Such approach is challenging for the traditional forests governance that is focused on regulatory policy tools and are challenged by the international regime on forests (Glück *et al.*, 2009).

Adaptation measures to climate change should be incorporated in forest policy as part of SFM. Specific focus of those measures also need to be taken into account, such as: medium and long-term perspectives, need for additional investments and balance between the benefits and costs, multi-stakeholder participation and improved policy learning (Glück *et al.*, 2009).

Current national policies involve mix of regulatory (strengthening of forest law, or equivalent processes aiming at SFM), economic (grants, subsidies and compensatory payments) and informational policy instruments (Roberts *et al.*, 2009).

Traditional forest governance, which is focused on hierarchical ('top-down') policy formulation and implementation and use of regulatory policy instruments, usually have not been designed to escort all challenges posed by climate change (Glück *et al.*, 2009; Corfee-Morlot *et al.*, 2011). New modes of governance are seen as appropriate system, as these appreciate the participation of multiple actors in identification and implementation of policy goals, through the policy networks (vertical and horizontal dimensions of decision) (Table 5). Those types of new governance are also known as 'governance with government' and 'governance without government' (Kleinschmit *et al.*, 2009, Kjær, 2010). In any of these it does not mean that traditional policy tools are supplanted (e.g. forest regulations, subsidies or tax exemptions) (Glück *et al.*, 2009)

Table 4 Summary of adaptations to climate change for forest management (adapted according to Spittlehouse and Stewart, 2003)

A Summary of adaptations to climate change for forest management	
Topic	Management issues
Gene management	• Determine the responses of species and genotypes to climate and the limits of their transferability, and developing climate-based seed zones that will change over time • Breeding for pest resistance and for wider tolerance to range of climate stresses and extremes in specific genotypes • Re-evaluating seed orchard locations • Planting a mixture of provenances at a site • Re-evaluating conservation and recovery programs
Forest Protection	• Focusing on the protecting of areas with high economic and social value, while in other areas allowing fire to run its course • Altering forest structure (e.g. tree spacing and density, standing dead trees, or coarse woody debris on the forest floor) to reduce the risk and extent of disturbance • Increase prescribe burning to minimize fuel loading • Developing "fire-smart" landscapes by using harvesting, regeneration, and stand-tending activities that manage fuels to control the spread of wildfires • Enhancing forest recovery after fire disturbance • Adaptive actions for protection against insects and diseases (e.g. partial cutting, tinning, sanitation cuts, shortening the rotation length to decrease stand vulnerability)
Forest Regeneration	• Identifying drought-tolerant species • Assisting the migration of commercial tree species from their present to future ranges through artificial regeneration • Planting provenances that grow adequately under wide range of conditions • Controlling undesirable plant species, which become more competitive in a changed climate, through vegetation management treatments
Silvicultural Measures	• Pre-commercially thinning or selectively removing suppresses damaged or poor quality individuals to increase light, water, and nutrient availability to the remaining trees • Reducing vulnerability to future disturbances by managing tree density, species composition, forest structure • Underplanting with other species or genotypes where the current advanced regeneration is unacceptable as source for the future forest • Reducing the rotation age followed by planting to speed the establishment of better-adapted forest types
Forest Operations	• Increasing the amount of timber from salvage logging of fire/ insect- disturbed stands • Maintaining, decommissioning and rehabilitating roads • Including adaptation planning in forest certification as part of a risk management strategy • Mitigating climate change through forest carbon management • Increasing the use of forest for biomass energy • Developing policies to facilitate the creation and implementation of adaptive management responses to climate change
Non-Timber Resources	• Minimizing fragmentation of habitat and maintaining connectivity • Maintaining representative forest types across environmental gradients and protecting primary forests • Maintaining diversity of functional groups as well as species within groups
Park and Wilderness Area Management	• Managing to delay, ameliorate and direct change (reassessment of current view of conservation) • Identifying and planting alternate tree species • Conserving biodiversity and maintaining connectivity in a varied dynamic landscape to aid vegetation and wildlife migration as the climate changes

Core instruments of a new forest governance at national level is a national forest programme (NFP) (FAO, 2011; Glück *et al.*, 2009). National forest programmes are recognized by all countries as comprehensive forest policy frameworks in pursuit of SFM at the county level. NFPs include three elements: (i) forest policy and forest-related policies; (ii) forest-related legislation; and (iii) institutional framework (organizational structures, coordination and participation mechanisms) (FAO, 2011, p.8).

As it is suggested in FAO guideline (2011), climate change issues should be integrated in NFPs of each country, at any stage of its development/phase. This helps to promote efficient and comprehensive forest-related responses to climate change issues, and make links to other land use sectors.

Table 5 Types of governance (Glück *et al.*, 2009, p. 191)

	Government determines societal goals (ends)	Society determines societal goals (ends)
Government selects the means of policy	**Traditional governance** (Hierarchical steering)	Hybrid types
Society selects the means of policy	Hybrid types	**New governance** (society itself organizing)

Integrating climate change in NFPs assumes implementation of changes in all elements that constitutes NFPs framework (Figure 10), which are:

- three main element of NFPs - policies and strategies; legislation and institutional framework;
- three enabling factors: capacity; financial arrangements; and information, communication and research.

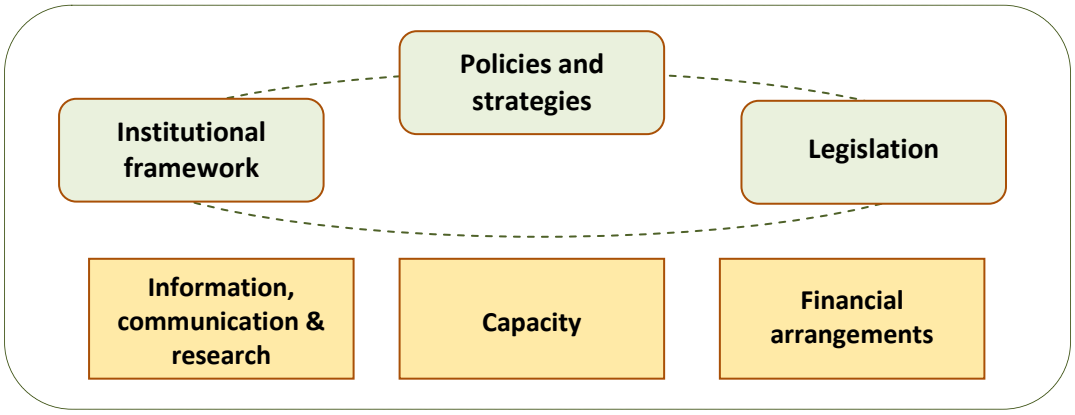

Figure 10 The six elements of the NFP framework (FAO, 2011)

The necessary changes can assume: (i) revision of related legislation, (ii) adapting organizations, (iii) adjusting coordination and participation mechanisms. In parallel those changes need to ensure coherence, consistency and coordination with national climate change policies and strategies; as well to help in enhancement of good forest governance on national level (FAO, 2011). It is the choice of each country how it can implement relevant

actions, taking into account national circumstances related to forests and forestry.

3.4.3 *Key aspects of climate change adaptation in urban forests*

Urban forest contribute to climate change by controlling GHGs emissions, shading effect of trees on buildings (reduce energy use and carbon emission), by regulating the urban microclimate (reducing albedo, providing shade and cover) and the hydrological regime of cities. Assessing the vulnerabilities of urban forest system is very essential for adaptation process, and is a matter of local importance (Nowak, 2000; Ordóñez *et al.*, 2010) (Table 6).

Human influences in urban forests are more pronounced, and can downplay many measures that might be taken. Adaptation responses in urban forest systems consist of: (i) adapting the urban forests to change and (ii) using urban forests to help cities to adapt to changes. Adaptations in urban forest policy and management need to be considered in relation to a wider forest community, people and infrastructure (Ordóñez *et al.*, 2010). They are focused on reducing a system's climate vulnerability and increasing its climate adaptive capacity (Adger *et al.*, 2007).

Adaptive management is increasingly seen as an adequate approach for the management of urban forests. Traditional management of urban forests with a sector specific focus cannot meet the increasing challenges that management of urban forests face nowadays (e.g. in terms of climate change). *"Adaptive organisations that incorporate organisational learning, enhance social capital through internal and external linkages, partnerships, and networks, and makes room for innovation and multi-directional information flow"* are important to be established (Lawrence et al., 2011; p.5).

Table 6 Aspects of an urban forest vulnerability assessment (Ordóñez *et al.*, 2010, p.6)

Dimension	Category	Elements (examples)
Environmental	Urban forest structure	Species composition Species mix Tree arrangement in relation to infrastructure Tree arrangement in relation to each other (ecological connectivity) Age structure
	Urban forest natural resilience	Degree of acclimatization (phenotypic change) Degree of biological adaptation (genotypic change) Ability of species to migrate
	Urban forest stresses	Building activities Pruning Urban microclimate Soil availability Water availability
	Climate Change Scenario (predicted)	Temperature Frequency and intensity of precipitation Frequency and intensity of climate disturbances
	Time horizon and space scale	Long-term perspectives
Social	Institutions	Number and kind of institutions Level of skill of staff Quantity of staff
	Ownership	Kinds and patterns of ownership
Economic	Valuation	Property values Saved infrastructure costs due to urban forest functions
	Institutions	Budget

4 Case study description

4.1 Research area: the city of Belgrade

Belgrade is the capital and the biggest city in the Republic of Serbia. It has a special administrative status within Serbia and it is one of five statistical regions[5] of Serbia (Figure 11). The administrative territory of Belgrade covers an area of 3222.7 km^2, while urban area covers 359.9 km^2. It is administratively divided into 17 municipalities - 10 urban (*Čukarica, Voždovac, Vračar, Novi Beograd, Palilula, Rakovica, Savski venac, Stari grad, Zemun, Zvezdara*) and 7 suburban municipalities (*Barajevo, Grocka, Lazarevac, Obrenovac, Mladenovac, Sopot, Surčin*). The largest municipality is *Palilula* (446.6 km^2), and the smallest is *Vračar* (2.92 km^2). Belgrade covers 3.6% of Serbia's territory. The bodies of the City of Belgrade include: City Assembly, Mayor, City Council and City Administration of the City of the Belgrade (Gudurić, 2008; Stojović, 2011).

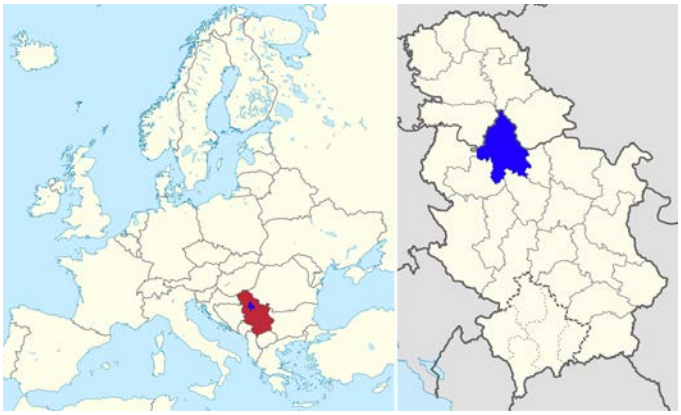

Figure 11 Position of the city of Belgrade in Europe and the Republic of Serbia

Belgrade is characterized with two different natural systems: in the north with the Pannonian depression, which is plain area, and in the south with Šumadija that is hilly and rich in orchards and vineyards (Figure 12). The highest peak in Belgrade area is Kosmaj (628 m), followed with Avala (511 m). Starting from south, the terrain gradually descends to the north, in shapes of wide plateaus, sectioned by stream and river valleys. High plasticity of Belgrade relief, south of the rivers Sava and Danube, spreads the city over many hills. North from the rivers Sava and Danube there are alluvial plains and loessial plateaus, which are divided by a steep section, up to 30 m high (Gudurić, 2008; Stojović, 2011).

The highest point of urban area of Belgrade is at Torlak (municipality Voždovac), with 303.1 m, while the lowest point is on Ada Huja (river island) at 70.15 m. The average altitude of Belgrade is 132 m (Stojović, 2011). The Danube, as the country largest river, flows through 60 km of Belgrade area, while the Sava flows through 30 km. The length of the riverbanks of Belgrade is 200 km. In this area, there are 16 river islands in that area, and the best known of them are Ada Ciganlija, Veliko ratno ostrvo and Gročanska ada (Stojović, 2011).

There are many forests in the city area, and the best preserved are the forests of Kosmaj, Avala, Trešnja, Lipovica, Topčider, Obrenovački zabran and Bojčin (Stojović, 2011).

Figure 12 Belgrade's urban and peri-urban area (personal collection)

In the period from 1948 to 2002 the total population of Belgrade has increased by 2.5 times (Dražić *et al.*, 2006). Today in Belgrade live 1.735.000 inhabitants, and the average density is 538 inhabitants/km^2 (Development Strategy of the City of Belgrade, 2011).

[5] The statistical regions of Serbia are administrative subdivisions created for the purpose of statistics gathering in accordance with the Nomenclature of Territorial Units for Statistics. The National Assembly of Serbia drafted the Law on Equal Territorial Development in 2009 which formed seven statistical regions. The Law was amended in 2010, to reduce the original number of regions from seven to five (Official Gazette of RS, no 88/10).

Significant migrations were primarily caused by conflicts and wars in the Balkans during the 1990s. This change in number, structure and behaviour of the population has had an impact on the identity of city (Development Strategy of the City of Belgrade, 2011), as well as on structure and quality of the green areas of the city (Savić, 2006).

The city was expanding in recent years primarily in radial-concentric direction with respect to the city centre (Savić, 2006). The development followed a number of illegal constructions that have had a major impact on the city green space. Many forests in the city had to be cut down, a little (or nothing) was done to prevent this situation (Gudurić, 2008).

Belgrade has a complex structure of urban development that emerged as a result of numerous inadequate transformations following the many changes in the social-political system during the last fifty years. Since the end of World War II until the early nineties, socialism was a major political formation. With the reduction in strength of the Eastern bloc and Yugoslavia, the political scene in Serbia was characterized by the representatives of the socialist, nationalist and radical stances in politics. This period officially ended in 2000 (Savić, 2006). After the twelve years of political change, the political system in Serbia still can be characterized as unstable. These changes and unstable functioning of the States affected the status of many areas within the state and the cities, including the system of (urban) forestry.

The economic situation of Serbia has also experienced a crisis in recent decades. The poor condition was affected by the UN sanctions, as well as the wars in the region. During these crises the country had difficulties with the export and import of goods. There was insufficient energy supply (oil, gas, gas) and hyperinflation. Decreased production was recorded in all industries. Since 2000 the political changes and processes of recovery has been and still is slow, often with a lack of adequate national policies (Savić, 2006).

This situation has a profound influence on the development of various areas of the state. The effort to stabilize main sectors in the country (e.g. economy, energy, health), affected the slow development of others (e.g. nature protection, forestry). Moreover, this situation affected the people. The struggle for survival influenced the views, opinions and aspirations of people and changed their attitude related to environmental protection.

4.1.1 Urban forests of Belgrade

According to Forest Law (2010), the term 'urban forest' does not exist in Serbia. In the informal communication term 'city forests' is commonly used. This term is mostly used by Public Utility Company 'Greenery Belgrade' that manages urban green areas in the city of Belgrade, and in the planning documents (e.g. Master Plan of Belgrade, Regional Spatial Plan for the Administrative Territory of the City of Belgrade).

For the purpose of this research, urban and peri-urban forests are assumed to cover all forest resources and other types of green areas (e.g. parks, park-forest, alleys) that are situated within the administrative border of city of Belgrade.

A single comprehensive cadastre or record of forest green areas in Belgrade does not exist, which is the major problem for planning and management of urban forests. Forests cover 11.2% of the total city area (Official Gazette of RS, no 10/04). More than half of the forest cover is situated in suburban parts of Belgrade (Zelena regulativa, 2004).

According to the data from the Public Enterprise (PE) 'Serbia Forests' and Public Utility Company (PUC) 'Greenery Belgrade', there are in total 35,980.00 ha of urban and peri-urban forests in the Belgrade administrative area. State Agency 'Serbia Forests' manages 32,322.7 ha of forests, from which 16,686.70 ha are state and 15,636.00 ha are private forests. The 610.75 ha of forests and 2,900 ha of other urban green areas (park-forests, parks, costal green areas, protected areas) are managed by PUC 'Greenery Belgrade' (Gudurić, 2008). These two management organizations are the most important once at the city level. The rest of forests are managed and maintained by other organizations (water management organizations, military organizations, agricultural organizations, churches), while the development of management plans for those areas is done by external forestry experts (from PE 'Serbia Forests', Faculty of Forestry, private companies).

The forest per inhabitant is about 230 m² (Zelena regulativa, 2004; Dražić *et al.*, 2006), which is comparably large to other capitals (e.g. approximately 115 m² in Vienna, or even 1.5 m² in Amsterdam). In Belgrade forest areas are mostly small in size, fragmented and unequally distributed through the city area (Figure 13).

Share of the forests, according to the origin, in the Belgrade is following: natural high forest (10.7%), natural coppice forests (44 %), artificially established stands (45.2%) and shrubs and bushes (0.1%) (Ratknić et al., 2009). Deciduous species (96.2%) are more common then coniferous (3.8%) (Gudurić, 2008, Gudurić *et al.*, 2011).

Urban forests of Belgrade are classified as forests in the central part, the middle and the exterior part of the urban city area, forests in the suburban part and forests out of the administrative border of the city (Zelena regulativa, 2004).

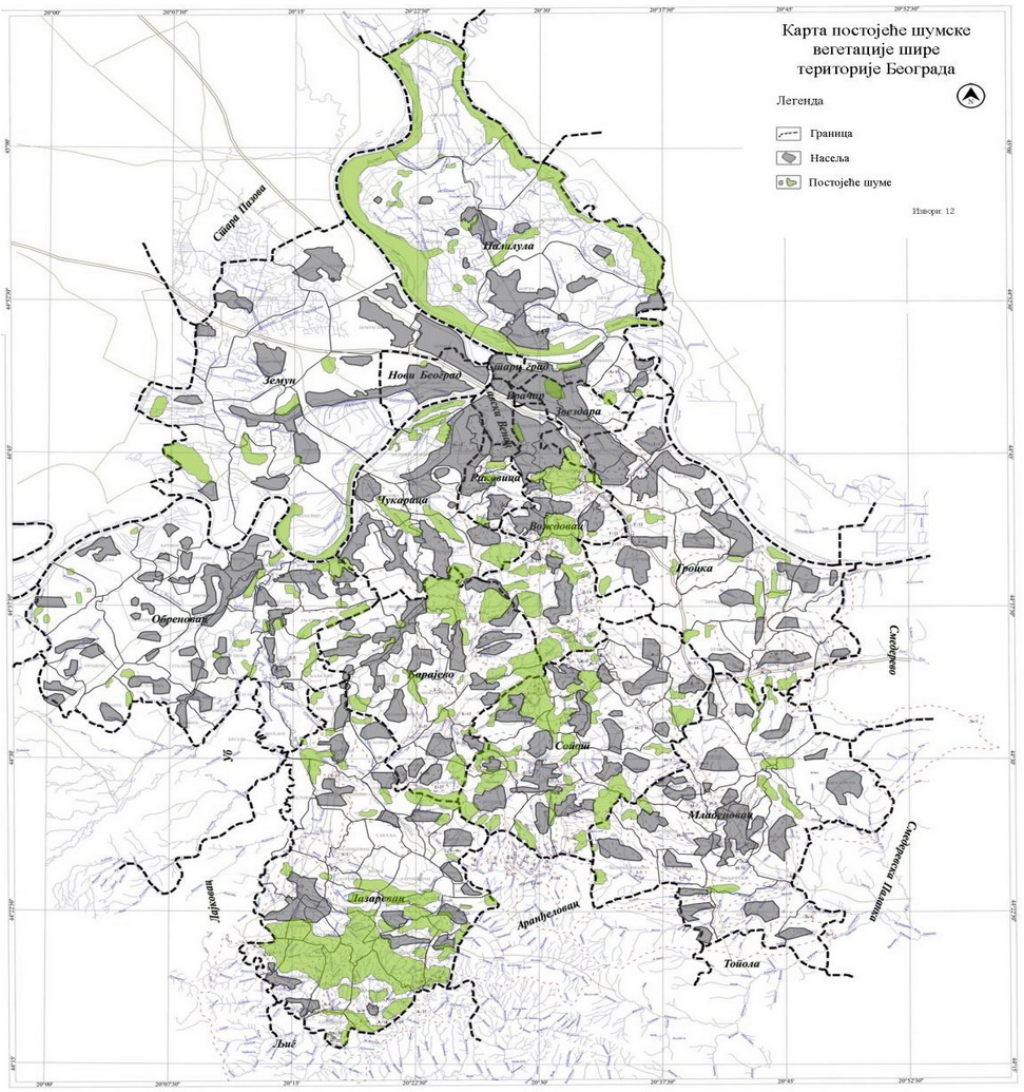

Figure 13 Map of existing forest areas in the administrative area of the city of Belgrade (source: Ratknić *et al.*, 2009; p. 161)

The stated aims of management plan prioritize the ecological protection, recreation, nature conservation and aesthetics. The production function is stated as a secondary aim. However, the study done in 2011 (Gudurić *et al.*, 2011) showed that planned goals and objectives are different from the situation in practice. Timber production is still a main function in 42% of all forests. Reasons for this

practical focus of management include insufficient finances for appropriate forest management to fulfill other prioritized functions (Gudurić *et al.*, 2011).

General assessment of existing forest cover in Belgrade, according to their origin and conservation status, indicates a lower proportion of natural high forest stands compared to natural coppice and artificially established stands. Such a situation is unfavorable, and the main goal of today's management is conversion of coppice forests into higher stands, as well as timely and adequate maintenance of artificially established stands. It is also necessary to reduce the large share of some species like: linden, american ash, black ash, which are of poor quality, low aesthetics quality, and are spreading on the areas of oak, wild and white ash, fruit trees, maple, white poplar and willow and other species, which are higher quality species (Zelena regulativa, 2004; Gudurić, 2008).

4.1.2 Ownership structure and management of urban forests

The two companies, PE 'Serbia Forests' and PUC 'Greenery Belgrade', have the authority to manage the main UPF in the city of Belgrade. The system of institutions and laws that have an impact on policy, planning and management of urban forests is rather complex.

State institution PE 'Serbia Forests' manages forests through its Forest Estate 'Belgrade', and is responsible for most of the forests on the territory of Belgrade (89.8% of forest area). The founder of a PE is the state, through the Ministry of Agriculture, Forestry and Water Management. Forest Estate 'Belgrade' undertakes its activities through four forest management units, two working units and nursery (Gudurić, 2008). Every ten years PE 'Serbia Forests' pass the general forest management plan, for the forests in their jurisdiction. Based on the general forest management plan, every year annual plans and lower-level programs are being made (e.g. plans of special purposes, hunting plans, programs of protected areas). The approval of the management plan is given by the Government of the Republic of Serbia, and with the support of various national organizations (e.g. Institute of Nature Protection of Serbia). In terms of financing, PE 'Serbia Forests' is financed by its own activities, like selling wood (40%), and involvement of other resources (60%) (e.g. regulation of forest areas for recreational and tourist use, construction and reconstruction of green areas, nursery production, hunting and wildlife management, protection of natural resources). In addition, part of the income comes from the budget of RS and the Ministry of Agriculture, Forestry and Water Management. These funds are intended primarily for work in the forests, related to the expanded reproduction, planting, and conversion of forest stands to high forests. Furthermore, part of the income is received from the city budget (e.g. the Secretary of Housing and Utilities, the Institute of Nature Conservation and the Secretariat for Environmental Protection) (Gudurić, 2008).

According to the management plans of Forest Estate 'Belgrade', the management of forests is adapted to environmental conditions and needs of Belgrade. The general purpose of the forests are: production function (51.64%), protection of water reserves of I category (2.25%), protection of soil (8.21%), recreational and tourist use (4.7%), forests of strict nature protection (0.02%), forests for seed production (0.16%), managed hunting areas (7.25%), forests in urbanized areas (20.70%) and forests for protection of tailings (5.07%) (Official Gazette of RS, no 10/04).

PUC 'Greenery Belgrade' is responsible for the management of 9% of the urban forest and green areas in Belgrade. These are very important forest areas, as they are mostly situated in the city center and are of importance for regulation of the urban microclimate. Furthermore, they have important social and aesthetic functions for areas such as Big and Small War Island, Banjička forest, Šumice, Topcider Hill. In addition, the PUC 'Greenery Belgrade' is engaged in planning, organization and maintenance of other green areas of the city, which are also part of the concept of urban forests (Gudurić, 2008).

In the PUC 'Greenery Belgrade' two units are responsible for the management of urban forests: the Working Unit for 'Maintenance of the Forests', and the Working Unit for 'Maintenance of Protected Areas, Coasts and Coastal Areas'. The Working Unit for 'Maintenance of the Forests' is managed by the head of the unit and has two sections. The

responsibilities are divided over certain municipalities of Belgrade. The main activity of PUC 'Greenery Belgrade' is the maintenance of all urban green areas in the city, which strives to meet the ecological, aesthetic and social functions (Gudurić, 2008).

The Working Unit for 'Maintenance of Protected Areas, Coasts and Coastal Areas' of PUC 'Greenery Belgrade' is managing forest areas in the same manner as the PE 'Serbia Forests', by the development of ten-year forest management plan that is approved by the Government of the Republic of Serbia. The Agency for Nature Conservation and the Agency of Environmental Protection are asked to agree upon the management plan. After receiving approval, requests for funding are sent to the Secretariat for the Environment and the Secretariat for Housing and Communal Affairs of the city. Finances are obtained on the basis of Annual Plans for the areas that are managed by this unit (Gudurić, 2008).

The Working Unit for 'Maintenance of the Forests' is managing the forests based on annual plans and programs. The Faculty of Forestry is in charge of developing the management plans for these areas. Professional control of the annual plan and the program has a Republic Forestry Inspector and Communal Utility Operations Control. Main income for this unit comes from the Secretariat for Housing and Communal Affairs (Gudurić, 2008).

The rest of forests are managed and maintained by other organizations, while the development of management plans for those areas is done by external forestry experts.

4.1.3 Urban forest governance

Urban forest policy in Serbia is mainly influenced by national laws, regulations and plans from different sectors. The most important laws and policies that affect urban forestry in Belgrade include:

- Law on Forests - which is the national level law and sets the rules for operation in the field of forestry (Zelena regulativa, 2004).
- Law on Communal Activities; and Regulation on Organization and Maintenance of Parks, Green and Recreational Areas. Institutional competence ower it has the Secretariat for Utilities and Housing Services (Zelena regulativa, 2004).
- Law on Environmental Protection - regulates the integrated environmental protection system, which makes the conditions and measures for sustainable management of natural resources and the prevention, control, reduction and repair of all forms of environmental pollution (Secretariat for the Environment, 2005). For the urban forest is essential Inspection Service that implements the control of legal compliance (Zelena regulativa, 2004).
- The Law on Cultural Heritage; and Regulation on Establishing an Immovable Cultural Property - refers to the protected area of immovable cultural property enjoying the protection of cultural property (and within the urban forests). For the urban forest is essential Inspection Service that implements the control of legal compliance (Zelena regulativa, 2004).
- Law on Strategic Environmental Impact - regulates the conditions, manner and procedure for carrying out impact assessment of certain plans and programs on the environment: spatial and urban planning, agriculture, forestry and so on. Report on the Strategic Environmental Assessment approved by the authority responsible for environmental protection plan or program cannot be addressed in further adoption procedures without the consent (Sekretarijat za zaštitu životne sredine, 2005).
- Law on Planning and Construction - regulates the planning and building, also on green and forest areas in the city (Zelena regulativa, 2004)
- The Law on Spatial Plan of the Republic of Serbia (Official Gazette of RS, no 88/10)

The planning documents which have an impact on urban forestry in Belgrade, whether it comes to planning or building new green and forest areas in the city, are:

- Regional Spatial Plan for the Administrative Territory of the City of Belgrade (Official Gazette of RS, no 10/04)
- Master Plan of Belgrade 2021 (Official Gazette of RS, no 27/03)
- Plans of Detailed Regulations for the City of Belgrade.

Jurisdiction over these plans has the City of Belgrade and Institute of Urbanism of Belgrade. The inspection

is done by Urbanistic Inspection (Zelena regulativa, 2004).

In addition to the national and local legislation, there are numerous international agreements signed by the Serbian government that must be respected. This applies particularly to the international criteria for the Protection of Biodiversity, the Convention on Biological Diversity, the Convention on the Conservation of European Wildlife and its Habitat, the European Landscape Convention, a resolution on halting further degradation of nature and natural resources. These documents, among other things, emphasized the necessity of providing multiple roles of forests and forest lands.

Main actors in urban forestry are the management companies that are responsible for policy, planning and management of urban forests of Belgrade (PE 'Serbia Forests' and PUC 'Greenery Belgrade'). These two companies create their own management policies, independently of one another. Through legislation and policy of the Republic, the Republic of Serbia is considered as the most important actor of the urban forestry policy, especially considering that State is the main owner of forests in the Belgrade area. Ministry of Agriculture, Forestry and Water Management has an impact on management, often through the Inspection Service for forestry management activities. Institute of Nature Conservation is also very important organization on national level.

Regarding the financial issues, on the city level the most important actors are the Secretariat for Environmental Protection and the Secretariat for Housing and Communal Affairs, usually through financing the management of green areas and by controlling the performance of responsibilities.

Research organizations that have an impact on policy-making are: Institute of Forestry and Faculty of Forestry in Belgrade. These organizations collaborate with companies that manage urban forests in Belgrade, through research and help in expertise.

In Belgrade there are numerous NGOs and civil associations dealing with environmental issues. The communication of these NGOs with the companies involved in the management of green areas and forests is not very good. Public involvement in the process of management and policy-making of urban forests is increasing in the last years. The media is beginning to be more engaged in issues related to ecology, horticulture and forestry.

Although the great number of actors exist in field of urban forestry, their role in creating a unique and multifunctional urban forestry policy is still not coordinated and effective.

4.2 Climate change policy in Serbia

In Serbia climate change is recognised as multisectoral problem. The assessment of climate change for the territory of Serbia by a regional climate model[6] showed that the annual temperature in Serbia is expected to change from 0.8-1.1 °C (according to A1B scenario) to 3.4-3.8 °C (A2 scenario) (INC, 2010). The precipitation is projected to decrease for 1% each decade, which will be followed by a decrease in the number of the days with snow cover (HIDMET, 2011).

In 10 June, 2001 Serbia became a Party to the UNFCCC convention from. It is a non-Annex I (developing country) and non-Annex B (do not have legally binding mitigation commitments) to the Kyoto Protocol from 17 January 2008 (Ekoplan, 2011).

The Ministry of Environment, Mining and Spatial Planning is a national coordination body for the realisation of the UNFCCC convention and protocol. In collaboration with other ministries (e.g. Ministry of Infrastructure and Energy, Ministry of Foreign Affairs, Ministry of Economy and Regional Development, Ministry of Finance, Ministry of Agriculture, Forestry and Water Management) and other governmental bodies (e.g. Republic Hydrometereological Service, EU Integration Office), Serbia formed a working group that initiated some activities with the aim of fulfilling obligations that were ratified by UNFCCC (INC, 2010). These efforts have not resulted in substantial improvements. The Initial National Communication (INC) to UNFCCC represents one output from this working group (INC, 2010). This is a first state-of-the-art report in field of climate change at the national level. It was developed

[6] Coupled regional model – Eta limited area model and POM limited area model for the ocean (INC, 2010).

in accordance to the UNFCCC Resource Guide[7], the procedures of Global Environment Fund (GEF) and other national legislation and strategies. The overall process was supported by the UNDP country office for Serbia. The report was written with the participation of relevant ministries, organizations that monitor climate parameters, scientific institutions, private and economic subjects, as well as with NGOs and other interested parties (INC, 2010).
The process of development of the INC to UNFCCC indicated several obstacles for the effective identification and implementation of actions to adapt to climate change. The main problems identified were:

- lack of systematic data collection and databases,
- weak structure of the sector and
- lack of financial and technological capacity.

This situation indicates the needs for the development of a National Action Plan for Adaptation (INC, 2010).

With those actions climate change issues have been popularized on all levels, from policy-makers, representatives of state organizations, industry stakeholders, media, NGOs and the public. However, results from these initial actions are still very modest (Ekoplan, 2011).

A systematic approach, detailed studies and research is needed in the future to help to improve adaptation and mitigation strategies. Different training schemes, workshops, educational material and dissemination system need to be developed, as well as, reforms of the educational system to integrate climate change issues in the curricula (Ekoplan, 2011).

The main goal of the state is primarily to build and strengthen the existing capacities of national experts and decision makers who formulate policy on climate change in their institutions, organizations and agencies, and representatives of the academic sector, industry, private sector, non-governmental organizations and the media. Key issues in implementation of these activities may be limited financial and human resources (Ekoplan, 2011).

The Serbian National Climate Change Policy Framework includes a large number of strategies, laws and other legislation. Those are: The Law on the Ratification of the UNFCCC, The Law on the Ratification of the Kyoto Protocol, The Law on the Ratification of the Convention of the World Meteorological Organization, The Law on the Ratification of the UN Convention on Biological Diversity, The Law on Environmental Protection, The Law Hydrometeorological Activities. Some of the strategies and programs on national level that already to certain extent deal with the climate change issues are: National Strategy for incorporation of the Republic of Serbia into Clean Development Mechanism under the Kyoto Protocol for waste management, agriculture and forestry sectors; National Environmental Protection Programme; National Sustainable Development Strategy (NSDS) and Action Plan for the implementation of the NSDS for the period 2009-2017; Serbian Energy Development Strategy by 2015; Forestry Development Strategy; Strategy for Scientific and Technological Development; National Strategy for Biodiversity (UNDP, 2011).

In addition to national bodies, several bodies have been formed at the regional level that can be considered of great importance for tackling climate change. These are: Belgrade Climate Change Initiative[8] (which supports the implementation of the South-East European Climate Change Framework Action Plan for Adaptation[9] and has established the Sub-regional South-East European Virtual Climate Change Centre hosted by National Hydrometeorological Service of Serbia); Energy Community of the SEE Region (which aims to improve the environmental situation via support for energy efficiency and renewable energy); Regional Cooperation Council (which supports regional cooperation in six key areas, including energy, and is based in Sarajevo) (UNDP, 2011).

[7] UNFCCC Resource Guide, Module 1: The Process of National Communications From Non-Annex I Parties For Preparing The National Communications Of Non-Annex I Parties (available at: www.unfccc.int/resource/docs/publications/09_resource_guide1.pdf)

[8] The initiative was fully supported by the Serbian Government as well as national hydrometeorological services across SEE. Initiative is devoted to enhancing regional cooperation in Southeast Europe in the field of climate change).

[9] The South-East European Climate Change Framework Action Plan for Adaptation wad published in November, 2008. The process was financially supported by the Royal Ministry of Foreign Affairs of Norway, and has been adopted by the Ministers responsible for environment of the Republic of Albania, Bosnia and Herzegovina, FYR of Macedonia, Montenegro and Serbia.

5 Results and Analysis

5.1 Climate interpolation for Serbia and Belgrade

5.1.1 Serbia

According to the measurement made during 1961-2010, the main climate parameters for the territory of the Serbia are summarized in the Table 7.

Table 7 Main climate parameters - Serbia (1961-2010)

Tavg (°C/year)	Tmin avg (°C/year)	Tmax avg (°C/year)	Prcp avg (mm/year)
10.2	5.1	15.4	745

Temperature

The mean annual air temperature over the whole territory of Serbia is 10.2 °C (Table 7, Figure 14, 15). The year 1965 had the lowest average minimal air temperature (4.0 °C), while in the year 2000 the highest average maximal air temperature (17.6°C) is observed.

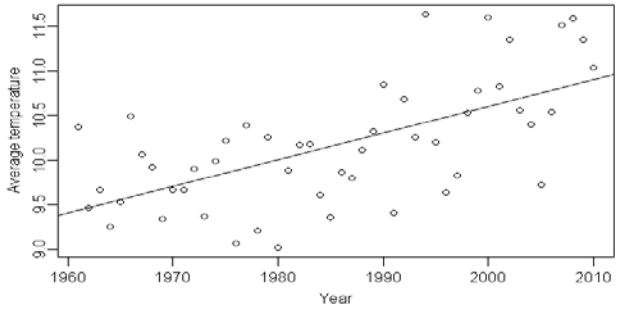

Figure 14 Average temperatures – Serbia (1961-2010)

The higher average air temperature (10.5 to 12.5 °C) are mostly present in the northern (lowland area) and east part of the country, as well in the valleys of the rivers *'Zapadna Morava'* '*Velika Morava', and 'Južna Morava'* (central Serbia). The lowest temperatures are present in the south, south-west and south-east parts of the country (on the altitudes over the 1000 m.s.a.l.), mainly in mountainous areas (e.g. '*Kopaonik', 'Stara Planina', 'Bjelasica'*) (Figure 15).

Historic climate records (1961-2010) reveal trends of the temperature variables on the territory of the Republic of Serbia (Table 8).

Table 8 Annual trend of temperature – Serbia (1961-2010)

Annual trend	min.	max.	mean	StdDev.
Temperature (°C/y)	-0.005	0.062	0.030	0.007

The results showed that increase in mean annual temperatures were present in almost all parts of Serbia (Figure 16), except in the small areas on the north-east and south, where the positive trend is not present (-0. 0048 °C/y). The higher temperature increase, up to 0.04 °C/y, has taken place in north, east and central part of the country with low or moderate elevation. The highest values of temperature increase were pronounced in the areas with higher elevation in the south and south-west part of the country (e.g. *'Kopaonik', 'Sjenica'*), where the observed trend was up to 0.06 °C/y.

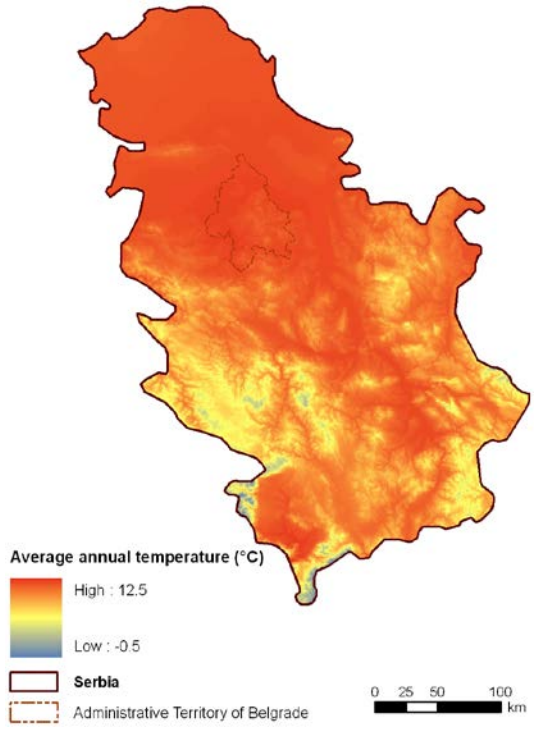

Figure 15 Average annual temperature (°C) for the territory of Serbia (1961-2010)

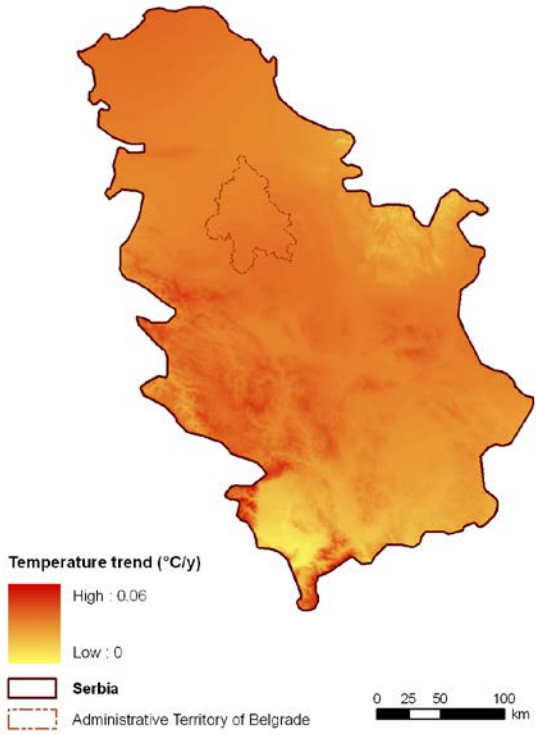

Figure 16 Temperature trend (°C/y) for the territory of Serbia (1961-2010)

Precipitation

The average amount of annual precipitation over the analyzed period is 745 mm (Table 7, Figure 17, 18). The year 2000 had the lowest annual average precipitation (435 mm), while in the year 2010 the highest annual average precipitation (930 mm) is observed.

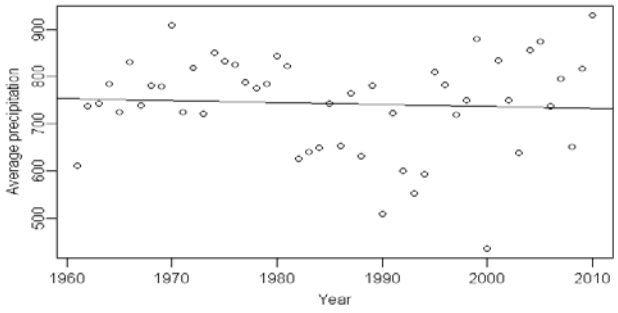

Figure 17 Average precipitation – Serbia (1961-2010)

The lowest amounts of precipitation are characteristic for northern ('Vojvodina') and southern ('Kosovo') parts of Serbia. The mountainous areas in the south, south-west and south-east part of the country are characterized with the higher precipitation values (up to 1370 mm) (Figure 18).

As for the temperature, results obtained by DAYMET model, showed that variations and trends of the precipitation are evident on the territory of the Republic of Serbia (Table 9).

Table 9 Annual trend of precipitation – Serbia (1961-2010)

Annual trend	Min.	Max.	mean	StdDev.
Precipitation (mm/y)	-19.820	2.998	-0.397	2.368

In the period 1961-2010, most of the territory of Serbia, except the south and south-east part, was characterized by a positive precipitation trend (Figure 19).

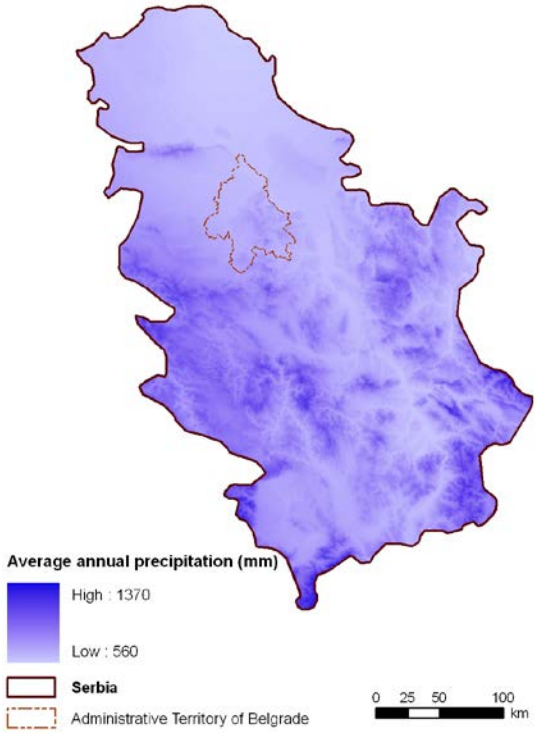

Figure 18 Annual precipitation for the territory of Serbia (1961-2010)

The higher values of increase in annual precipitation were in the west and north-east part of the country (up to 3 mm/y), while the decreasing trend were in the south-east and south-west part (with slightly lower trend values). The strongest negative trend has

taken place in high elevations of 'Stara Planina' mountains, in the south-east part of the country.

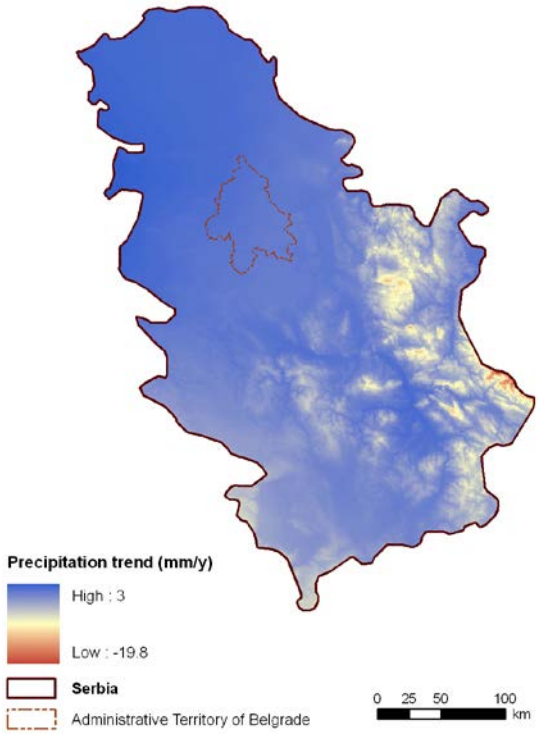

Figure 19 Precipitation trend (mm/y) for the territory of Serbia (1961-2010)

5.1.2 Belgrade

According to the measurement over the period 1961-2010, the main climate parameters for the Administrative Territory of the city of Belgrade are summarized in the Table 10.

Table 10 Main climate parameters – Belgrade (1961-2010)

Tavg (°C)	Tmin avg (°C)	Tmax avg (°C)	Prcp avg (mm)
11.7	6.7	16.8	669

Temperature

The mean annual air temperature on the administrative territory of the city of Belgrade is 11.7 °C (Table 10, Figure 20, 21). The year 1963 had the lowest average minimal air temperature (5.5 °C), while in the year 2000 had the highest average maximal air temperature (19.3°C).

The higher average air temperature are mostly present in the northern (lowland area of Belgrade) and west part of the city (up to 12.5 °C), while the lower are in the central, east, south and south-east part (mostly in hilly terrain). The lowest temperatures are present in the mountains area (*'Avala'* and *'Kosmaj'*) (Figure 20).

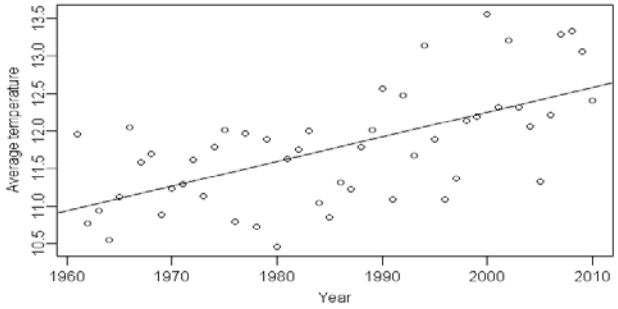

Figure 20 Average annual temperatures – Belgrade (1961-2010)

Like in the whole country, variations and trends of the temperatures variables are evident for the Administrative Territory of the city of Belgrade, over the analyzed period (1961-2010) (Table 11).

Table 11 Annual trend of temperature – Belgrade (1961-2010)

Annual trend	min.	max.	mean	StdDev.
Temperature (°C/y)	0.028	0.036	0.033	0.002

The results of the DAYMET model showed that there was an increase in mean annual temperatures in all parts of Belgrade (Figure 22). The rises in temperatures are slightly higher in the southern part of the city. Temperature trend were most pronounced in the municipalities '*Mladenovac*' and *'Lazarevac'* (south), where the observed trend was up to 0.04 °C/y. Those areas represent the hilly parts of the city with a high amount of forests.

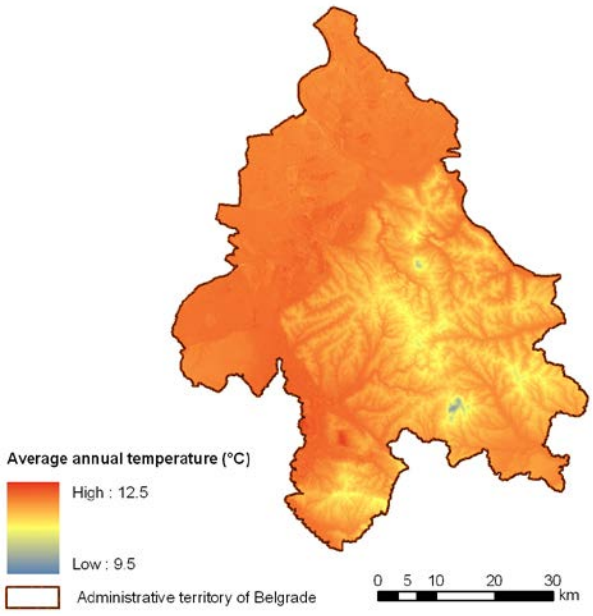

Figure 21 Average annual temperature for the AT of Belgrade (1961-2010)

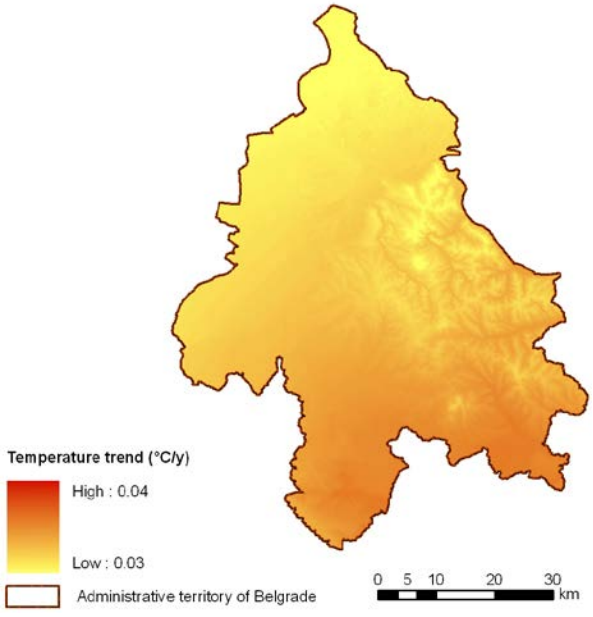

Figure 22 Temperature trend (°C/y) for the AT of Belgrade (1961-2010)

The urban area of Belgrade has been characterized with temperature trend of 0.033 °C/y, which is around 3 degree Celsius per century. If the trend is calculated just for the two stations (Belgrade and Surčin) that are located on the Administrative Territory of the city of Belgrade slightly higher value can be observed, where the trend is 0.034 °C/y (Table 12).

Table 12 Temperature trend (°C/y) for the single stations on the AT of Belgrade

Name of Station	T trend (°C/y)	Years of measurement	First year of measurement	Last year of measurement	Altitude (m)
Beograd	0.034	50	1961	2010	132
Surčin	0.034	45	1966	2010	96

The reason for this difference is the low density of the stations over the territory of Belgrade city, and the effect of the measurements form surrounding stations. Therefore, the data produced by DAYMET have been slightly smoothed.

For the comparison of the results, the temperature trend is calculated for these two stations over the period when most of the stations around Belgrade have been in operation (1966-2005), and is compared with the calculated trends for the single stations in surrounding. All stations are mostly similar in terms of the altitude and the natural characteristics where they are situated. From all those stations, the Belgrade and *Surčin* have the highest value of temperature trend (0.029 and 0.027 °C/y), except the *Smederevska Palanka* that has 0.032 °C/y trend, which is situated more on the south (Table 13).

Table 13 Temperature trend (°C/y) for the single stations in surrounding of the AT of Belgrade (1966-2005)

Name of Station	Temperature trend (°C/y)	Years of measurement	First year of measurement	Last year of measurement	Altitude (m)
Beograd	0,029	40	1966	2005	132
Surčin	0,027	40	1966	2005	96
Smed. Palanka	0,032	40	1966	2005	122
Sremska Mitrovica	0,013	40	1966	2005	82
Veliko Gradište	0,016	40	1966	2005	80
Vršac	0,023	40	1966	2005	84
Bela Crkva	0,023	35	1966	2005	90
Sremski Karlovci	0,023	37	1966	2005	130

If the average annual temperatures are compared for the periods 1961-1980 and 1991-2010, the difference is ranging from 0.85-1.1 °C (Figure 23). The higher difference can be noticed in the southern part of the city; while in the urban part of Belgrade, (north-east) the difference is lower. It can be observed that in the urban structure of Belgrade higher temperature trends coincides with the main transportation corridors, which are mostly situated in the valleys. However, DAYMET incorporates elevation data, which influences the interpolation of the temperature data and thus can cause small scale artefacts. However, it should be noted that changes in the climate are caused not just because the change of weather parameters, but also due to the increase of population, urbanisation, and technological development.

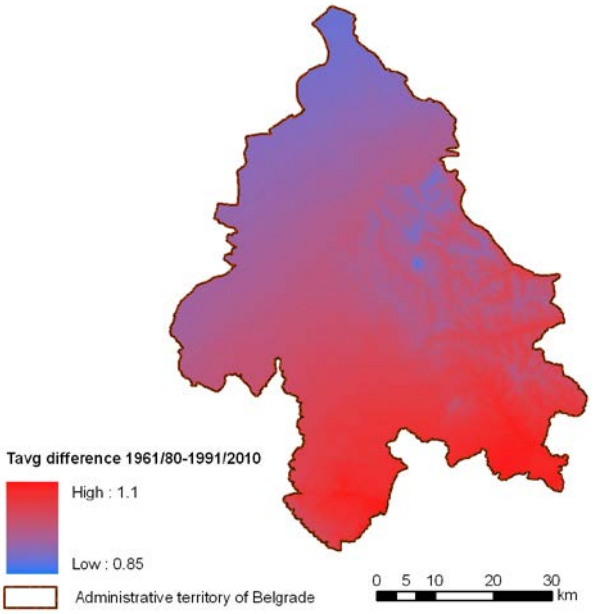

Figure 23 The difference between average annual temperatures (°C) for the periods 1961-1980 and 1991-2010 for the AT of Belgrade

Precipitation

The average amount of annual precipitation over the analyzed period is 669 mm (Table 10, Figure 24, 25), with lower amounts for the north and west part of the city. The hilly areas of Belgrade (e.g. *'Avala'*, *'Kosmaj'*) and the central part of the city are characterized with a higher precipitation (up to 930 mm/year) (Figure 25).

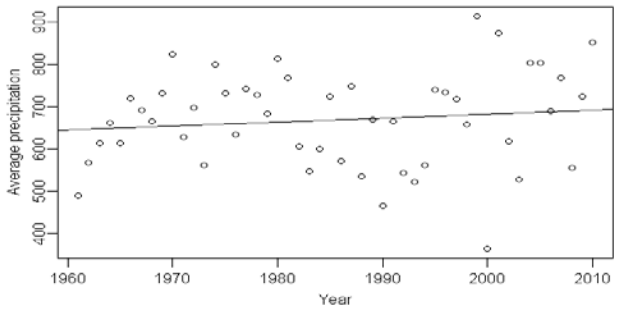

Figure 24 Average precipitation – Belgrade(1961-2010)

The variations and trends of the precipitation values are evident for the Administrative Territory of the city of Belgrade, over the analyzed period (1961-2010) (Table 14).

Table 14 Annual trend of temperature and precipitation – Belgrade (1961-2010)

Annual trend	min.	max.	mean	StdDev.
Precipitation (mm/y)	0.143	1.666	0.944	0.336

During the period 1961-2010, is evident precipitation increase over the whole area of Belgrade (Figure 26).

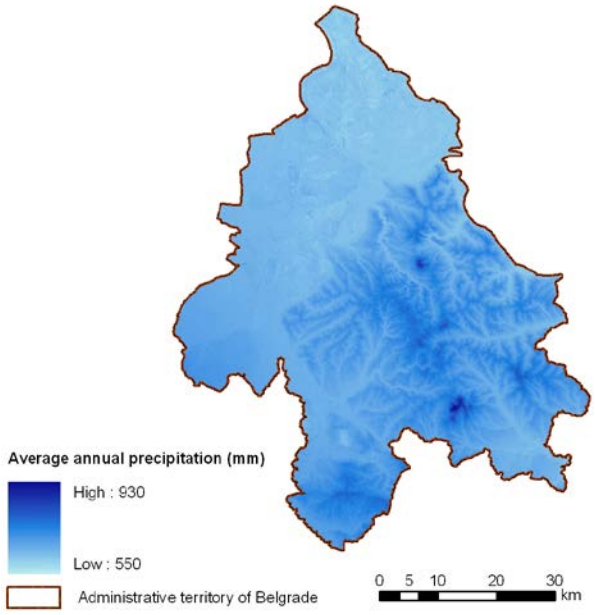

Figure 25 Average annual precipitation (mm) for the AT of Belgrade (1961-2010)

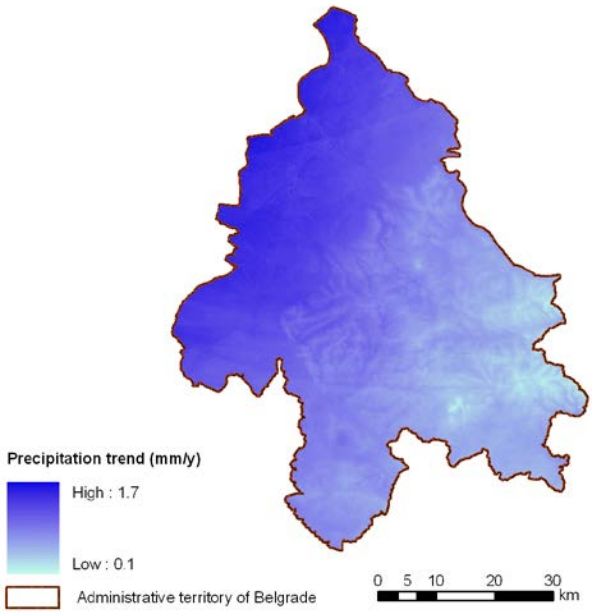

Figure 26 Precipitation trend (mm/y) for the AT of Belgrade over the period 1961-2010

The highest positive trend in annual precipitation was in the very north and west part of the city (up to 1.7 mm/y), while with slightly lower amount of positive trend are characterized central parts and hilly areas of the city. The lowest positive trend is present at the highest elevation of the south part of Belgrade (*'Kosmaj'*).

5.2 Climate change and UPF management and policy documents

The UPF management is influenced by various national and local policy documents. For better understanding of climate change implication on UPF management, the content of the main management and policy documents were analysed. Analysed documents are mainly from the forestry sector, but also land-use planning, tourism and sustainable development. The aim was to describe how climate change and climate change adaptation issues are incorporated in the selected documents.

5.2.1 Law on Forestry of the Republic of Serbia

The Law on Forest (2010) has 121 paragraphs and considers climate change issues mostly from a mitigation perspective. One of the aims of the law is that "…potential of the forests must be enhanced for mitigation of climate change…". Mitigation of GHGs and carbon sequestration are stated as one of the most important purposes and functions of forests (Official Gazette of RS, no 30/10, p.1, 2).

The rest of the document deals with sustainable forest management (Official Gazette of RS, no 30/10). Many of those general statements are of great importance for tackling climate change. However, climate change adaptations have not been directly mentioned in the law.

In addition, it can be noted that the awareness related to the importance of forests for climate change issues is high. A provision of the Law on Forests in 1929 had some aspects that targeted this issue, such as prohibition of conversion of forest to other type of land that was justified by importance of forests management for "…a public interest, such as the general economy, public security, defence of the country, or the protection of climate and hygiene interests and economic needs of a region" (FDS, 2006).

5.2.2 Forest Development Strategy of the Republic of Serbia

The Forestry Development Strategy of the Republic of Serbia poorly addresses climate change adaptation issues.

This is different for climate change mitigation issues. In a section concerned with the main principles of forest development, where multifunctionality of forests is set as one of the goals, it is mentioned that: "Forests have an irreplaceable role in the mitigation of climate changes caused by anthropogenic impacts and, in this sense, carbon sequestration. Efforts should be made to increase permanently the forest capacity in this respect." (FDS, 2006, p. 10). In the strategy an emphasis is also put on the importance of carbon sequestration in forests, where it is stated that "The Government will, bearing in mind the forest hazard caused by anthropogenically induced climate changes and their regulatory functions in the global carbon cycling, support the research and analysis of the potential scope and method of carbon sinks in forests, promote the efficient generation and consumption of bio-energy from the sustainably managed forests, pursuant to the UN Framework Convention on Climate Change and Kyoto Protocol, and thus create the conditions for applying for the international funds for the increase of forest area" (FDS, 2006, p. 18).

5.2.3 Afforestation Strategy of Belgrade

The Afforestation Strategy of Belgrade is an important document as it aims to contribute in tackling climate change. Afforestation is generally considered as one of the most important mitigation measures. In 2011, Strategy is developed with the aim to improve the environment, protect biodiversity and enhance the use of forest resources.

Climate change, as one of the main constraints of today's development, is described in detail in separate part of the Strategy (part 7). The main parameters (e.g. temperature increase, precipitation decrease, number of days with frost) of the change in climate are given for Serbia, and Belgrade (SPB, 2011).

The Strategy has high importance for the long term development of UPF sector. It presents a comprehensive overview of forest resources of Belgrade area: data on forest area, forest types, ownership issues, forest condition, tree species and associations. It contains detail measurements and advices for afforestation process. Suggestions are given for: selection of tree species (e.g. using autochthonous vegetation, exclusion of alochtonous and invasive species), techniques and technology of afforestation, potential areas of afforestation, economical aspects. However, none of those suggestions have been directly given with the climate change (SPB, 2011).

The Strategy can be used in the future, for the development of more precise climate change measures.

5.2.4 Management Plans of UPFs

For the purpose of this research, four management plans of UPF areas in Belgrade were analyzed (Table 15). Management plans were chosen based on the position of forest area for which MPs were developed, where different forest types of UPF areas (urban and peri-urban forests) were taken into analysis. The second criterion was the responsible agencies that manage the areas. Therefore, two FMPs that were developed for areas managed by PE "Serbia Forests" and two FMPs that were developed for areas managed by PUC "Greenery Belgrade" were chosen. The variety in the responsible bodies that develop the MPs was also covered.

In all FMPs that were analyzed issue of climate change, in both mitigation and adaptation aspects were not directly covered. Climate as an issue is mentioned in the part where general description of climate condition for the territory of Belgrade was described. This part contains abundant information of all climate parameters, but no treats or future expectation of climate change is mentioned (FMP 'Kosmaj', 2006; FMP 'Košutnjak', 2007; FMP 'Bežanijska kosa', 2008; FMP 'Milićevo brdo', 2009; FMP).

From the common factors that are important for good conditions of the forest vegetation, climatic factors are also listed (besides orographic, edaphic and biotic). However, these are the very general statements, which are not supported with any more detailed description.

Similarly to this, in all FMPs as main forest functions, provision of multiple benefits is highlighted, e.g. forests positive impacts on the environment, especially the protection of water resources, climate, hygiene and health, recreation, business and other functions. However, nowhere else in the documents

these issues were explicitly covered. The indirect contribution of UPF to climate change can only be found through the sustainable forest practices, which are advised in the FMPs (favoring of autochthonous and deciduous vegetation, changes in the ratio of tree species in the forest mixture, increasing the number of species in the areas, protection measures against diseases and pests, protection measures against fire, establishing and maintaining a healthy and stable physiological condition UPF, with due regard to the need of recreational and aesthetic and functional values of those areas) (FMP 'Kosmaj', 2006; FMP 'Košutnjak', 2007; FMP 'Bežanijska kosa', 2008; FMP 'Milićevo brdo', 2009; FMP).

Table 15 Forest management plans analyzed by content analysis

FMP (management unit and duration)	Type of UPF area	Location in the city (municipality and position)	Area (ha)	Responsible Management Body	Responsible body for the development of the MPs
"Kosmaj" (2006-2015)	Peri-urban forest Landscape of Outstanding Qualities (V category of IUCN)	Sopot and Mladenovac (south part of the city)	652,99	PE "Serbia Forest" - Forest Estate "Belgrade"	Department for Project and Planning in Forestry
"Košutnjak" (2007-2016)	Urban forest	Rakovica i Čukarica (south-west part of urban area of the city)	444,62	PE "Serbia Forest" - Forest Estate "Belgrade"	Department for Project and Planning in Forestry
"Bežanijska kosa" (2008-2017)	Urban forest	Novi Beograd and Zemun (north-west part urban area of the city)	30,37	PUC 'Greenery Belgrade'	Faculty of Forestry
"Milićevo brdo" (2009-2018)	Peri-urban forest	Palilula and Zvezdara (north-east part of the city)	46,80	PUC 'Greenery Belgrade'	Faculty of Forestry

In case of FMPs that were developed by the Faculty of Forestry, the analyzed forest areas are characterized as urban (*'Bežanijska kosa'*) and peri-urban (*'Milićevo brdo'*)[10], and therefore their function is mainly protective. Based on the current state of research, experience and role of forests near cities and industrial points, it is recognized that forests represent a "*protection against the adverse impacts of climate"*, and have a function to *"improve the microclimate and mitigate major weather fluctuations"* (FMP 'Bežanijska kosa', 2008; FMP 'Milićevo brdo', 2009; FMP).

Negative effects of climate change were not explicitly described in FMPs, even though in some forests (e.g. "Bežanijska kosa" and "Milićevo brdo") an increased number of dry trees have been observed. Other challenges, which urban forests are facing, are recognized and emphasized in the FMP of "Bežanijska kosa" management unit. It is said that: *"The negative impact of citizens is reflected in the usurpation of land, uncontrolled felling, especially in the disposal and storage of wood waste and scrap. This is one of the fundamental problems in the management of these forests"* (FMP 'Kosmaj', 2006;

[10] This categorization is developed in accordance to Regional Spatial Plan for the Administrative Territory of the City of Belgrade, and can be noted just in the management plans developed by Public Utility Company "Greenery Belgrade", which manage forests areas that are more close to the urban structures. According to the Law on Forests those categories are not recognized.

FMP 'Košutnjak', 2007; FMP 'Bežanijska kosa', 2008; FMP 'Milićevo brdo', 2009; FMP).

5.2.5 *Law on Spatial Plan of the Republic of Serbia*

The Spatial Plan of the Republic of Serbia is the main planning document at the national level. It has the status of a law. The plan that is currently in force has been developed for the period 2010-2012. It determines the long-term fundamentals of the organization, development, use and protection of areas of the Republic of Serbia with the aim of harmonizing economic and social development of the natural, ecological and cultural resources and constraints on its territory.

The Spatial Plan of the Republic of Serbia gives a very comprehensive overview of various aspects of spatial development in regards to climate change issues (e.g. water resources, forestry, industry, tourism). Moreover, it has a whole chapter that contains the explanation of climate change effects and main problems for the territory of RS.

At the beginning of the spatial plan a SWOT analysis is presented. Climate change has been included in all four aspects of the SWOT analysis. *"Unused potential to reduce emissions of greenhouse gases and established National Center for Climate Change"* are presented as one of the potential of spatial development of Serbia (Official Gazette of RS, no 88/10; p.16). As weaknesses are stated *"Lack of funds for the implementation of multidisciplinary studies of the impact of climate change on specific sectors of the economy, and the lack new standards on the application of climate data and information in the planning and design processes"* (Official Gazette of RS, no 88/10; p.16). As opportunities are highlighted the needs for *"Identifying climate change as a factor for sustainable development of certain sectors of the economy and overall economic development; the introduction of EU standards in the field of disaster risk management, renewable energy, energy efficiency, design and construction of infrastructure systems that are relevant to different aspects of climate change"* (Official Gazette of RS, no 88/10; p. 20). The main treats are *"the slow institutional capacity (adaptation potential), inadequate attitude towards the problem of climate change in education and public information"* (Official Gazette of RS, no 88/10; p. 20).

With regards to the forest resources, the Spatial Plan elaborate that status and characteristic of forests are jeopardized by various biotic and abiotic problems, *"that are caused by the climate change and its increasing levels of adverse impact"* (Official Gazette of RS, no 88/10; p. 79).

According to the Spatial Plan, more unfavorable effects of climate change on the production of food and energy, water, biodiversity and human health can be expected in next decades by: "*increased water stress due to reduced availability of drinking water, increasing the frequency and intensity flash floods and landslides, worsening water quality in all conditions, frequent periods of drought or floods, reduction in rainfall, runoff and river water level, reducing the number of days with snow and snow cover duration ... increased risk of extinction of many species due to synergistic effects of climate change and habitat fragmentation, and redistribution, migration or extinction of some forest species due to high temperatures and reduced groundwater, increasing the risk of forest fires...".* Therefore, the main problems in the field of climate change in the Republic of Serbia are identified:

- The application of climate data and information in the planning and design still apply standard methods and guidelines based on stationarity of climate;
- There is low awareness of the need to include climate change as a factor of sustainable development into sectoral strategies, particularly sectors vulnerable to climate change (agriculture, water management, forestry, energy, tourism, health, construction, transportation);
- Lack of adequate support for implementation of multidisciplinary research program on climate change, vulnerability and adaptation options;
- Lack of a special state program for solving problems of climate change;
- Limited funds for capacity building (institutional and individual), education, training and information (Official Gazette of RS, no 88/10; p. 116,117).

The main objectives identified for tackling these problems are: *"to include climate change as a factor for sustainable development and the environment into*

sectoral strategies, and to develop sustainable system of risk management of climate change in Serbia".
From eight identified operational aims, the following are relevant for adaptation issues:

- "*adoption of sectoral plans and programs of climate change adaptation measures, by harmonization of sector strategies with the EU strategies, White Paper on adapting to climate change and relevant EU directives"* (Official Gazette of RS, no 88/10; p. 117);
-" *reduce the risk of climate change by strengthening capacity to adapt to changed climate in the most vulnerable social groups and sectors of the economy"* (Official Gazette of RS, no 88/10; p. 118).

Based on the expected, mostly negative, influence of climate change and identified problems, the concept of spatial development in the context of climate change is developed. Between seven main fundamentals that are necessary for future development of Republic of Serbia, following are listed:

- *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 sustainable development and environmentally sound activities in areas vulnerable to climate change;*
- *adoption and implementation of new measures to conserve and protect water resources, agricultural and forest land, and use of renewable energy sources in the context of climate change and adapting to changing climatic conditions;*
- *updating of sectoral strategies, instruments, measures and policies, and improvement of inter-sectoral coordination and participation of relevant institutions and local communities, as well as raising awareness about the need for integration of climate change issues into sectoral strategies* (Official Gazette of RS, no 88/10; p. 118).

For the future development of the Republic of Serbia it is expected to continuously improve the knowledge, technology and strengthening capacity in the field of climate change. This is in line with the process of the European integration.

Basic measures and instruments needed for climate protection and risk management of climate change at the level of the Republic of Serbia are the following:

- *Legal instruments* (to revise the standard methods and guidelines for the use of climate data and information in the planning and design; to adopt a national climate action curriculum of multidisciplinary studies of the effects of climate change on individual services, public health, natural resources and environment; revise the sectoral strategies in regards to inclusion of climate change as an important factor for sustainable development of sectors vulnerable to climate change)
- *Economic and financial policies* (to conduct the analysis of economic effects of climate change and provide incentives and financial support for the adoption and implementation of economically viable measures for adaptation and mitigation of climate change)
- *Measures to strengthen the capacity* (to strengthen institutional capacity to fully implement the obligations; to defined institutional responsibilities in the field of climate change; to strengthen the capacity of all relevant actors in relation to the issue of climate change) (Official Gazette of RS, no 88/10; p. 119, 120).

It is important to highlight that the Spatial Plan gives the indication of the importance of tackling climate change issue at the level of cities and other urban settlements. One of the identified main aims for development of the cities is *"protection of environmental quality and combating climate change".* The operational aims are: *"integrating issues of climate change in decisions about the spatial development of cities, reduce pollution and environmental pressures, the use of natural resources to remain available for future generations*" (Official Gazette of RS, no 88/10; p. 181).

5.2.6 Regional Spatial Plan for the Administrative Territory of the City of Belgrade

The Regional Spatial Plan for the Administrative Territory of the City of Belgrade is one of the main instruments for the implementation of sustainable development of the Administrative Territory of the City of Belgrade. It is based on the principles of the Agenda 21, Habitat II, Aarhus, Lisbon, Sofia and other declarations and regulations that oblige the Republic of Serbia and Belgrade in the planning and achieving solutions.

Compared to the Spatial Plan of Republic of Serbia, integration of climate change issues in the Regional Plan for the Administrative Territory of the City of Belgrade is very general.

Sustainable development of all natural resources in the city is recognized as one of the main directions of future development of the city. In order to achieve this, some of the identified measures are: *"to protect nature and landscape in order to affect the protection and improvement of the environment, including microclimate. It is highly important to: preserve natural ecosystems, especially forest in the urban environment (e.g. 'Topčider', 'Košutnjak', 'Avala') and forests along river banks and on islands (e.g. 'The Great War Island', ' Ada Ciganlija', 'Ada Huja'), establish new forest areas and green areas in the city (e.g. parks, small squares, gardens and alleys). A good example for this is Banjička forest, as counterpart to the monocultures, especially conifers and poplar trees in foreland"* and *"reducing greenhouse gas emissions"* (Official Gazette of RS, no 10/04; p. 13).

Afforestation measures are seen as a great potential for sustainable development of the city (Official Gazette of RS, no 10/04, p. 16). This is a direct measure that can be connected to mitigation potential of forests to climate change.

As specific advices in terms of improvement of forest and green areas in the city the following is important: *"Choice of trees should correspond to the potential natural vegetation. Plants that are hosts to harmful insects should be avoided. Connectivity of biotopes should be improved. Care and management of a ecological network of biotopes must be long-term planed and possibly with the less permanent intervention."* (Official Gazette of RS, no 10/04, p. 46). For the urban area of the city the identified needs are: establishing of green corridors (connecting various types of green areas in the city), enlarging and improving the green area resources and much greater care and maintenance of existing green areas (Official Gazette of RS, no 10/04, p. 15). All of those aspects can be indirectly connected to the possible measures that would increase adaptation potential of green areas in the urban part of the city.

5.2.7 Master Plan of Belgrade 2021

The Institute of Urbanism Belgrade has issued the Belgrade's Master plan until the year 2021 that the Belgrade City Assembly approved in 2003. The Master plan defines long-term spatial development projections of city and determines construction sites, prevailing space/land use inside particular sites, tracings corridors and capacities for transportation, power supply, water management, communal and other infrastructure, as zones and entities where urbanistic plans will be elaborated for and zones and entities of the uniformed construction rules, defined by Master plan (Official Gazette of RS, no 27/03 (25/05; 34/07)).

The long-term development policies of Belgrade will focus on the establishment of *"the necessary environmental and economic balance in the Belgrade area, by using all natural resources in a sustainable way with the help of utility systems"* (Official Gazette of RS, no 27/03, p 1). In the Master Plan, climate change issues are one of the main challenges of sustainable development (e.g through various aspects of forestry and public greenery sector).

The relation can be found in the statement that *"...lack of awareness exists over the importance of the ecosystems, climate issues, beauty and overall wealth of natural resources in the city..."* (Official Gazette of RS, no 27/03, p 19).The other aspect that is emphasized is: "*Unlike many other urban sectors, which are regulated by various financial and construction measures, a system of public greenery, although it represents the climatic infrastructure, is not supported by any financial or legal mechanisms. In this regard, Belgrade will have to make a series of regulations to ensure the improvement of this system."* (Official Gazette of RS, no 27/03, p 79).

5.2.8 National Sustainable Development Strategy 2008-2017

The National Strategy for Sustainable Development (NSSD) defines sustainable development of the Republic of Serbia, as a target-oriented, long-term, continuous, comprehensive and synergetic process that affects all aspects of life (economic, social, environmental and institutional) at all levels.

In NSSD, climate change has been identified as one of the main risk factors for the environment. The main problems that are identified in this regards are: "*absence of a national inventory of GHGs emissions; the lack of strategic documents related to climate change; inconsistent legislation, relating to emissions, with the regulations of EU".* Therefore, the main aims of NSSD are:

- *harmonization of national regulations in the field of climate change and ozone depletion with EU regulations;*
- *adaptation of existing institutions in relation to the needs for active implementation of climate protection policy and fulfilment of obligations under international agreements (UNFCCC, Kyoto Protocol)*
- *adaptation of business entities in the energy, industry, transport, agriculture and forestry, utility and housing business policy of climate protection and compliance with international agreements;*
- *developing an action plan for adaptation to the climate change of all economic sectors*;
- *the design, development and implementation of an adequate health response system on the effects of global climate change* (Official Gazette of RS, no 55/05, p.91).

The rest of the document generally connects climate change to the long-term development perspectives of various sectors. The NSSD stresses the need for higher involvement of the media in relation to the environmental issues. It is noted that in recent years certain improvement exists, mostly due to *"…increased presence of issues related to climate change in the foreign media and on the other hand, an increase of media freedom system in the state"* (Official Gazette of RS, no 55/05, p. 72).

5.2.9 Development Strategy of the city of Belgrade

Development Strategy of the city of Belgrade (SRGB) has been developed in 2011. It is "jointly agreed document of the City and its citizens, in accordance with which to plan, develop and edit their own future; and based on which will establish a system of actor's accountability for implementation of priorities until year 2016" (SRGB, 2011).

In SRGB, the field of future projects, which include topics and exchange of good practice that are of importance for the spatial development of the city or region, have been presented. As one of the field of future capital projects have been identified *"Protection and development of environment and control the impact of climate change, with control of water quality and usage, storage and processing of solid waste, drainage and treatment of liquid waste, control of risks from natural disasters"* (SRGB, 2011; p. 13).

The other aspects of climate change have been tackled indirectly. The main problems identified are: (i) lack of awareness, (ii) lack of researches and resources, (iii) lack of monitoring and early-alarming systems, (iv) and poor state of the environmental conditions. The forestry and greenery have been identified as potential and valuable nature resource that can improve environmental conditions in the city.

5.2.10 Tourism Development Strategy of the city of Belgrade

The Tourism Development Strategy of the city of Belgrade results from a study of the Institute of Economic Sciences (IES) demanded by the City of Belgrade (SRTBG, 2008). It gives a comprehensive and long-term oriented perspective of tourism development of the Belgrade area.

Climate change has been identified as one of the constraints of potential future tourism in Belgrade. Highlighted are eight key challenges for sustainable tourism, where some of the proposed approaches and actions to overcome them are: *"reducing the impact of tourist transport on climate change and pollution the environment globally and locally"* (SRTBG, 2008; p. 131) and *"protection and valorization of natural and cultural heritage"*, where *"impacts of climate change on heritage, and the lack of adequate resources (human and financial) for the protection and preservation of heritage"* are identified (SRTBG, 2008; p. 132, 133).

The following statements in relation to climate change and green areas are evident: *"Climate change imposes an obligation to improve the microclimate conditions, by conservation of the existing and establishment of new green infrastructure (alleys and*

green areas) along all pedestrian paths and cycling routs, wherever possible in the existing urban setting. This problem is almost completely neglected in the past two decades of development" (SRTBG, 2008; p. 137).

5.2.11 Summary of analysed UPF management and policy documents

Table 16 Summary of analysed UPF management and policy documents

Name of the document	Year of passing	Influence of document	Mitigation aspects	Adaptation aspects	Relation of CC to UPF
Law on Forestry of RS	2010	national	+	+/-	+/- (forest in general)
Forest Development Strategy of RS	2006	national	+	+/-	+/- (forest in general)
Afforestation Strategy of Belgrade	2011	local	+	+/-	+ (all types of green areas in Belgrade)
Management Plans of UPFs	2006-2009	local	+/-	+/-	+
Law on Spatial Plan of the Republic of Serbia	2010	national	+	+	+ (all types of green areas in cities)
Regional Spatial Plan for the Administrative Territory of the City of Belgrade	2004	local	+/-	+/-	+/- (all types of green areas in cities)
Master Plan of Belgrade 2021	2003	local	+/-	+/-	+/- (green infrastructure)
National Sustainable Development Strategy	2008	national	+	+	+/-
Development Strategy of the city of Belgrade	2011	local	+/-	+/-	-
Tourism Development Strategy of Belgrade	2008	local	+	+/-	+/- (green infrastructure)

+ directly addressed; **+/-** indirectly addressed; **-** missing

5.3 Perception of climate change and adaptation strategies in UPF of Belgrade

5.3.1 In-depth interviews

The objective of the in-depth interviews was to understand current state of UPF resources, management plans and ecosystem services regarding the climate change adaptation, as well as current actions undertaken and potential actions for adaptation of urban forest resources to climate change. Furthermore, it aims to understand the perception of managers towards climate change in general and its implication for UPF management.

In total 6 in-depth interviews were conducted. Four were done with the representative managers of two main management agencies in Belgrade, PE 'Serbia Forests' and PUC 'Greenery Belgrade', and two with

the experts involved in the development of management plans (Appendix 2).

Climate change issue in the work of forest managers

Implication of climate change issue in the work of interviewed UPF managers is present in indirect way. Managers are mostly confronted with this issue in the process of development of management plans, which implies implementation of the aims of higher policy and planning documents relevant for UPF, as well as the documents from the other sectors. The most of the higher level policy and planning documents have been developed in last 10-15 years, when the inclusion of international regulations become very important as a process of harmonization of national regulations with the EU standards. Some of those are climate change regulations, e.g. Kyoto Protocol (KP), Clean Development Mechanism (CDM), and UNFCCC. However, the specific measures and actions regarding the climate change have not been incorporated in the management plans so far (manager 3). Therefore, the issue of climate change is mostly indirectly and superficially incorporated in UPF management plans through various other aspects.

The coordination and cooperation between managers of UPF and experts from the other sectoral organization is another way how UPF managers are confronted with the issue of climate change. Through the cooperation on the development of planning documents (e.g. spatial plans, master plans), importance of urban green areas and forests is highlighted and presented as important 'climatic' infrastructure. In this way understanding of the issue of urban forests contribution to climate change become more prominent between experts (manager 2).

However, the perception of other experts towards the importance of green infrastructure is very low and currently this aspect is very rarely mentioned in higher policy or planning documents. This situation makes the work of UPF managers harder, as they cannot refer to higher document that would support inclusion of climate change issues in forest management plans. The process of the development of management plans is top-down mandated, and this is characterized as crucial for the future actions in climate change policy making, also in forestry sector.

Implication of climate change is also evident in the daily management and maintenance of UPF (manager 1, 4, 5). Over the last decades managers have noticed changes in UPF resources, mostly through increased droughts and lower levels of ground water that have negative influence on tree resources. Most of those changes are linked with the negative influence of climate change. This has influenced the maintenance of UPF, mostly through increased need for more patient care about forest resources and change in maintenance operations, like: more frequent irrigation, control over pests and diseases, thinning, mowing. Because of such intensive maintenance, costs become higher and management agencies usually do not have enough financial resources for all of these needs. On the other side, the high social, aesthetic and recreational importance of the forests in urban areas requires that all mentioned operations are done in order to ensure provision of those services (manager 4). Such situation makes the management of UPF as very demanding and hard in last decades (manager 1, 4).

One of the interviewed managers has participated to the development of national level documents for climate change (the Initial National Communication to UNFCCC and CDM Report), by contributing to the calculation of carbon resources in forests (manager 3).

So far, the management of UPF had different aims and fulfilled mostly recreational, aesthetic and economic demands (manager 3, 4, 6). The issue of climate change has increased but is still not important enough for the work of UPF managers.

All the managers stated that climate change and climate change adaptation have not been perceived as strategic aims and important part of forest management planning. In addition, they noted that these issues need careful planning and coordinated actions.

Key aspects identified

- issue of climate change has become a topic for discussion on national level in last few years

- climate change and climate change adaptation have not been perceived as strategic aims and important part of forest management planning
- climate change has been indirectly and superficially incorporated in UPF management plans due to the lack of relevant national legislation
- managers are concerned with issue of climate through everyday operations and practices (notification of frequent droughts and lower level of ground water – which have negative influence on forest resources, and organization of forest activities)
- some managers have been involved in the development of national planning documents and national documents for climate change

Importance of climate change and climate change management in UPF management

All of the interviewed managers stated that climate change and climate change adaptation are becoming important issues for UPF management.

The level of the perceived importance varied between managers. Some managers stated clearly this importance, e.g. *"it is very important issue for the future state of our forests"* (manager 2) or *"it is very important issue… I do not know who we are to prevent future generation to breathe and enjoy in benefits of forests… we need to respond to coming challenges of climate change…"* (manager 1). Both of those statements also emphasize the importance of sustainable forest management. Other managers stated that it is *"globally important issue"*, but not that important on the level of Serbia or Belgrade (manager 6). The uncertainty of the importance was revealed in some interviews, by use of phrases *"it is maybe important issue"* (manager 5) or *"if there are some evidences and results of the researches, which show the changes, then this become important issue…also for the management of UPF"* (manager 3). In those cases the lack of information, data and research was expressed, which influence the uncertainty in how far climate change is important for UPF management (or in Serbia in general).

In some interviews it was expressed that the climate change becomes more important because of the perceived changes in forest resources (droughts, outbreaks of insects), changes in maintenance operation (manager 1) or in management practices (manager 5). However, it was frequently stated that it is an issue that is not that important in the case of Serbia, that none of the mentioned changes are as severe as else in the world, and that it can be possible problem in the future. This implies that managers lack the overall understanding of climate changes issues (e.g. the need for long term measures) and facts about the change, but also that they overlook the possibility of positive effects of climate change. Even though, the clear opinion does not exist between managers on how climate change can influence forests and management, and that their opinion is largely influenced by many assumptions, all managers stressed that it is an issue of importance for forest management.

Climate change was seen as less important challenge than other challenges with which UPF management in Belgrade is faced. The most important mentioned challenges are economic factors and urbanization, but others have been mentioned as well (e.g. land use conflicts, governance issues, lack of information and technical assistance, ownership issue). This perception is in line with the recent results of the survey conducted among various forestry stakeholders in the world, which was done by FAO (FAO, 2012).

Except challenges that are directly connected to forest management, during the interview the general crisis of economic and social aspects of the State were mentioned. Inferiority of the decision-makers, and employees in forestry, towards the climate change issue, is influenced by the numerous and long lasting problems with which society was faced in last decades. Therefore, the priority is on solving other issues such as: economic crises, fall down of industry and unemployment in the country.

The perception on mitigation and adaptation aspects of climate change showed that mitigation is better understood and better perceived then adaptation measures. In all interviews afforestation, as mitigation measure, is perceived as very important for UPF management. This is stated both because this is the only measure undertaken by the forest authorities in Belgrade, and because the lack of forest areas is present in the case of Belgrade. All managers expressed the opinion that afforestation will be of

great importance for Belgrade, and that it will indirectly have influence on adaptation potential of forest resources to climate change (e.g. through better condition of future forest, better microclimate in the city that will improve physiological state of current forests, improved connectivity of green areas). Apart from that, calculation of carbon resources in forests for the Initial National Communication to UNFCCC, development of the CDM Report, as well the direct participation of Serbia in Kyoto Protocol, showed that mitigation measures are more prominent and present in Serbia (also in forestry sector). This is the general state of climate change debates on climate change, where adaptation is becoming more prominent and highly important on global and national agendas (Dovers and Hezri, 2010; Ecologic Institute, 2011).

Key aspects identified

- the level of the perceived importance of CC varies among managers
- uncertainty on the importance and influence of CC exists, due to the lack of information, data and research (especially for Serbia)
- opinion of managers is largely influenced by many assumptions, which reveal the lack of knowledge about climate change
- climate change is seen as less important challenge than other challenges in forest management (e.g. land use conflicts, governance issues, lack of information and technical assistance, ownership issue)
- climate change becomes more important because of the perceived changes in forest resources (droughts, outbreaks of insects), changes in maintenance operation, or in management practices
- mitigation measures have been better understood than adaptation measures (e.g. afforestation)

Policy and legislation

According to all managers, policy documents (e.g. Law on Forests, Forest Development Strategy, Law on Nature Protection, Master Plan of Belgrade) that shape the management of UPF in Belgrade contain only little aspects of climate change. None of these documents provide detailed or more precise aspects of climate change adaptation. The document that has been closely connected to climate change and climate change mitigation is the Afforestion Strategy of Belgrade.

From the planning documents, the Spatial Plan of the Republic of Serbia and all lower level plans (e.g. Master plan of Belgrade, Regional Spatial Plan for the Administrative Territory of the City of Belgrade) refer generally to climate change and provide a good base for development of various sectoral strategies (manager 1, 2, 3, 5).

All these documents are of great importance and have influence on the development of UPF management plans, and are frequently used in daily work of managers.

All of the interviewed managers were aware of the existence of a national climate change regulatory framework that is developed so far. The knowledge about those documents is based only on individual interest and information. Managers are more familiar with the Initial National Communication to UNFCCC now (manager 1, 3). However, it is not used as a document on the level of forest management organisations. Only one manager has been directly involved in the development of this national report (manager 3), where the calculation of carbon reserves in forests was done by the experts from the Faculty of Forestry. All other managers have not been involved or asked to be a part of development of any national climate change documents.

The lack of legislation is one of the most common stated constraints for the integration of climate change adaptation measures in UPF management. The situation is slightly better in terms of the projects in this field. However, all interviewed managers stated that results of those projects are not accessible and are not coordinated between various organisations. The practical implementation of the recommendations and results of those projects is very low.

According to all managers, adjustments to the UPF management plans or practices in relation to national climate change regulations and other policy documents have just been superficially made. The ordinances from those regulations and documents were taken in the design of these documents, while the concrete actions and measures are still missing.

Hence, changes in management of UPF can just be indirectly connected to climate change and climate change adaptation, but not to any concrete policy measures.

Key aspects identified

- Policy documents very weakly contain aspects of climate change
- interviewed managers are aware of the existence of the national climate change regulatory framework
- managers' knowledge about existing national climate change regulatory frameworks is based only on individual interest and information
- the lack of legislation is one of the biggest constraints for the integration of climate change adaptation measures in UPF management
- adjustments of the UPF management plans or practices in relation to national climate change regulations has just been superficially made

Communication

The level of communication on climate change issues is perceived as very low and is mostly influenced by individual interest of the managers. None of the managers have been informed more in detail about climate change, because the specific knowledge and skills are not needed or implemented so far in their work. Furthermore, there is no any law that would guide the work in the direction of implementation of climate change issues. Managers stated that *"if there is a law that would regulate implementation of certain measures in relation to climate change, I would do that"* (manager 4) or *"we do not have base in the legislation so this issue can be tackled more properly"* (manager 2). Thus, the communication and information flow about climate change can be characterized as informal.

Management agencies did not organize any kind of workshops or educational programs so far that would raise awareness about climate change among employees. Also, managers mostly did not have a chance or were not invited to take part in some of the workshops that are held on the national level, even though they were informed about their existence (manager 1).

In the case of the PE 'Serbia Forests', managers have the opinion that the Headquarter of the company have more close connection to national initiatives regarding the climate change and that the Department for Information and Development communicates the issue of climate change with other stakeholders. However, the information flow from the Headquarter to the Forest Estate 'Belgrade' is characterized as low. The communication is organized via the technical director that decides which information is relevant for which department in the Forest Estate 'Belgrade' (manager 4, 6). Thus, it can be noted that issue of climate change has not been (or very weakly) communicated among employees so far.

Both management agencies have stated that communication about any issue that is of importance for forestry sector is done with the Faculty of Forestry on regular basis in terms of consultations. Anyhow, findings about climate change are still insufficiently communicated.

The lack of information regarding the financial opportunities for tackling climate change was confirmed by managers. It was said: *"We know that certain additional funds (from national budget) can be used for tackling climate change. But, procedure for application is complicated, and we are insufficiently informed that we do not use such opportunities..."* (manager 1).

Furthermore, new adaptive methods and implementation of new management goals often hampered by little self-initiative in a system of top-down mentality (manager 1, 4).

Interviewed managers stated that the internet and scientific literature is mostly used as the source of information about climate change issue. They had more opportunities to be informed about global aspects and findings then the specific finding for Serbia and region. Regardless of the certain level of awareness among manager, it is important that communication within forest sector be improved regarding the climate change. Thus, forest managers can be informed more directly of decisions and changes that are result of national or international discussions on climate change (FAO, 2012).

Key aspects identified

- the level of communication about climate change issues is very low (inside and between various organizations) and is mostly influenced by individual interest of the managers
- the need is expressed towards the information regarding the financial sources and other opportunities that exist on national level and can be used for tackling climate change in forest management
- inferiority of employees toward adopting of new methods and new aims in the management is present
- internet and scientific literature is mostly used as the source of information about climate change issue, on the individual bases
- managers have been more informed about global aspects and findings regarding climate change then the specific finding for Serbia and region

UPF contribution to climate change in management plans

All managers stated that the UPF contribution to climate change is not specifically described in management plans. It is seen as a part of various aspects described in UPF management plans (manager 5), mostly as main functions of forests (manager 3, 4, 6) and as sustainable and multifunctional practices of forest management (manager 1, 2).

The forest management in UPF in Belgrade is multifunctional. Attention is always paid that forests are fulfilling various functions, like: regulating the urban microclimate (reducing albedo/providing shade and cover), regulating hydrological regime in city, prevent erosion, controlling GHG emissions (are there some figures), shading effect of trees on buildings (are there interaction with building sector).

Wind protection is especially important in Belgrade area (northern part), which is of importance for stabilization of microclimate in the city. Furthermore, protection of drinking water sources, and prevention of erosion and landslides, is highly important.

However, none of those aspects is explained and described with the aspect of contributing to climate change in management plans. Despite this, all the managers are aware of this aspect and this cause-effect relationship (manager 3, 4). Manager stressed that terminology in relation to climate change is also very poorly present in management plans (manager 4). Through the contribution in planning documents, those aspects of forest contributions are expressed as important 'climate infrastructure' in planning documents (manager 2).

Precise data (e.g. quantity of stored carbon) or measurement instruments to illustrate the contribution of UPF to climate change mitigation does not exist in management plans, but could be of importance for highlighting importance of forest resources in urban areas (manager 1).

Key aspects identified

- UPF contribution to climate change mitigation is not specifically described in management plans (it is seen through the main functions of forests)
- terminology in relation to climate change is hardly used in management plans
- the long-term monitoring data are missing regarding the contribution of UPF to climate change mitigation, but seen as the crucial for further actions

Vulnerability of UPF to climate change

Vulnerability of UPF to climate change has been noticed in the last ten years in Belgrade, but they are not analyzed adequately (manager 4, 6) and no database exists for development of adaptation measures (manager 1).

In ecological terms, the vulnerability of forests is seen through the negative effects of drought periods on various tree species, both ill and health trees. Another aspect is stress induced by insufficient water resources and long dry periods, in spring and summer months resulting in more frequent attacks of various pests and diseases. Furthermore, braking of tree bark, due to dry and hot weather, becomes more frequent even at healthy trees. All of those aspects are noticed in daily maintenance of UPF areas, and managers have stated that *"those must be some influences of climate change, even if some other negative influences can be the cause (urbanization, changed land-use)"*.

As a result of those changes, management and maintenance operations have been changed in the

last years. Tree planting is now done in the autumn, compared to previous practice which favoured spring planting. Frequent dry periods in the spring are not adequate for planting any longer. Still, early cold periods that sometimes come in autumn months can distract autumn planting. Hence, a higher level of uncertainty is now associated with management operations (manager 1, 5). The mowing and irrigation operations cannot be adequately planned, due to weather changes, which usually result in inadequate planning of the budget (manager 4). Furthermore, Belgrade is facing more frequent extreme weather events (e.g. floods and storms), which have negative impact on tree resources (manager 1, 2, 4, 5). Trees are breaking under the pressure of more frequent and stronger winds, which did not occur in the past. The ratio of paved and unpaved (green) areas is seen as a problem today, as huge areas in the city are paved. This is especially seen when floods come, and large quantities of water cannot be drained in short period of time, both as a consequence of the bad state of drainage system and lack of open (green) areas (manager 2). In this aspect, Belgrade has not been adequately planned (even though it has complex and hilly terrain), and the problem of floods become more prominent in recent years (manager 2, 4, 5). All the changes in management and maintenance operations have been made as a consequence of already experienced negative influences. This - in terms of adaptation measures - can be defined as planned adaptation measures.

The structure of forests has also experienced change in previous years. It is noticed that coniferous species (e.g. *Picea abies* L., *Cedrus* sp., *Abies* sp., *Pseudotzuga mensiensii* Mirb.) are highly vulnerable to dry periods, and in today's practice they have been replaced with deciduous trees (e.g *Quercus cerris* L., *Quercus frainetto* Ten.). Except the negative influence on coniferous stands, it is noticed that stands of *Fagus silvatica* L. and *Acer sp.* experienced negative influence. As a consequence of insufficient water availability, *Fagus silvatica* L. has disappeared from some stands (e.g. Guberevačka and Košutnjak forests), and was replaced usually by natural succession of *Tilia* sp., which have strong resistance potential. In such cases, managers say that management measures must be undertaken and that those stands should be replanted with *Quercus cerris* L. and *Quercus frainetto* Ten., which are more resistant than *Fagus silvatica* L. and *Tilia sp.* (manager 5).

Nowadays, attention is paid on planting autochthonous vegetation and fulfilling eco-physiological demand of each species. The previous practices of planting coniferous trees and monoculture stands have been skipped in management. These changes appear as a consequence of observations during the years, and are also explained partly as negative consequence of climate change (but more informally) (manager 1, 4, 5, 6). Invasive tree species (e.g *Acer negundo* L., *Ailanthus alitissima* Mill., *Amorpha fruticosa* L., *Celtis occidentalis* L., *Fraxinus pennsylvanica* Marshall.) become more frequent in urban areas, and management has been oriented on their removal from the forest stands (manager 3). Problems are also identified within smaller green areas in the city, which are very hard to be maintained adequately, or trees in alleys.

In recent years a change in forest increment is noticed, mostly due to long dry periods. For example, the increment of *Poplar sp*. stands, which is used in plantations along the Danube river (and have high economic value), has decreased in the last years. (manager 5).

Most of these negative changes can be noticed in 'Košutnjak', which is one of the most popular urban forests in Belgrade. The future management of this area is seen as a great problem, as there is high interest in conservation of this forest area due to high social and ecological values of the area. Managers expressed that *"nobody wants to admit these problems, and start implementing measures"* (manager 4) and that *"there is a lack of knowledge and skills how to adequately tackle this highly sensitive situation"* (manager5). Managers also expressed that there exists high uncertainty how to change forest structure, both in terms of species to be used for replanting (with the aspect of future climate change), and how intensive operations can be performed (manager 4, 5).

Despite of all those vulnerabilities of urban forests that are identified in management of UPF, some of the managers still have opinion that these changes of climate are not rapid and gravid (manager 5, 6). In addition, they are of opinion that most of the tree

species and vegetation, in general, will be able to adapt to the change of climate without the help of management measures. This is in line with the concept of autonomous adaptation potential of forests (IPCC, 2007a). Still, managers are aware of the importance of prospective adaptation measures in forests, especially in urban areas where the long-term succession of vegetation is not sufficient to react (manager 1, 2, 5).

Key aspects identified

- vulnerabilities of UPF to climate change have been noticed in the last ten years in Belgrade, but they are not analyzed adequately
- database of resulting changes does not exist
- in ecological terms, the vulnerability of forests is seen through the negative effects of drought periods on various tree species, through water stress, and lower physiological state of trees
- more frequent weather accidents (e.g. floods and storms) have been occurring
- management and maintenance operations have been changed in last few years (more frequent irrigation and mowing are needed, planting is done in autumn)
- the structure of forests have been changed in previous years (coniferous species as very vulnerable to climate change have been replaced with deciduous species; invasive tree species become more frequent in urban areas)
- change in forest increment is noticed in last few years, mostly due to long dry periods
- all the changes in management and maintenance operations have been made as a consequence of already experienced negative influences (planned adaptation measures)

Monitoring of climate change impact on UPF

All managers stated that monitoring of climate change impact on UPF was not done so far. Even though certain changes have been noticed in forests resources, analysis of these changes have not been done. Management practices have been changed after the observed changes in UPF, but more constructive and comprehensive approaches to the negative impacts of climate change have not been developed.
All managers highlighted the necessity for comprehensive monitoring practices. They said: *"it would be of great help for adequate planning of forest operations"* (manager 1) and *"long-term planning for UPF"* (manager 5). It is suggested that experiences from managers and workers employed in maintenance should be used as a starting point for analysis of climate change influence on UPF (manager 4).

Some of the managers have the opinion that Faculty of Forestry has more notions and maybe more access to data about existing change in forests over the years (manager 5, 6). However, during the interview with the representative of Faculty of Forestry (manager 3) it was understood that such data are not comprehensive and that are part of separate projects. An important movement in this field of climate change, which is expected to bring new perspectives and data in this field, is the initiation of four years project "*Studying climate change and its influence on environment: impacts, adaptation and mitigation*". It is financed by the Ministry of Science and coordinated by the Faculty of Forestry in Belgrade. The strategy of scientific and technological development until 2015 identified climate change as a priority area for research. This strategy triggered the initiation of a project that aim to undertake interdisciplinary research to explain and analyze climate change issue on national and sectoral levels (manager 3).

As an useful base for future development of monitoring system of climate change impact can be used existing data obtained by Serbian forest condition monitoring survey at Level I, which is done in framework of the International Cooperative Programme on Forest Condition in Europe (ICP Forest) (manager 6). The survey was done by Institute of Forestry, as National Focal Centre, and in collaboration with the Faculty of Forestry (in Belgrade) and Institute of Lowland Forestry and Environment (in Novi Sad). Data collected from IPC monitoring 2003-2009 have not been analyzed so far as a time-series bundle, but can be used as a base for the analysis of effects of climate change (Mátyás, 2010).

Key aspects identified

- monitoring of climate change impact on UPF was not done so far

- the necessity for comprehensive monitoring practices was highlighted by all managers
- new project to (partially) overcome the gaps

Climate change adaptation measures in UPF

Climate change adaptation measures have not been applied as such in UPF management plans so far. Some changes in management practices, like replacing coniferous species with deciduous, enforcement of autochthonous vegetation, extraction of invasive tree species, can indirectly be referred as climate change adaptation measures. Anyhow, this was not the main reason why these measures were applied.

During the interviews managers expressed opinions on which climate change adaptation measures should be of importance for future management of UPF. Selection of climate-resilient species and optimizing species mixture are seen as very important (manager 1, 2, 4, 5, 6). In addition it is noted that this require more research, experiments and monitoring, in order to minimize uncertainties of success of suggested measures.

Arrangement of urban forests in relation to infrastructure and creation of ecological corridors is expressed as important by the managers of PUC 'Greenery Belgrade'. Thus, it can be understood that urban forest resources and green areas are smaller and fragmented, which minimizes their adaptation potential as well as benefits they provide. Moreover, the understanding of importance of urban forests and urban forestry is more comprehensively understood by managers of PUC 'Greenery Belgrade', mostly due to various types of green areas that are in their competence and various functions that these forests and green areas provide.

Forest protection measures (e.g. protection of areas with high economic and social values, fire protection, enhancing forest recovery, reducing diseases through sanitation cuts, partial tinning or cutting to increase vigour) are of great importance for future adaptation potential of forests (manager 1, 2, 5, 6). Furthermore, actions for protection of UPF against insects and diseases should be more adequately tackled in the future, as greater problems in these terms are expected. All of those measures will enhance better physiological state of the trees, and thus enhance their adaptation potential and reduce vulnerabilities. From the social and economic point of view, the most important actions are the adjustment of institutions and the inclusion and empowerment of various actors, in order to tackle all climate change aspects properly. Capacity building of employees in forestry and other actors is necessary. Furthermore, finance resources should be assured. Valuation of functions and benefits from urban forests is also seen as necessary, despite the skepticism that this is not understood and done adequately so far.

Key aspects identified

- climate change adaptation measures have not been applied as such in UPF management plans so far
- the most urgent and most valuable adaptation measures as perceived: selection of climate-resilient species, optimizing species mixture, creation of ecological corridors, enhanced forest protection measures.
- in social and economic terms many actions are highlighted: adjustment of institutions, inclusion and empowerment of various actors, capacity building of employees in forestry, provision of financial resources.

Constraints to climate change adaptation responses in UPF

As it was elaborated previously, comprehensive approaches to climate change have not been developed in management practices of UPF. This topic is still superficially incorporated in work of forest managers, beside the certain level of understanding of the topic. Managers are aware of many constraints that are causing such situation.

The lack of political will and legislation were expressed as the most important. All managers have that opinion that stronger initiation and leadership for this issue should come from policy makers on higher level. They said: *"if the Government is more involved in popularization of the climate change issue, and if this is regulated by laws and regulations, we would not have problem to implement it in the management"* (manager 4) or *"I think that all new topics that are global, like climate change, which need*

to be implemented (also because of the accession to the EU) should be mandated from the higher level and from one place" (manager 3) or *"if the issue of climate change is regulated in higher level policy document then documents on lower level will be automatically in accordance to the higher"* (manager 2).

Lack of financial resources is highlighted as other constraint, which are limiting forest management responses to climate change. The budget and financial resources that are obtained so far are sometimes even not enough for the management that is planned. The integration of climate change adaptation measures would need additional finances. However, all managers stated that it is not realistic to expect, as the state of the country economy is very low.

Beside those, the lack of the research, information, data, knowledge and skills about climate change are expressed. In general, this topic is new, and up-to-date data and experiences are needed for tackling it (manager 2). The management practices applied currently are very old, and new methods and approaches are necessary (in terms of other aspects of forestry) (manager 2, 4). Involvement of experts in this field, as well as more prominent expert understanding and popularization of the climate change is needed (management 2).

Coordination of various actors is seen as possible constraint. Certain level of skepticism is expressed towards the involvement of more actors on various levels, which should tackle the issue of climate change (manager 3). According to some notions, coordination between various organizations and actors is not very good (manager 2, 3, 5).

Furthermore, long-term planning is absent in current practice of UPF management (manager 4). Implementation of all laws, regulations, and planning documents (especially The Law on Spatial plan of the Republic of Serbia) in UPF management should be improved (manager 5).

In general, inferiority of employees and lack of information were also seen as constraints for implementation of climate change adaptation measures. Initiatives from the lower level are insignificant, and there is no will for pushing any new topic (manager 4).

Key aspects identified

- the lack of political will and legislation
- lack of financial resources
- lack of the research, information, data, knowledge and skills about climate change
- inadequate coordination of various actors
- inferiority of employees
- absence of long-term planning in current practice of UPF management is seen as one of the constraints
- the management practices applied currently are very old, and new methods and approaches are necessity

5.3.2 Q methodology

In this study Q methodology is employed to reveal expert's opinions, believes, perception and awareness towards climate change adaptation as an issue (and climate change in general) in UPF of Belgrade. It tries to differentiate which aspects of adaptation process are seen as the most important; as well which viewpoints towards climate change exists.

Q studies related to climate change, which have been conducted so far, have assessed the perception of society related to this issue. It is showed that climate change is dependent on the capacity of society to adapt (Niemeyer *et al.* 2005; Wolf, 2005; Hobson and Niemeyer, 2011). This capacity shifts the direction of adaptation potential between adaptation to non-adaptation, or to maladaptation. It is recognized that vulnerability to climate change relies on relationships between individuals, as well their environmental, economic and political circumstances (Bohle *et al.*, 1994, Lindner *et al.*, 2010). Therefore, it is necessary to understand social responses to climate change, its individual actors, its institutions and their interrelations. So far, systematic investigation of the social aspect of climate change adaptation processes has been lacking (Niemeyer *et al.*, 2005).

According to the Niemeyer *et al.* (2005), the role of institutions and role of trust is very important in terms of responses to climate change adaptation. Institutions should act as "governance structures" providing a regulatory function, which influence adaptation process. The usual absence of trust

creates wider legitimacy problems for governing institutions, resulting in difficulties in mobilizing resources and in redused possibility of collective resonses. The role of the provision of information is therefore seen as important, as it helps to facilitate positive adaptive change. Less is known about the cognitive aspects, such as perceptions and motivations of actors, that lead (or not) to some actions (Lopez-Marrero, 2010).

Based on the overall analysis of social aspects of the adaptive capacity (Niemeyer *et al.,* 2005; Wolf, 2005; Lopez-Marrero, 2010; Hobson and Niemeyer, 2011) the underlying questions for the Q methodology were posed:

Recognition: Do UPF actors recognize climate change adaptation as a general issue in urban forest management? What are the most important perspectives of the adaptation process?

Knowledge: Do UPF actors have knowledge and skills needed for adaptation actions? How they are informed about the issue?

Political efficacy: How members of government, city agencies or organizations might address the issue of climate change adaptation? Do the actors trust in institutions and governance systems?

Q-set, P-set, Q sorting

In Q methodology, concourse of the statements is called 'Q-set' and interviewed respondents are called 'P-set'. For the purpose of this study, a Q-set of 48 statements was made. Some of the statements comprised of direct quotes from the in-depth interviews, while others are modified or constructed based on literature.

A matrix of statements was made (Table 17) to cover the broad scope of climate change adaptation in UPF. The matrix of statements was organized according to the general understanding on climate change adaptation, based on the work by Lasswell and Kaplan (1950), which covers:

- **Identification** (which shows the perception of status quo),
- **Expectation** (which identifies anticipated items) and
- **Demand** (which illustrates a wish for response or action).

An additional issue is the climate change adaptation process, where three broad categories were developed (based and modified on FAO, 2011):

- adaptation of **Policy** (policies, strategies, legislation, government, actors, responsibilities)
- adaptation through various **Resources** (information sources & flow, human resources, knowledge, finances)
- adaptation with forest **Management measures** (forest management measures, ecosystem services, ecological aspects)

The statements with the random numbering were entered in to the matrix, with the attention to secure overall balance between categories.

P-set was formed from 23 respondents from various national, local and regional organizations (Table 1, p.9). Some of the respondents were identified at the beginning of the study (e.g. managers of UPF), while others are reached by snow-ball technique. A list of the respondents can be found in Appendix 6.

All Q-sortings were conducted during June 2012. During the Q-sorting process, most of the respondents react positively, as it was innovative and interesting method. Respondents also expressed opinion that at the beginning it seemed easy to conduct the sorting, while at the end, the process of decision between levels of agreement/disagreement required more efforts.

Table 17 Matrix of Q-statements

	Policy (policies, strategies/legislation, government, actors, responsibilities) 16	**Resources** (information sources & flaw, human resources, finances, knowledge) 17	**Management measures** (forest management measures, ecosystem services, ecological aspects) 15
Identification (Perception of status quo) 17	6. Adaptation of the urban forests to climate change is important to preserve the forests for the future generations. 25. There are many other competent problems in city, which should be solved, than climate change adaptation. 28. Everybody has to contribute in tackling climate change, through individual actions. 30. Failure to address climate change is the fault of political leaders. 37. Urban scale and local adaptations are not important part of national and international policy agenda to climate change. 48. Enforcement and implementation of international agreements on climate change is more important at the global level, rather than separately at the national or local level.	8. Public awareness about climate change is already high; there is no need for more educational programs and trainings. 17. Employees in forestry are informed about climate change only through informal sources (e.g. internet, newspapers). 18. Actions oriented on reducing impacts of climate change are expensive for companies and enterprises. 35. There is not enough information to definitely say that climate change exists. 40. Media insufficiently bring reports about climate change. 47. The organizations responsible for issue of climate change and other enterprises involved in urban forestry have good communication about climate change.	15. Climate change adaptation actions in urban forests are not needed because forests will naturally adjust to future climate variability. 31. As effect of climate change we have more trees that are drying now in urban forests. 32. Climate variation is normal, so we cannot say that there is global climate change. 39. Non-native (alochtone) species in urban forests are not negatively influenced as consequence of climate change. 41. Urban forest management has other priorities then climate change adaptation.
Expectation (Identifies anticipated items) 16	5. Adaptation to climate change in urban forest will not contribute minimizing climate change effects if other sectors in city (e.g. transport, energetic) are not adapted as well. 12. Consideration of the process of adaptation to climate change in urban planning will help the process of adaptation. 20. Stronger political leadership would be of great importance in initiating climate change adaptation actions. 38. Only when negative effects of climate change become evident, it will be acted in finding a resolution.	1. Introducing monitoring system and modelling tools for forest management will be of great importance for adaptation to climate change. 3. Scientific knowledge about adaptation of urban forests to climate change would help in adaptation process. 9. Climate change adaptation actions in urban forests are costly; it not makes sense to invest in it. 11. Popularization of climate change topic can be done through greater involvement of experts 13. Lack of interest of urban forestry actors toward climate change will not influence adaptation process. 42. When schools/universities include climate change in their curriculum, young generations will know what to do in the end.	5. The protection of biodiversity and forest habitats will depend on how well we adapt the forests to climate change. 26. Natural forests are best suited to adapt for climate change. 27. It is already too late to do anything, as any action to adapt urban forests to climate change will take a long time to take effect. 29. Water supply will be endangered if nothing is done about adaptation of urban forests to climate change. 33. In future invasive species will become a big problem with climate change. 36. Climate change adaptation in urban forests will not help in regulation of city microclimate.

Demand (Wish for response or action) 15	19. In adaptation of urban forests to climate change the enterprises/agencies that manage the forests should take the main decisions. 21. Local authorities should play a crucial role in developing climate change adaptation strategies in various sectors. 23. Companies and enterprises need to consider climate change in all activities (corporate responsibility). 24. We need legislation that addresses climate change adaptation in urban area. 34. Adapting forests to climate change should be done because of the sustainable development of the city. 44. Climate change adaptation policy for urban forests should be top-down mandated.	2. The establishment and development of dialogue between various actors about climate change adaptation is highly important for management of urban forests. 4. Public institutional money is needed to deal with the adaptation of urban forests to climate change. 16. Education of employees in urban forestry towards climate change is needed for adaptation process. 22. More funds from national funds should be secured for doing research on climate change adaptation. 46. The cost and effects of climate change adaptation in urban forests need to be calculated before actions are taken.	7. Management of urban forests should adapt on more frequent weather accidents that are consequence of climate change. 10. Selection of climate-resilient species in management of urban forests is needed action for adaptation of urban forests to climate change. 14. In order to make forests resilient to climate change we should aim at planting as many species as possible. 43. Climate change adaptation in urban forests is urgent issue that asks for immediate change of management with forests.

Q analysis

The results of Q-sortings were entered into the PQMethod[11] software for further analysis. Firstly, the *Principal Component Analysis* (PCA) was done. Secondly, a *varimax* rotation was applied, which is followed by the *judgmental (manual) rotation*. Finally the resulting factors, documented in output file are analysed and interpreted.

Correlation

The scoring continuum employed in the study ranges from +4 to -4, with the mean of 0 and a standard deviation of s = 2.21 for each Q sort. The scores for all 48 statements in all n = 23 Q sorts are are used for calculating the correlation coefficient (r) for each pair of Q sorts.

The perfect correlation between Q-sorts is registered as r = +1.00, a perfect negative correlation is r = –1.00, and the absence of correlation r = 0.00. As the means and standard deviations are identical for all Q sorts, the following equation is suitable for calculating correlations (Brown, 1980):

$r = 1- (\sum d^2/2Ns^2)$,

where N is the size of Q sample, s^2 the variance of the forced distribution, $\sum d^2$ is the sum of squared differences (d^2) in scores for the items in two Q sorts, and r is the resulting Pearson product-moment correlation coefficient (Brown, 1980).

To determine how large a correlation must be before it is considered substantial, it is needed to calculate the standard error (SE). SE is calculated by the expression $SE = 1/\sqrt{N}$, where N is the number of statements (N = 48). In this case the value of SE is:

$SE = 1/\sqrt{48} = 1/6.93 = 0.14$

As a rule of thumb, correlations are generally considered to be significantly significant if they are approximately 2.58 times the standard error (Brown, 1980) assuming a 99% confidence interval. For this study the correlations are significant if they are in excess of +/- 0.37.

As the result of the correlation, a 23 x 23 correlation matrix is produced (Table 18). Commonly the correlation matrix is of minor interest, compared to the factors calculated in following steps of Q methodology (Brown, 1980, 1993).

From the correlation matrix it can be seen, that correlations between 'respondent 1' (R-1) and 'R-2' is r = 0.49, which indicates a high level of agreement, while the correlations between 'R-11' (0.19) and 'R-16' is only equal to 0.07 indicating a very low level of agreement. The high disagreement can be observed between 'R-3' and 'R-11' (-0.29), or between 'R-16' and 'R-22'.

[11] *"PQMethod is a statistical program tailored to the requirements of Q studies. Specifically, it allows to easily enter data (Q-Sorts) the way they are collected, i.e. as 'piles' of statement numbers. It computes intercorrelations among Q-Sorts, which are then factor-analysed with the Centroid or, alternatively, PCA method. Resulting factors can be rotated either analytically (Varimax), or judgmentally with the help of two-dimensional plots. Finally, after selecting the relevant factors and 'flagging' the entries that define the factors, the analysis step produces an extensive report with a variety of tables on factor loadings, statement factor scores, discriminating statements for each of the factors as well as consensus statements across factor…"*
(Available at: http://www.lrz.de/~schmolck/qmethod/).

Table 18 Correlation matrix between sorts

SORTS		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	R-1	100	49	45	39	58	41	30	59	23	26	19	28	13	27	31	7	24	33	46	57	24	47	44
2	R-2	49	100	51	54	48	49	37	56	35	33	0	37	35	38	20	-4	33	38	45	43	36	67	55
3	R-3	45	51	100	87	53	66	55	56	37	35	-29	18	34	45	27	-29	52	53	64	40	50	68	50
4	R-4	39	54	87	100	53	78	63	56	45	44	-29	25	31	59	37	-20	56	66	62	45	48	70	57
5	R-5	58	48	53	53	100	52	62	60	37	38	0	13	27	50	33	1	60	57	47	44	55	56	64
6	R-6	41	49	66	78	52	100	71	56	63	64	-22	13	45	64	36	-17	65	52	47	51	51	75	73
7	R-7	30	37	55	63	62	71	100	53	51	53	-19	14	36	54	34	-15	57	54	52	40	51	64	69
8	R-8	59	56	56	56	60	56	53	100	39	61	2	41	20	60	30	-8	44	55	37	63	45	57	57
9	R-9	23	35	37	45	37	63	51	39	100	47	-6	8	17	44	30	-10	59	42	44	30	36	47	53
10	R-10	26	33	35	44	38	64	53	61	47	100	15	38	32	57	40	4	55	39	20	42	43	48	51
11	R-11	19	0	-29	-29	0	-22	-19	2	-6	15	100	35	-15	-7	3	43	-23	-21	-19	-9	-22	-16	3
12	R-12	28	37	18	25	13	13	14	41	8	38	35	100	17	27	20	25	-6	13	20	26	6	20	19
13	R-13	13	35	34	31	27	45	36	20	17	32	-15	17	100	42	34	-7	29	20	33	34	34	40	32
14	R-14	27	38	45	59	50	64	54	60	44	57	-7	27	42	100	41	-4	52	60	27	39	31	46	54
15	R-15	31	20	27	37	33	36	34	30	30	40	3	20	34	41	100	14	38	40	14	37	28	30	33
16	R-16	7	-4	-29	-20	1	-17	-15	-8	-10	4	43	25	-7	-4	14	100	-17	-14	-13	-19	-19	-32	-3
17	R-17	24	33	52	56	60	65	57	44	59	55	-23	-6	29	52	38	-17	100	60	40	27	60	51	47
18	R-18	33	38	53	66	57	52	54	55	42	39	-21	13	20	60	40	-14	60	100	45	38	64	49	53
19	R-19	46	45	64	62	47	47	52	37	44	20	-19	20	33	27	14	-13	40	45	100	37	39	43	33
20	R-20	57	43	40	45	44	51	40	63	30	42	-9	26	34	39	37	-19	27	38	37	100	33	63	50
21	R-21	24	36	50	48	55	51	51	45	36	43	-22	6	34	31	28	-19	60	64	39	33	100	52	52
22	R-22	47	67	68	70	56	75	64	57	47	48	-16	20	40	46	30	-32	51	49	43	63	52	100	77
23	R-23	44	55	50	57	64	73	69	57	53	51	3	19	32	54	33	-3	47	53	33	50	52	77	100

As it can be seen, the levels of agreement are much more common between respondents, also in terms of the extent of agreement, which goes up to 0.87 (R-3/R-4). However, the significant levels of disagreement (with 99% of confidence interval) are not common, even some are close to, e.g. -0.32 (R-16/R-22), or -0.29 (R-3/R-11).

Factor Analysis

Factor analysis *is a method for classifying variables. In case of Q methodology it refers to classifying Q sorts (Brown, 1980, Webler et al., 2009). It determines how many different Q sorts are in evidence, thus showing how persons have classified themselves. If two persons have sorted the statements in the similar way and are likeminded on a topic, their Q sorts will be both end up on the same factor (Brown, 1993).*

Two factor analysis algorithms, which are used in PQMethod, are centroid and principal component analysis (PCA)[12]. Centroid analysis is based solely on the commonalty among Q sorts and ignores the specificity of individual sorts. PCA considers both commonalty and specificity; and is the most common type of factor analysis (Webler et al., 2009). However, it is shown that the centroid and PCA produce virtually the same results (Brown, 1980, Webler et al., 2009).

After examining both analyses, principal component analysis was chosen. However, both analyses were tried and have revealed similar parameters and showed a consistent distinction of one factor from the others. The variations between other factors are revealed by varimax and manual rotation of factors, where the distinction between other factors was searched.

Table 19 contains the initial set of unrotated factor loadings for each of the 23 Q sorts. The table was created by PQMethod, applying the principal component analysis that extracts eight principal factors.

The loadings express the extent to which each Q sort is associated with each factor. As previously, factor loadings in excess of +/- 0.37 can be considered significant. *This is one of the methods where factors can be extracted. Factors can be accepted if they have at least two significant loadings.* According to this rule, two loadings that are significant can be found in six factors (i.e. factor1-7). It is apparent that the first factor exhibits the significant loadings, which are all quite high (> 0.47). In terms of high loadings, second factor can also be emphasized. In all other factors, significant loadings that appear are of lower value, and are characteristic for the sorters that load on the few factors at the same time ('confounders') (Table 19). *In terms of factor extraction, it is best to minimize the number of 'confounders' people who load on multiple factors) and 'non-loaders' (people who do not load on any factor) (Webler et al., 2009).*

The most widely used method to determine the number of factors is to extract the factors that have eigenvalues in excess of 1.00. An eigenvalue is the sum of squared loadings for a factor (Brown, 1980). If this criterion is used, only first four factors would have been extracted. *The eigenvalue divided by the number of variables, express a percentage of total variability within the factor (Brown, 1980).* According to this, the first factor is accounted for 44% of total variability in the correlation matrix, second for 10%, third for 6% and fourth for 5% (Table 19).

The third method for the determination on the number of factors is the *Humphrey's rule*, which states that a *factor is significant if the cross-product of its two highest loadings (ignoring sign) exceeds twice the standard error (Brown, 1980),* i.e. 2(SE)=2x0.14=0.28. According to this rule, just two factors would have been extracted (Table 19).

The range based on statistical criteria appears to be from two to six factors. *For the purpose of rotation, which is the next step of analysis, it is better to use more factors (Brown, 1980).* After examining few options for the purpose of this research varimax rotation has been performed with two and four factors.

[12] The nature of the calculation of diagonal entry for correlation matrix is a matter that distinguishes various factor-analytic approaches (Brown, 1980).

Table 19 Unrotated factor matrix

		FACTORS							
SORTS		1	2	3	4	5	6	7	8
1	R-1	**0.5713**	0.3908	**-0.4301**	-0.2745	0.0021	0.2588	-0.0918	0.2151
2	R-2	**0.6609**	0.1947	-0.3551	0.0714	-0.0165	-0.1416	-0.1578	-0.1849
3	R-3	**0.7770**	-0.2235	-0.2922	0.0090	0.1974	-0.1299	0.1099	0.0237
4	R-4	**0.8358**	-0.1685	-0.1364	0.0458	0.1929	-0.1897	0.1848	0.1003
5	R-5	**0.7492**	0.0974	-0.0222	**-0.3869**	0.0693	0.2036	-0.1382	-0.1602
6	R-6	**0.8634**	-0.1144	0.1310	0.1346	-0.1291	-0.1494	-0.1182	0.1337
7	R-7	**0.7846**	-0.1204	0.1583	-0.0343	-0.0406	-0.1234	-0.1074	-0.0213
8	R-8	**0.7655**	0.2730	-0.1254	-0.0595	-0.1783	0.0905	0.3240	-0.0505
9	R-9	**0.6238**	-0.0693	0.2837	-0.1535	-0.1729	-0.3398	-0.1505	0.3634
10	R-10	**0.6617**	0.2864	**0.3986**	0.1826	-0.2158	-0.1102	0.1477	-0.0561
11	R-11	-0.1583	**0.7926**	0.0893	-0.1808	-0.1447	-0.1097	-0.1291	-0.0722
12	R-12	0.2915	**0.6586**	-0.1760	0.2847	0.1570	-0.2827	0.3021	-0.1461
13	R-13	**0.4726**	-0.0328	0.0679	**0.6121**	0.2885	0.1397	**-0.4069**	-0.1778
14	R-14	**0.7081**	0.1061	0.3072	0.1935	0.0422	-0.0166	0.2472	0.0397
15	R-15	**0.4839**	0.2242	0.3515	0.1433	0.3099	**0.4224**	0.0056	0.3366
16	R-16	-0.1722	**0.6583**	0.2667	-0.2007	**0.3862**	-0.0938	-0.2129	0.0024
17	R-17	**0.7192**	-0.2590	**0.3717**	-0.2145	0.0337	-0.0044	-0.0178	-0.0037
18	R-18	**0.7298**	-0.1392	0.1384	-0.2394	0.1981	0.1418	0.3230	-0.1214
19	R-19	**0.6233**	-0.1428	-0.3591	-0.1462	**0.3843**	-0.2680	-0.1312	0.1569
20	R-20	**0.6480**	0.1617	-0.2811	0.2004	-0.2377	**0.3911**	0.0287	0.2082
21	R-21	**0.6661**	-0.2218	0.1366	-0.1725	0.0742	0.1658	-0.0181	**-0.4697**
22	R-22	**0.8327**	-0.0803	-0.2010	0.1326	-0.2753	0.0035	-0.1555	-0.0529
23	R-23	**0.7929**	0.1172	0.0779	-0.0777	-0.2765	-0.0200	-0.2444	-0.1165
Eigenvalues		**10.1236**	**2.2276**	**1.4759**	**1.1170**	0.9859	0.9264	0.8604	0.7656
expl.Var.%		44	10	6	5	4	4	4	3

Factor rotation

The rotation of factors is usually incorporated into the technical phase of Q methodology (same as correlation and factor analysis). This is in particular case with the varimax rotation, which is a statistical routine of rotating original factors to a mathematically precise solution (Brown, 1980, Van Exel and de Graaf, 2005, Webler et al., 2009). This kind of rotation is also called atheoretical rotation, as it seeks a rational solution acceptable by statistical criteria (Brown, 1980). From theoretical point of view, judgmental rotation is perceived as very important as it enables the investigator to follow theoretical inclinations and hunches, and take advantage of the impressions and any other bits of information at his disposal (Brown, 1980). It is also useful for testing particular hypotheses about how certain individual's perspectives relate (Webler et al., 2009).

Eigenvalues and total variance are dependent too the great extent on the number of persons included in the study. Therefore, communality (h^2) becomes very important. It represents the sum of squares of the factor loadings by the row, and therefore is the measure of the extent to which a person's response has something in common with the other subjects. Rotation reshuffles the amount of communality associated with various factors (Brown, 1980).

With judgmental rotation, relationship of the observer to observed is not passive one, like in the inductive or deductive research. It is abductive, as it begins with effects and pursues potential causes (plausibilities). The concern primarily is with discovery (Brown, 1980). Theoretical rotation (e.g. judgmental rotation) is an important procedure, which is frequently downplayed by varimax and other automatic routines (Brown, 1980). However, none of the rotation types (atheoretical or theoretical) is "correct" in some

supernatural sense, and it should varies according to one`s aims and to search for real representation of situation that is in question (Brown, 1980).

As it was previously mentioned, in the framework of this study varimax rotation was performed with two (based on Humphrey's rule) and later on with the four factors (based on the rule of significance of eigenvalues).

The first varimax rotation was run to produce two factors, where the clear distinction between two factors can be seen (Table 20).

Table 20 Factor matrix with an X indicating a defining sort (two factors)

		LOADINGS	
QSORT		1	2
1	R-1	**0.5455 X**	0.4261
2	R-2	**0.6473 X**	0.2361
3	R-3	**0.7896 X**	-0.1740
4	R-4	**0.8448 X**	-0.1153
5	R-5	**0.7416 X**	0.1446
6	R-6	**0.8689 X**	-0.0596
7	R-7	**0.7906 X**	-0.0706
8	R-8	**0.7467 X**	0.3208
9	R-9	**0.6270 X**	-0.0297
10	R-10	**0.6423 X**	0.3276
11	R-11	-0.2080	**0.7810 X**
12	R-12	0.2493	**0.6757 X**
13	R-13	**0.4737 X**	-0.0028
14	R-14	**0.7000 X**	0.1507
15	R-15	**0.4688 X**	0.2543
16	R-16	-0.2135	**0.6461 X**
17	R-17	**0.7342 X**	-0.2130
18	R-18	**0.7372 X**	-0.0928
19	R-19	**0.6310 X**	-0.1031
20	R-20	**0.6365 X**	0.2023
21	R-21	**0.6788 X**	-0.1792
22	R-22	**0.8361 X**	-0.0275
23	R-23	**0.7839 X**	0.1671
expl.Var. %		44	10

The first factor (factor 1) explains 44% of total variability and is characterized with high loadings by 20 respondents. The second factor (factor 2) explains 10 % of total variability with high loadings of 3 respondents (Table 20). This rotation considers 54% of the existing variances between discourses in the given analysis. This would lead to an assumption that some of discourses are missed, at least 11% that can be found in factor 3 and 4 of the unrotated factors (Table 19), which are based on significant eigenvalue (>1.00).

The second varimax rotation was performed with the four factors. The corresponding loadings together with the automatic flagging are shown in Figure 23.

Four-factor rotation showed a clear distinction between three factors, which have more than one significant loading that are automatically flagged by PQMethod. High loading (0.72) on the fourth factor demonstrated just one respondent (R-13). For the better understanding of the fourth factor, sorting number 13 is more detailed examined. Based on the statements that were chosen as most agree and most disagree, it was not possible to find distinct difference of this sorting to the others, and many similarities were found with the factor 1. Additionally, as all of the respondents were of same importance regarding the analyzed issue and none had higher power or influence in the field, extraction of single sort as factor was not possible to be done. Therefore, factor four was subject of the rotation, which is explained later on.

Based on the loadings showed in the rotated factor matrix (Figure 27), attention was also placed on respondent 12, that has significant loading on the three last factors (0.46, 0.44, 0.46). In the two-factor varimax rotation (Table 20), respondent 12 belongs to the factor 2, which indicates the opposite to the majority of the respondents. Detail examination of the sorting number 12 and results of the interviews were the reasons for performing the first manual rotation.

In Figures 27 and 28, it can be seen that respondent 12 is significantly associated with factor 2 (in the amount of 0.46), and in the approximately same amount with the factor 3. The first rotation was made to reposition the respondent 12 more closely to the factor 2, as the connection with respondent 11 and 16 was perceived as significant. This is accomplished by rotating the factors 20° counter clockwise (Figure 29).

		1		2		3		4	
1	R-1	0.19		0.26		0.80	X	-0.05	
2	R-2	0.20		-0.00		0.70	X	0.26	
3	R-3	0.42		-0.37		0.63	X	0.17	
4	R-4	0.52		-0.29		0.56		0.27	
5	R-5	0.65	X	0.10		0.54		-0.05	
6	R-6	0.65	X	-0.20		0.38		0.43	
7	R-7	0.68	X	-0,15		0.33		0.26	
8	R-8	0.44		0.15		0.63	X	0.25	
9	R-9	0.67	X	-0.02		0.16		0.14	
10	R-10	0.57		0.25		0.15		0.55	
11	R-11	-0.13		0.82	X	0.05		-0.02	
12	R-12	-0.12		0.46		0.44		0.46	
13	R-13	0.14		-0.22		0.16		0.72	X
14	R-14	0.58	X	0.05		0.20		0.52	
15	R-15	0.44		0.21		0.07		0.43	
16	R-16	-0.01		0.75	X	-0.12		-0.03	
17	R-17	0.85	X	-0.17		0.12		0.10	
18	R-18	0.71	X	-0.11		0.33		0.05	
19	R-19	0.32		-0.26		0.63	X	-0.02	
20	R-20	0.19		-0.04		0.62	X	0.38	
21	R-21	0.65	X	-0.20		0.27		0.07	
22	R-22	0.43		-0.25		0.62	X	0.35	
23	R-23	0.61	X	0.06		0.46		0.26	

Options:

F1: Help

F2: Get factor matrix from a PQMethod study

F3: Choose cases to highlight

F4: Choose two factors and rotate them

F5: Invert a factor

F6: Perform automatic pre-flagging

F7: Manually flag factors

F8: Save factor matrix in a PQMethod file

Figure 27 Rotated factor matrix - varimax rotation of four factors, with automatic flagging

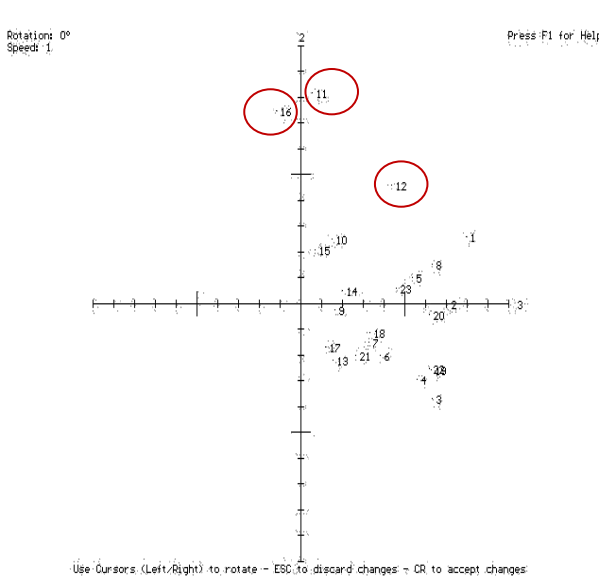

Figure 28 Unrotated position of factor 2 to factor 3

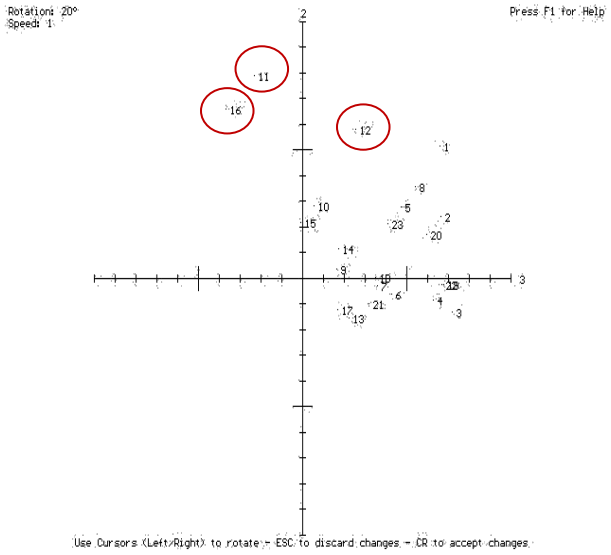

Figure 29 Position of factor 2 to factor 3 after the rotation

The rotation produces the result shown in the Figure 29. The consequence of this rotation was that respondent 12 become loaded on factor 2 with the amount of 0.58, which was also marked by automatic flagging.

As a consequence of this rotation, loadings of other respondents to the certain factor has changed (e.g. R-4 becomes loaded 0.62 on factor 3 (from 0.54)). However, the significant loadings (in excess of +/- 0.37) that were marked by automatic flagging have not changed significantly.

The second rotation was done between factors 1 and 4, where the rotation was primarily done in order to reshuffle initial loading of respondent 13 on factor 4

(which was in amount of 0.72) (Figure 26). As explained before, high similarity of respondent 13 to factor 1 was revealed based on the interview and two-factor rotation results.

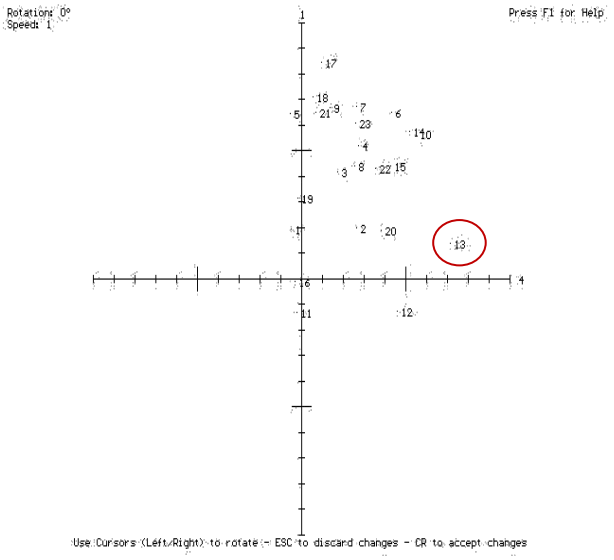

Figure 30 Unrotated position of factor 1to factor 4

The rotation was done by rotating the factors 35° counter clockwise (Figure 27), which as result had loading of respondent 13 to the factor 1 in amount 0.52, and on factor 4 in amount of 0.22. As a result of this rotation factor 4 was excluded from further analysis and interpretation.

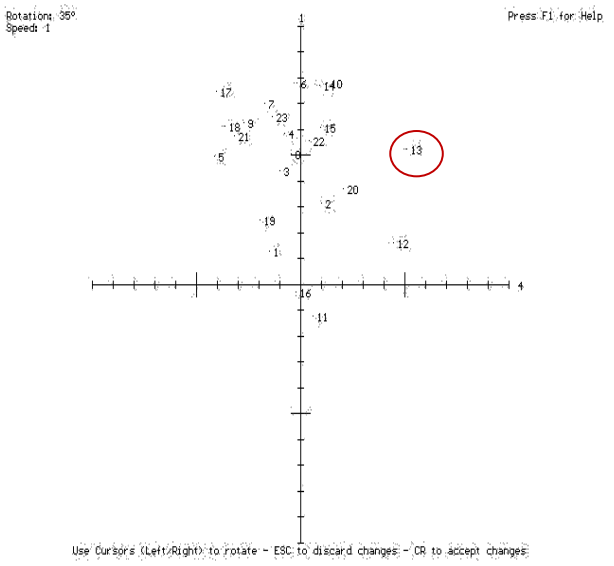

Figure 31 Position of factor 1 to factor 4 after the rotation

Further rotations were not performed, as they would influence the analysis. By testing this and other possibilities with the PQMethod (e.g. by applying centroid analysis, extraction of different number of factors), it was concluded that three factors adequately and realistically represent discourses that exist around the issue of climate change adaptation in urban forests in Belgrade. The final result of the original factoring and all of the subsequent rotations described above are in the Table 21, which present rotated factors with automatic flagging done by PGMethod.

Manual flagging as an option within PQMethod allow that certain loadings are marked as important for the further step of analysis (factor interpretation), which is based on a weighted average of only those sorts that are flagged (Webler et al., 2009). In this analysis, additional manual flagging was not done, since the exemption or adding of certain sorts for interpretation of the results did not show significant difference for the final factor interpretation (Table 21).

Table 21 Factor matrix with an X indicating a defining sort (three factors)

		LOADINGS		
QSORT		**1**	**2**	**3**
1	R-1	0.1317	0.5155	**0.6585X**
2	R-2	0.3146	0.2407	**0.6626X**
3	R-3	0.4403	-0.1305	**0.7201X**
4	R-4	0.5846	-0.0845	**0.6269X**
5	R-5	0.4990	0.2782	0.4709
6	R-6	**0.7804X**	-0.0587	0.4254
7	R-7	**0.7040X**	-0.0265	0.3603
8	R-8	0.5071	0.3589	0.5402
9	R-9	**0.6297X**	0.0366	0.1621
10	R-10	**0.7821X**	0.2855	0.0562
11	R-11	-0.1212	**0.7892X**	-0.2303
12	R-12	0.1617	**0.5836X**	0.2530
13	R-13	0.5239	-0.1523	0.2214
14	R-14	**0.7700X**	0.1167	0.1718
15	R-15	**0.6092X**	0.2192	-0.0078
16	R-16	-0.0274	**0.6621X**	-0.3671
17	R-17	**0.7494X**	-0.1193	0.1678
18	R-18	**0.6117X**	0.0069	0.3491
19	R-19	0.2498	-0.0254	**0.6766X**
20	R-20	0.3731	0.1711	**0.5961X**
21	R-21	**0.5750X**	-0.0971	0.3175
22	R-22	0.5578	-0.0234	**0.6667X**
23	R-23	**0.6495X**	0.2146	0.4096
expl.Var. %		29	10	20

The three final factors explain 59% of total variability, which is 5% higher than in the two-factor rotation case. It can be seen that factor 2 explains the same variability as before (10%), while the rest of variability is shared by factor 1 and 3 (Table 21).

Factor interpretation

The interpretation of factors in Q methodology proceeds mainly in terms of factor scores. A factor score is "the score for a statement as a kind of average of the scores given that statement by all of the Q sorts associated with the factor" (Brown, 1993; p. 117). The purpose of the factor scores is to give a closer examination of how the conceptions look like.

The estimation of a factor is achieved by merging together Q sorts that are associated with it. The result of this merging is one Q sort, with factor scores for the statements ranging as response categories (e.g. from +4 to -4), which represent the factor (Brown, 1980).

Prior to merging the separate Q sorts, the factor weight is assigned to each sort as a reflection of the fact that some Q sorts are closer approximations to a factor than others are. Factor weights are calculated based on the Spearman`s expression $w=f/1-f^2$, where f is the factor loading and w is the weight. The weighted scores for each statement are summed and reported in the total column. Since each factor contain differing numbers of subjects producing statements totals of differing magnitudes, it is necessary to normalize the total column, by converting each item total to the z score. The resulting z score make possible direct comparisons with scores for the same statements in each of the factors (Brown, 1980).

For the practical matters of most use are the rounded factor scores. They are produced based on either the total or z scores, i.e. where it is possible to select three items with the highest scores and assign them the value of +4, the four next-highest items the value of +3. These rounded scores contain small amount of error due to the arbitrary grouping involved, but they are usually reported, since they conform to the format in which the data were originally collected (Brown, 1980).

The table with all rounded factor scores and z scores for each statement of this research are presented in the Table 23. For the examination of each factor statements are grouped based on the rounded factor scores. They are classified in three groups. In the first group are the statements with which respondents agreed in the amount of +4, +3, +2; in the second are neutral statements and statements with low amount of (dis)agreement, and in the third are the statements with which respondents disagreed in the amount of -4, -3, -2 (Table 22).

Table 22 Statements grouped by factor and value of rounded factor scores

	+4	+3	+2	+1	0	-1	-2	-3	-4
Factor 1	1 22 24	2 6 12 33	4 20 23 42 44 46	3 5 11 16 28 31 40	10 19 21 26 29 30 38 43	7 14 25 32 39 41 45	13 15 17 18 34 35	27 36 37 48	8 9 47
Factor 2	3 15 32	9 25 41	6 11 23 26 28 35 45	1 18 19 22 42 44 46	4 13 27 34 37 38 40 47	5 12 17 24 31 36 39	2 8 10 16 29 30	14 21 33 48	7 20 43
Factor 3	3 22 23	12 42 44 45	1 6 10 16 20 28	4 5 7 11 25 31 40	2 14 24 29 30 38 43 48	17 21 33 39 41 46 47	13 18 26 35 36 37	8 15 32 34	9 19 27

Table 23 Rounded factor scores and z-scores for each statement

No.	Statement	Factor 1		Factor 2		Factor 3	
		Rounded factor scores	Z-SCORES	Rounded factor scores	Z-SCORES	Rounded factor scores	Z-SCORES
1	Introducing monitoring system and modelling tools for mng	4	1.45	1	0.28	2	0. 87
2	The establish and develop of dialogue between various ac	3	1.11	-2	-0.95	0	0.33
3	Scientific knowledge about adapt of UF to CC	1	0.70	4	1.66	4	1.62
4	Public institutional money is needed to deal with the	2	0.98	0	0.12	1	0.68
5	The protection of biodivers forest habitats will depend on	1	0.56	-1	-0.42	1	0.62
6	ACC is important to preserve the UF for the future gen	3	1.26	2	0.83	2	0.93
7	Mng UF should adapt on freq severe weather events	-1	-0.56	-4	-1.82	1	0.61
8	Public awaren about CC is high no need for more edu pr	-4	-1.91	-2	-0.70	-3	-1.42
9	CCA act in UF are too costly it not makes sense to inv	-4	-1.86	3	1.33	-4	-.91
10	Selection of climate-resilient species in mng of UF is	0	0.28	-2	-0.71	2	0.71
11	Popularizat of CC topic through greater involv of expe	1	0.64	2	0.96	1	0.65
12	Consid of ACC in urb planning will help the process of	3	1.36	-1	-0.33	3	1.25
13	Lack of interest of UF act toward CC will not influenc	-2	-0.98	0	0.04	-2	-1.10
14	In ord to make for resilient to CC plant as many diff	-1	-0.47	-3	-1.73	0	0.06
15	CCA act are not need bec UF will nat adj to fut clim v	-2	-0.91	4	1.53	-3	-1.36
16	Edu of employees in UF towards CC is needed for adapt	1	0.52	-2	-0.62	2	0.78
17	Employees in for are informed about CC only thr infor	-2	-0.79	-1	-0.50	-1	-0.27
18	Act orien on reduc impact of CC are expens for comp	-2	-0.74	1	0.79	-2	-1.14
19	In ACC the enterpr that mng UF should take the main de	0	-0.16	1	0.29	-4	-1.59
20	Strong polit leadersh would be of importa in initiat C	2	0.82	-4	-1.86	2	1.09
21	Loc auth should play cruci role in dev CCA strat in va	0	0.00	-3	-1.20	-1	-0.61
22	More funds from nat budg should be secur for research	4	1.65	1	0.67	4	1.32
23	Comp and enterpr need to consider CC in all activities	2	1.11	2	1.16	4	1.40
24	We need improved legislation that addresses CCA in urb	4	1.60	-1	-0.38	0	0.23
25	There are many oth compet problems in city, should be	-1	-0.67	3	1.45	1	0.47
26	Natural forests are best suited to adapt for climate c	0	0.40	2	1.00	-2	-1.07
27	It is alr too late to do anyth any act will take a lng	-3	-1.33	0	0.13	-4	-2.04
28	Everybody has to contribute in talking CC thr individ	1	0.42	2	1.16	2	0.92
29	Water supply will be endangered if nothing is done CCA	0	0.31	-2	-0.95	0	0.43
30	Failure to address CC is the fault of political leader	0	-0.01	-2	-1.00	0	0.09
31	As effect of CC more trees are drying now in UF	1	0.49	-1	-0.54	1	0.55
32	Clim var is normal, so we cannot say that there is glo	-1	-0.73	4	1.73	-3	-1.49
33	In future invasive sp will become a big problem with C	3	1.39	-3	-1.59	-1	-0.11
34	CCA of UF to cannot be consid separ from sust develop	-2	-1.07	0	0.04	-3	-1.35

35	There is not enough info to definitely say that CC exi	-2	-0.94	2	1.03	-2	-0.77
36	CCA in UF will not help in regulation of city microcli	-3	-1.61	-1	-0.58	-2	-1.22
37	Urb adapt are not impo part of nat internat poli agend	-3	-1.16	0	-0.28	-2	-1.22
38	Only when neg eff of CC become evident, act will be ta	0	-0.01	0	-0.33	0	0.29
39	Non-native sp in UF are not neg influenced as conseq	-1	-0.54	-1	-0.37	-1	-0.62
40	Media bring reports about CC only insufficiently	1	0.47	0	0.04	1	0.60
41	UF mng has other priorities than CCA at the moment	-1	-0.70	3	1.28	-1	-0.51
42	When sch univ incl CC in curr, y gen will know what to	2	1.06	1	0.29	3	1.14
43	CCA in UF is urg issue that ask for immediate change o	0	0.04	-4	-1.82	0	0.24
44	CCA policy for UF should be top-down mandated	2	0.74	1	0.45	3	1.30
45	CCA in UF will not contr minim CC eff if oth sect in c	-1	-0.19	2	1.16	3	1.14
46	The cost and effects of CCA in UF need to be calculate	2	1.00	1	0.21	-1	-0.44
47	The org resp for CC and enterpr involv in UF have	-4	-1.89	0	0.12	-1	-0.40
48	Enfor and imp of int agree on CC is more import at glo	-3	-1.12	-3	-1.08	0	0.32

Factor descriptions

Three factors that are extracted represent idealized perspectives in relation to climate change and climate change adaptation in UPF of Belgrade. Each factor is labelled with a descriptive form[13]. Second factor, which is by its characteristic on the opposite side of the first and the third factor, is labelled with a term – **'Skepticism'**. It basically reveals the perspective which does not recognize the climate change as a challenge. The other two factors are characterized by apprehension towards climate change and climate change adaptation. Based on the interviews that were conducted after the sorting process, it can be noted that in both factors a good understanding related to the issue of climate change exists. However, the level of concern is not high, because the overall opinion is that Serbia still does not face sever changes and that there is still time left to react on such challenges. The first and the third factor have certain similarities but differ since they are labelled with the term **'Apprehension – management imperative'** versus '**Apprehension – general issues'**.

'Skepticism' (factor 2)

This factor represents an example of skepticism towards the issue of climate change in general. It defines the opinion that climate variations are normal, thus it is not possible to talk about global climate change (32)[14]. It is said that "climate was always changing, and today's changes are just one of those cycles which society and nature need to adapt". Therefore, they perceive that climate change adaptation actions in urban forests are not needed because forests will naturally adjust to future climate variability (15). Such a stand is further strengthened by an opinion that there is not enough information to definitely say that climate change exists (35). Thus the education of employees in forestry (16) or an improved dialogue between various organizations around this issue (2) is not necessary. Consequently this is associated with the view that more scientific knowledge about adaptation of urban forests to climate change (3) and more expert involvement (11) would be needed in order that their perspective is changed.

Factor 2 is strongly associated with the belief that there are many other competent problems in city of Belgrade, which should be solved and are more important than climate change adaptation (25). They perceive that it does not make sense to invest in climate change adaptation actions in urban forests because they are too costly (9). Urban forest management has other priorities than climate change adaptation at the moment (41). This perception is confirmed by strong disagreement with the statements that 'climate change adaptation in urban forests is urgent issue that asks for immediate change of management with forests' (43) or that 'management of urban forests should adapt on more frequent severe weather events that are consequence of climate change' (7).

If the disagreeing statements are examined than it is evident that *factor 2* is strongly reluctant towards the issue of stronger political leadership which could be of importance in initiating climate change adaptation actions (20). They have the opinion that "as soon as the issue becomes more apparent and present on higher political level, it becomes blurred". In that sense they characterized themselves as "apolitical". *Factor 2* disagree with the statement that it is failure of political leaders why climate change is not enough addressed (30), both because they have opinion that issue of climate change should not be issue of decisions and because they do not believe in the necessity of prominent role of political leaders in this issue. However, they hold and opinion that state should regulate this issue if it is proved and if it is necessary in future. And they are disagreeing with the possibility that 'local authorities should play a crucial role in developing climate change adaptation strategies in various sectors' (21).

Position of *factor 2* is not so rigid that the possibility of climate change is denied. They need more proves in order that their skepticism is reduced. This is confirmed during the interviews after the sorting process, because they reveal the concern towards the issue of climate change in other regions of the world, where "the evidences of changes are apparent". Still

[13] These labels are not a substitute for more detail understanding of the each factor's content, but are useful in describing the factors.

[14] Some of descriptions are based on the concrete statements, which are then indicated by its number in the brackets.

they holds and opinion that Serbia and Belgrade are not facing any challenge in this sense, especially when looking on forest resources. They perceive Belgrade's forest resources as enough adaptable to climate change by their nature. Therefore they disagree with the statement that 'selection of climate-resilient species in management of urban forests is needed action for adaptation of urban forests to climate change' (10). Or, that planting as many different species as possible can make forests resilient to climate change (14) and that 'in future invasive species will become a big problem with climate change' (33). All of this can be confirmed by the agreement with the statement that 'natural forests are best suited to adapt for climate change' (26).

The lack of evidence revealed very strong uncertainty of *Factor 2* towards the importance of climate change issue on national and local level. However, during the interviews they stated "if their perspective would become proved wrong, then they would favour collective and individual responses to climate change" (23, 26), but as for now it stays just hypothetical perception.

'Apprehension – management imperative' (factor 1)

Factor 1 is characterized by strong apprehension towards the issue of climate change and climate change adaptation, especially in terms of UPF aspects and concrete needs for the improvement of management. The overall perception of the *factor 1* is that climate change is reality, which is confirmed with disagreement that there is no enough information to say that climate change exist (35) or that climate change actions are not necessary in UPF management (15).

The strongest agreements of *factor 1* are revealing the most important aspects that need to be enforced in future in order to adequately tackle the climate change adaptations in UPF of Belgrade, and more specifically in forest management. They stated that the most important is to introduce monitoring system and modelling tools for forest management (1), to improve legislation that addresses climate change adaptation in urban area (24) and to secure more funds from national budgets for doing research on climate change adaptations (22). This is elaborated further on in interviews[15] after the sorting process. The respondents said that "if they have stronger base in legislation and concrete regulations, then the application of concrete measures in management would be done". Also, they stated that "the lack of findings and research, as well the lack of monitoring data over the years, that are relevant for Serbia are slowing down the process and putting away the implementation of concrete actions". It is also emphasized that collaboration between various actors and professions can help in adaptation to climate change, especially through the urban planning sector (12).

If the agreement statements are examined more in depth then the strong focus of *factor 1* is put on the establishment and development of dialogue between various actors about climate change adaptation (2). This statement is in line with disagreement, which state that 'the organizations responsible for issue of climate change and other enterprises involved in urban forestry have good communication about the issue' (47). The need for better communication, stronger leadership from competent state bodies (44, 20) and stronger involvement of experts (11) is revealed through *factor 1*.

Factor 1 revealed also a high awareness of this comprehensive issue by highlighting the statements that ask for involvement of various actors, from schools (42) and individuals (28) to various companies and enterprises (23). This was confirmed because adaptation of the urban forests to climate change is seen as important in order to preserve the forests for the future generations (6).

Some specific problems in relation to management of urban forests and climate change have been stressed by respondent in *factor 1*, e.g. problems with invasive species (33) and more frequent drying of the tress (31).

Public awareness towards climate change is seen as low (8) and issue which need to be strengthen in future, in order to gat "stronger support from society for initiating needed actions".

Even though the respondents assumed that the costs for adaptation actions are high and that they need to

[15] Those aspects are also emphasized during the in-depth interviews with the managers of UPFs of Belgrade.

be carefully calculated in advance (46), they stated that "this should not be a reason not to take actions" (9) and that "they should be initiated as soon as possible" (27).

In addition to this, strong importance is put on the importance of local adaptations compared to global, by disagreeing with statements that 'urban scale and local adaptations are not an important part of national and international policy agendas to climate change' (37) and 'enforcement and implementation of international agreements on climate change is more important at the global level, rather than separately at the national or local level' (48).

'Apprehension – general issues' (factor 3)

Factor 3 is characterized by strong awareness for climate change and related needs. This is illustrated by a disagreement that there is no enough information to say that climate change exists (35), that climate variations are normal (32), or that public awareness is already high in this respect (8).

The aspects specially targeted to urban forests are also valued as important, but less in comparison to the statements that highlights the general issues. This can be described by agreement with the statement that 'adaptation to climate change in urban forest will not contribute minimizing climate change effects if other sectors in city (e.g. transport, energetic) are not adapted as well' (45).

Need for more scientific knowledge (3) and for more funds from national budgets for conducting researches (22) are seen as the most important currently in Serbia regarding the issue of adaptation of urban forests to climate change, and "in general regarding the issue of climate change in various sectors".

Higher corporate responsibility of all enterprises and companies towards climate change (23) is seen as very valuable, where is said that "it would be good example to all employees and citizens in general to act differently". Furthermore, the strong focus by *factor 3* is put on the need to integrate climate change adaptation through urban planning sector (12, 34), through education (42) and active involvement of state bodies (44, 20).

In *factor 3*, the government perspective is strongly emphasized, which is confirmed by highest disagreement with statement that 'in adaptation of urban forests to climate change the enterprises/agencies that manage the forests should take the main decisions' (19). The communication flow between organizations responsible for issue of climate change and other enterprises involved in urban forestry (47) is seen as better than it was perceived by *factor 1*. Furthermore, the need for improvement of legislation is seen as not important and adequate at the moment (24).

Factor 3 strongly disagree that 'it is already too late to do anything, as any action to adapt urban forests to climate changes will take a long time to take effect' (27) and that 'climate change adaptation actions in urban forests are too costly; it not makes sense to invest in it' (9). They said that "no matter that actions are not taken so far, this cannot be reason to not perform them in the future", as well that "such pessimistic perspectives does not make sense when it comes to such important issues".

From management aspects, which were marked with lower values of agreement and disagreement by *factor 3*, the need for monitoring and modelling tools (1), and for selection of climate-resilient species (10) are seen as important, while the capacity of natural forests to adapt to climate change is seen as low (26). The need for education of employees in forestry regarding the climate change is seen as essential for future actions (16), as well as raising awareness of citizens towards this issue (8).

6 Discussion

Results obtained from different methods, comments from expert interviews and relevant findings of the literature are used for discussion. They are structured by answering five research questions. Triangulation of the data is used as a procedure of assuring the validity of research results through the use of a variety of research methods and approaches. Weaknesses and biases are controlled by using not only one method (Guion, 2002).

Current trend of climate parameters in Serbia and Belgrade

Assessing the current trend of climate parameters over the last 50 years (1961-2010) at the territory of Serbia and Belgrade was a starting base for the research on climate change adaptation in UPF of Belgrade. DAYMET model for interpolation of climate data was utilized over the whole territory of Serbia, as this gives broader picture for current climate change trend and better understanding of Belgrade as single case.

The findings of DAYMET model showed significant increase of average annual air temperatures and slightly decrease in average annual precipitation over the territory of Serbia. The mean trend of temperature (1961-2010) increase is 0.030 (°C/y), with the highest trends in the areas with higher elevation in south and south-west part of the country (0.062 °C/y). The mean trend of precipitation decrease is – 0.397 (mm/y), with the strongest negative trend at high elevations of *Stara Planina* Mountains, in the south-east part of the country (-19.8 mm/y).

Such results are corresponding to the findings that mean annual temperature across the land in Europe in last hundred years generally increased by 1.4 °C (SEE/CCFAP-A, 2008), with the highest increase of 4-5 °C in northern Europe and Mediterranean region (IPCC, 2007c). Serbia is one of the countries that are located in the hinterland of the Mediterranean region that are considered to be severely affected with global climate change (Nikolić, 2010). The trend of precipitation trend for Europe varies widely between the regions, where drying was observed in Mediterranean area and southern Europe (SEE/CCFAP-A, 2008). According to DAYMET results, Serbia still did not experienced higher decrease in precipitation patterns, except particular locations that can give and insight in possible future trends.

Regarding the trends that are observed in the territory of Belgrade, the mean annual air temperatures showed positive trend of 0.033 °C/y, which compared with the trends from single stations on the territory of Belgrade is a slightly lower value (0.034 °C/y). Annual precipitation also showed increasing trend, with the mean value of 0.944 mm/y. Pötzelsberger *et al.* (2012) utilized the same model over the territory of Austria for period 1960-2009, and the results for the city of Vienna showed a mean annual air temperatures increase of 0.041°C/y and decrease of annual precipitation trend for -0.4 mm/y.

Results for Serbia and Belgrade illustrate a clear trend of the change of climate parameters for the last 50 years. This is comparable with results of other studies that were done for the territory of Serbia (SEE/CCFAP-A, 2008; INC, 2010; Nikolić, 2010). Therefore it can be said that climate change poses a challenge for the territory of Serbia.

If the results of climate change scenarios are taken into consideration this becomes even more urgent problem, which asks for timely and responsible actions. Assessment of climate change for the territory of Serbia obtained by a regional climate model, predicts an increase in annual air temperature for 0.8-1.1 °C according to A1B scenario, while an increase for the period 2071-2100 is from 3.4-3.8 °C in case of the A2 scenario. Precipitation showed minor increase of +5% in the first thirty years of the century in case of scenario A1B, while according to A2 scenario deficit in annual precipitation during the last thirty years of century is expected maximum -15%. The growth of atmospheric CO2 concentration after the 1750th is 31% (INC, 2010). South-eastern Europe is identified as a major natural disaster hotspot, exposed to floods, droughts, forest fires, wind storms, heat waves, earthquakes and landslides, according to the

Hotspot project of the World Bank[16]. Serbia suffered from floods in 1999, 2000, 2002, 2005 and 2006, and major droughts period were recorded in 1989-1991, 1993, 2000 and 2007 (INC, 2010, Stamatović, 2010).

Results of the DAYMET model, supported with the facts from other studies, clearly show that one of the main challenges with which Belgrade (and Serbia in general) is faced is how well it will adapt and respond to such increasingly complex risk parameters.

It should be stressed that many of these changes are not caused just by the change of weather parameters. The population growth, urbanization and technological development have had a certain influence on the overall change as well. Therefore, the local and national adaptation actions must be coordinated between various sectors and needs. The necessity to adapt is needed in all aspects: social, economic, political and environmental. This is identified as one of the critical tests to the global (Deere-BirkBeCk, 2009) and local governance (Satterthwaite, 2011b). Adaptations at local level ask for flexibility to respond in ways that meet particular needs, and apply solutions that are locally acceptable (Lim and Spanger-Siegfried, 2005). Developing a dialogue within local actors is essential in this process (Spittlehouse and Stewart, 2003).

The focus of this research was on adaptation to climate change in urban and peri-urban forests of Belgrade. In respect to the previously mentioned aspects of adaptation process, the aim of the research was to focus on the local aspects of adaptation process in terms of legislation and management plans of UPF resources and opinions and beliefs of urban forestry actors towards the issue of climate change adaptation in UPF. This will strengthen understanding of current state of adaptation process in forestry sector on local level and reveal adaptive capacity of local governance to adapt to the issue in the future.

Climate change policy framework in Serbia

Serbia is in its initial stages of the development of a national climate change regulatory framework. Serbia became a Party to the UNFCCC convention in 2001 and ratified Kyoto Protocol in 2008. The First Initial National Communication (INC) to UNFCCC is done in 2010 and it represents first state-of-the-art in field of climate change on national level. The National Strategy for Incorporation of the Republic of Serbia into Clean Development Mechanism under the Kyoto Protocol for Waste Management is the only national strategy that is directly connected to climate change. Currently, the priority need is development of a National Action Plan of Adaptation and furthermore adaptation of various sectoral policies.
For better understanding of local issues (i.e. Belgrade) it is necessary to review the state of the adaptation to climate change on national level. For this purpose, Serbia is compared with the two surrounding countries based on the criteria used at European Climate Adaptation Platform (CLIMATE-ADAPT, 2012)[17].

Table 24 shows that Serbia is in its initial stage of development of adaptation policies on national level. This has the direct influence on the development of this issue on local level, as Serbia is characterized by top-down policy-making.

Concerning the adaptation to climate change on local level, both Hungary and Romania have initiated certain actions. In Hungary and Romania, several cities have developed their own local climate change strategy[18]. Such actions were not initiated in Serbia, so far, mostly due the lack of relevant legislation.

In addition, it should be noted that both selected countries (Hungary and Romania) are part of the EU, which require and strongly support improvement of existing and development of new regulations for climate change in its member states. Up to now, the European Commission (EC) published a green paper

[16] http://www.worldbank.org/ieg/naturaldisasters/maps/

[17] CLIMATE-ADAPT, 2012 – available at: http://climate-adapt.eea.europa.eu/countries/hungary & http://climate-adapt.eea.europa.eu/countries/romania

[18] In Hungary, "The Hungarian Alliance of Climate- Friendly Cities" initiated by the Institute of Sociology of the Hungarian Academy of Sciences is a partnership of local governments and NGOs providing technical advice, tools, case studies and information to cities on climate change adaptation and mitigation. In Romania, the Romanian Municipalities Association initiated a consultative process through "The Romanian Municipalities Association Commitment for Climate Change Effects Prevention", which has so far been signed by 35 out of 109 municipalities. One aspect of this commitment is related to the assessment of climate change risk and implications for public services and local communities and their capacity to adapt to climate change (CLIMATE-ADAPT, 2012).

in 2007 ("*Adapting to climate change in Europe — options for EU action*") and a white paper in 2009 ("*Adapting to climate change: Towards a European framework for action*"). It is also expected that EU adaptation strategy is developed by 2013 (Ecologic Institute, 2011; EEA, 2012b).

Table 24 Climate change adaptation legal framework in Hungary, Romania and Serbia

	Hungary*1	Romania*	Serbia
National adaptation strategy	Adopted (as part of the NCCS)	Ongoing (National Climate Change Strategy - 2012-2020)	In plan
Action plans	Adopted, being developed: - Third National Environmental Action Programme - National Climate Change Programme 2009-2010 - National Climate Change Programme 2011-2012	To be developed	In plan
Impacts, vulnerability and adaptation assessments	completed, being developed: - VAHAVA - NAGIS	Adopted, completed: - National Guide on Climate Change Effects - Sectoral Plan for research and Development -"Agriculture, Food, Forestry and Rural Development" MAKIS - CLAVIER; CECILIA - Information system for agricultural management consulting in areas vulnerable to nitrate pollution	Not yet developed
Research programs	Currently being undertaken: - DMCSEE - ECCONET - CIRCLE-2 - COST ECHOES	Currently being undertaken, completed: - WATERCoRe - Sectoral Programme funded by Ministry of Agriculture and Rural Development - CCWaters - Climate Change and Impacts on Water Supply - The impact of climate change on tourism activities in Romania - FutMon; Env Europe Project; MENER; RODEDNRONET	Currently being undertaken: - "Studying climate change and its influence on environment: impacts, adaptation and mitigation". (financed by the Ministry of Science and coordinated by the Faculty of Forestry, Belgrade)
Climate services / Met Office	Established - Hungarian Meteorological Service	Established - National Meteorological Administration	Established -National hydrometeorological Services
Web portal	Online http://klima.kvvm.hu/	Not yet completed	Not yet completed
Monitoring, Indicators, Methodologies	Being developed: - NAGIS	Not yet defined	Not yet defined
National Communication on the UNFCCC	5th (Submitted in 2010)	5th (Submitted in 2010)	1st (Submitted in 2010)

* data obtained from European Climate Adaptation Platform (CLIMATE-ADAPT, 2012)

Integration of climate change adaptation issues in UPF policy documents

Content analysis of policy documents, which regulate UPF field in Belgrade, showed week integration of climate change aspects in general. The aspects of climate change mitigation are much more common in the documents compared to adaptation aspects.

From all analyzed documents Spatial Plan of the Republic of Serbia is most advanced in terms of integration of climate change aspects. The Spatial Plan is passed in the form of the law in 2010, and contain whole chapter where the specific aspects of climate change in relation with future development and various sectors (e.g. forestry, nature protection) in Serbia are described. In accordance to the spatial plan, lower level urban planning documents (e.g. Regional Spatial Plan for the Administrative Territory of the City of Belgrade and Master Plan of Belgrade) contain aspects of climate change. However, their adjustment is still needed, as they were mostly developed in the years before the newest spatial plan was passed.

The great emphasis of the importance of urban planning documents in UPF management and need for better collaboration with urban planning sector is expressed in both in-depth interviews and in Q methodology. *"Consideration of adaptation to climate change in urban planning will help the process of adaptation"* was strongly agreed statement by majority of interviewed actors. Furthermore, the most of the interviewed managers were aware of the content of Spatial Plan in regards to climate change. It is said that "just implementation of ordinances from Spatial Plan of RS in other legislations would be the right way to approach the issue of climate change". However, the frequent changes of the state government and renewal of legislation in short periods prevent adequate implementation of ordinances that were set so far. Such instable system in legislation passing is directly connected with limited reactions of lower levels of government and management.

Forestry related policy documents that were analysed were: Law on Forestry, Forest Development Strategy and Afforestation Strategy of Belgrade. All of those documents generally have been harmonised with various international regulations, between which are climate change related regulations. However, content analysis revealed that climate change issues are weakly integrated and mainly appear as general statements throughout the documents. It can be noted that a comprehensive and systematic approach to this challenge does not exist.

The Afforestation Strategy of Belgrade has been the most advance in this aspect, largely by integration of climate change mitigation aspects. It has aim to improve climate conditions in the city and contribute to mitigation, and in long-term to adaptation, to climate change (SPB, 2011). The Afforestation Strategy of Belgrade is developed in the year 2011, when the issue of climate change became prominent in policy arena, compared to the Forest Development Strategy that was developed in 2006, which just partly have introduced aspects of climate change mitigation. However, Forest Development Strategy largely contains aspects of sustainable forest management (SFM), which gives the opportunity for integration of climate change adaptation actions in future. Enforced implementation of SFM principles together with climate change adaptation (as well mitigation) is highly needed in today's forest practice (Seppälä *et al.*, 2009b).

Other documents that have been analyzed (National Sustainable Development Strategy, Development Strategy of the city of Belgrade, Tourism Development Strategy of Belgrade) recognize the climate change as future challenge and require development of serious approaches to this problem in the future. Most of the interviewed UPF actors hold an opinion that adaptations of UPF to climate change should be considered together with sustainable development of the city, which emphasize the importance of related documents and its content in work of UPF actors.

The conducted in-depth interviews revealed that one of the most common stated problems for management of UPF is the week legislation base. As common argument managers expressed that "passing of the laws and regulations usually have irregular order" and "competences over the resources (i.e. forests) are not adequately tackled in the regulations". Such aspects, combined with slow bureaucracy processes and multitude of actors and interest groups pose the great challenge to UPF management.

Integration of climate change adaptation issues in UPF management plans

In all four FMPs that were analyzed climate change mitigation and adaptation aspects were not directly covered. In none of those documents "climate change", "climate change mitigation" or "climate change adaptation" were not mentioned as such. The only implications regarding the climate change could be found in description of general aims of forest management, where it is stated that e.g. "forests have important role in improving climatic conditions" or "forests have positive impacts on the environment".
The parts which describe climate conditions in Belgrade are abundant with information of all climate parameters (e.g. annual average air temperatures, minimal or maximal annual temperatures/precipitation on the territory of Belgrade), but no treats or future expectation of climate change is mentioned. In this regards it can be noted that most of those plans in this respect are not updated to current challenges and data that can be found in most of the documents from National Hydrometeorological Service of Serbia (RHMZ). During the in-depth interviews it is said that data obtained for those parts are based on the data gained from RHMZ, however, they never asked for the data on the climate change aspects. This can be partly explained as pragmatic attitude of managers to introduce new issues in the management plans. Interviews reveal that old practices are still mostly applied in management and that strong reluctance exists towards adoption of new and improved practices. When it comes to the content of management plans (e.g. description of general aims of forests or climate conditions) it can be noted that exactly the same phrases and parts of the texts are used in different management plans.

The interviews with managers revealed that aspects of climate change are perceived through the main functions of forests and as sustainable and multifunctional practices of forest management, which are described in FMPs. However, they stressed that terminology in relation to climate change is very purely present in management plans. The implementation of SFM practices is seen as adequate in reviewed FMPs, and this is seen as potential for further improvement in the field of climate change. Implementation of SFM and introduction of adaptive management is seen as the right way for integration of climate change adaptation aspects in forests management from various scientists (Spittlehouse and Stewart, 2003; Adger *et al.*; 2007; FAO, 2010).

Management agencies did not organize any kind of workshops or educational programs so far that would raise awareness about climate change among employees. This could be an option how to bring this issue on agenda of UPF managers. It is important that the perception of climate risk of mangers is adjusted and improved (Adger *et al.*, 2007).

The lack of legislation is one of the most common stated constraints for the integration of climate change adaptation measures in UPF management plans. All managers stated that if they would have laws, regulations and strategies with recommendations and direction how to integrate climate change adaptation issues on forest management plans they would then be able to do that.

It is recognized that forest management measures and strategies to adapt to climate change can be supported by proper policy means. It is necessary that forest managers ensure flexibility so they are able to respond to specific local conditions of forest site and to consider the needs of local people in management. This becomes challenging for traditional policy and management of forests ('top-down') that exist in Serbia. It is focused on regulatory policy tools, which are incompatible to the flexibility demand posed by challenges of adaptation to climate change. All of this calls for different models of forest governance with involvement of multiple actors in decision making process. In addition to that, national forest policies are challenged by the international regime on forests (Corfee-Morlot *et al.*, 2011, Glück *et al.*, 2009). All these challenges are present in case of forest (and UPF) policy making and management in Serbia, which can be characterized as governance by government type (Kleinschmit *et al.*, 2009, Kjær, 2010).

In addition, it should be mentioned that Serbia is in the process of development of a National Forest Program (NFP), which is recognized as a core instrument of new forest governance and as comprehensive forest policy frameworks in pursuit of SFM at the county level. According to FAO guideline (2011), climate change issues should be

integrated in NFPs of each country at any stage of its development/phase. This helps to promote efficient and comprehensive forest-related responses to climate change issues, and make links to other land use sectors (FAO, 2011; Glück *et al.*, 2009). Therefore, it can be expected that the development of a Serbian NFP can support the integration of climate change issues in forestry, and then UPF, practice.

Opinions and beliefs of UPF actors toward CC adaptation in UPF of Belgrade

Results obtained by in-depth interviews and Q methodology offer some insights around deliberation and governing climate change, and specifically climate change adaptation in UPF of Belgrade. It also gives a better understanding of current state of the UPF management regarding these issues.

As already noted the majority of participants in Q methodology (*factor 1 and 3*) possess understanding of climate change issues. However, these two views are differing in type of the statements that were selected as the most important. One is focused on management issues and needs regarding the climate change adaptation, while other is more focused on climate change issues in general.

In this study 'skeptic' view towards climate change was revealed, even though it is defined by a small number of respondents (3). It mainly holds an opinion that anthropogenic climate change does not exist, that variations in climate patterns are normal and that there is a lack of data and evidences that would prove that change exists. This factor provided the evidence of what can be found in some sources as mainstream perception toward climate change – skepticism (Wolf, 2005; Hobson and Niemeyer, 2011). Relation between three experts that shape this factors cannot be made, therefore it cannot be said that this is an opinion held by one type of actors. Such perspective can be found in some newspaper texts and commercial material in Serbia, which were reviewed during the process of forming the concourse of statements. Explanations of such perspectives are usually clarified with the lack of knowledge and data concerning the impact of climate change in Serbia, but sometimes are going in the direction of theories of conspiracy. This perspective reveals very low level of awareness towards the issue of climate change, as well as a low level of communication regarding the issue and inadequate sharing of research results inside and between competent UPF organizations. Such low awareness of employees in forestry sector calls for coordinated and comprehensive educational programs.

In addition, it can be said that this 'skeptic' perception is not so rigid. This is revealed with agreement that more scientific evidence regarding climate change is needed, in order that their skepticism is reduced. This is confirmed during the interviews after the sorting process, because the respondents reveal the concern towards the issue of climate change in other regions of the world, where "the evidence of changes is apparent". Still, they hold the opinion that Serbia and Belgrade are not facing any challenge in this sense, especially when looking on forest resources. They perceive Belgrade's forest resources as enough adaptable to climate change by their nature (autonomous adaptation).

Furthermore, it was observed that high correlation exists between the viewpoint shaped in *factor 1* and data obtained by majority of interviewed managers in in-depth interviews. The Q-sorts confirmed that *factor 1* is mainly shaped by the views of managers, urban planners and university professors. It cannot be generalized that the perspectives of these experts always correlate; however in the case of this study it is shown that these experts are more aware of concrete aspects in UPF management compared to other experts.

Issues identified by this group of experts correspond to the most important needs for improved UPF management, which are: introduction of monitoring and modelling tools, obtaining more funds for research and improved legislation. All those aspects are confirmed by the in-depth interviews. The necessity for comprehensive monitoring practices was highlighted by all managers. They said: *"it would be of great help for adequate planning of forest operations"* and *"long-term planning for UPF"*. Better and more efficient legislation, need for more funds and researches are generally stated as essential, both for current planning and in regards to introduction of new measures (e.g. adaptation).

One of the main weaknesses regarding the issue of climate change, which was stressed in in-depth interviews, is the low level of communication between actors in urban forestry. Q methodology

revealed that the organizations responsible for issue of climate change and other enterprises involved in urban forestry does not have good communication about climate change issue and that establishment and development of dialogue between various actors is highly important for management of UPF in Belgrade. Main clarifications regarding this issue are that climate change is not set as important issue on management level, that possible existing data and findings are not adequately shared and used in management and that all communication that exists around the issue is matter of individual interest or personal communication between the employees. So far, none of the management agencies, local or national actors did not organized workshops or trainings for managers of UPF that would deal with climate change.

Regarding this aspect the main distinction was revealed between *factor 1* and *factor 3*. *Factor 3* reflects the opinion that level of communication regarding the climate change is not as bad as it was perceived by *factor 1*. In addition, the need for improved dialogue between various actors in UPF arena is not identified as important.

When *factor 3* sortings were examined in detail, it was identified that *factor 3* is mainly shaped by employees in national and regional level organizations. So far, in Serbia all activities regarding the climate change have been done on national level. The number of workshops, seminars and trainings were organized, which targeted broad aspects of climate change. However, interviewed managers stated that they were not invited to participate in none of those. When this was discussed more in detail with *factor 3* respondents, it was said that all the information from such events or projects are accessible by internet and in their opinion they are adequately communicated with all interested parties. This shows the difference and incoherence between national and local level actors in UPF. Activities in the field of climate change have been left to individual-level stakeholder interest, and coordinated activities and strategies have not been thought of so far. Communication between national and local level actors is performed only through legal documents and defined responsibilities in those. Neither of those organizations has initiated any kind of new communication types, which would improve management of UPF areas in Belgrade.

A competence over the climate change issue is differently perceived between interviewed experts. For most of the actors in national and regional organizations climate change adaptation policy for urban forests should be top-down mandated. Furthermore, they hold an opinion that enterprises/agencies that manage the forests should not take decisions regarding the issue, but they should just perform the actions. Respondents from management and university professors hold an opinion that national level organization (e.g. Ministry of Forestry) should lead the process of integration of climate change issues in UPF management. However, they expect that enterprises and agencies that manage the forests should have a certain role and be involved in that process as confirmed by the in-depth interviews as well. Such distinction of opinions emphasize the current state of policy making process in Serbia in forestry sector, where all decisions and actions are directed top-down from national-level organizations. This creates a great challenge for urban forestry governance, which needs coordination of various actors on different levels (Van Herzele *et al.*, 2005; Lawrence et al., 2011). Current state of urban forestry governance in Belgrade can be described as governance by government, where low level of communication exists between various actors in decision-making process and where all decisions are made from one governmental actor (cf. Kleinschmit *et al.*, 2009). Therefore, the participation of various stakeholders still needs to become more prominent.

Statements that are arguing for importance of education, public awareness and involvement of all individuals and various actors in tackling issues of climate change are selected by most of the managers as the important. It can be seen that representatives of national and regional agencies have favoured those 'general' statements compared to other respondents. Such 'general' view towards the climate change was revealed also through the strong agreement with the statements that adaptation to climate change in urban forest will not contribute minimizing climate change effects if other sectors in city (e.g. transport, energetic) are not adapted as well. Those actors are emphasizing the need for comprehensive actions in various sectors that need to be done on local level. They recognized that cities

face various challenges and will be in many ways affected by climate change (Ecologic Institute, 2011). What is common to all cities and must be underlined is that large overlap exists between most of the measures needed for adaptation and local development (Satterthwaite, 2011b).Therefore, integrated urban planning should be crucial to both adaptation and mitigation processes on city level (Corfee-Morlot *et al.*, 2011). This standpoint was revealed as very important for future management of UPF in Belgrade both through the interviews and by Q-methodology. It can be further connected to other challenges with which UPF management in Belgrade is faced, and which should be dealt with through overall sustainable development practices. Challenges such as economic crises, urbanization, land use conflicts, governance issues, lack of information and technical assistance, ownership issue, are judged as more important than climate change by managers of UPF in Belgrade. This perception is in line with the recent results of the survey conducted among various forestry stakeholders in the world (FAO, 2012).

On the local level, natural infrastructure (e.g. water, forests, parks, green corridors) are becoming increasingly valuable and important in regulating problems posed by climate change (Ecologic Institute, 2011). Such development can be observed in Belgrade in last years as well, and is confirmed through conducted interviews.

Over the last decades managers have noticed changes in UPF resources, mostly through increased droughts and lower levels of ground water that have negative influence on tree resources. Most of those changes managers are linking with the negative influence of climate change, but they do not have concrete evidences. This uncertainty around the issue of climate change, the lack of data, information, and knowledge are the main aspects of all conducted interviews.

It can be stressed that most of the actors in UPF system are accepting climate change and recognize its importance for more adapted management in the future in UPF. However, their actual response to this challenge is still low and their attitudes can be characterized as very pragmatic. These aspects need to be addressed and form one of the major challenges in CC adaptation process in UPF in Belgrade.

Provision of environmental goods and services from UPF in relation to climate change adaptation

Ecosystem services provided by UPF are various. In Belgrade, the main aims of UPF management are ecological and water protection (regulating services), recreation (cultural services), nature conservation (supporting services) and aesthetics (cultural services). However, economic aspects of forest management (provisioning services) are still an important part of it, mostly due to the poor economic situation and low budget sources allocated to forestry (Gudurić *et al.*, 2011).

In this study, the relation of ecosystem services and climate change adaptation was tackled through the aspects of current and expected vulnerabilities of UPF resources and contribution of UPF resources to climate change.

Contributions of UPF to climate change mitigation and adaptation are mainly seen through the main function of forests, which are according to managers oriented towards the fulfilling broad functions and needs. Those contributions have not been specifically emphasized in terms of climate change, and manager stated that it should be done in the future. They see the great importance in highlighting this issue especially in collaboration with other city experts (e.g. urban planners, architects), because they need to become aware of the great importance of forests as climate infrastructure in city.

From in-depth interviews it can be concluded that vulnerabilities of UPF to climate change has been noticed in the last ten years in Belgrade. However, they were not analyzed and tackled in management adequately. It is necessary that this is done in the future, as it will facilitate the introduction of new measures in forest management.

In ecological terms, the vulnerability of forests is seen through:

- more frequent drought stress, water stress, lower physiological state of trees,
- more frequent weather accidents (e.g. floods and storms)
- changes in forest structure (share of deciduous/coniferous species is changed, invasive tree species become more frequent)

– changes in forest increment of some species (e.g. *Populus* sp.), mostly due to long dry periods.

In social term, vulnerability of forests is seen through much higher use of green areas and pressure from the users and visitors. The social demands towards the forests in Belgrade have been changed in last few years, and greater need is emphasized towards various recreational activities, touristic offers, and improved aesthetics. Managers said that higher number of visitors in urban forests has been observed during the summer, which leads to more intensive and frequent maintenance operation (e.g. frequent mowing, irrigation, changed season of planting).

This further leads to the economic vulnerability of forests/forest management, as the operations and activities in daily maintenance needed to be changed. The costs of those operations become higher, which often lead to shortage in budget. Additional money gained from timber production have also been influenced by changing patterns of climate, through e.g. decreasing increment of *Populus* species, which is one of the economically important species in Belgrade region. It is recognized that in Temperate continental and Mediterranean region, adaptive capacity is constrained with socio-economic factors, e.g. in south-eastern Europe with the lack of economic activities, as well with traditional top-down management of forests (Lindner *et al.*, 2010, Seppälä *et al.*, 2009a).

All these various aspects of vulnerability, combined with weak legislation and organizational structure of urban forestry in Belgrade present great challenges for securing and provisioning various ecosystem services in the future. The additional problem in this aspect is still a low level of awareness of employees in urban forestry sector about possible changes. One of the most frequently made comments during in-depth interviews and Q-methodology was that "impact of climate change in Serbia is not that severe". However , it is already known that even though in short-term both positive and negative impacts will be present in Europe, more drastic changes in climate expected at the end of century will cause more negative impacts in most European regions (Lindner *et al.*, 2010). Therefore, it is an urgent need in Serbia to raise awareness among experts and improve capacities that are needed for adequate adapting of tree resources to climate change.

If tree resources of Belgrade are examined more in detail, the high proportion of natural coppice forests (43.5%) and artificially established stands (45.9%), together with high share of deciduous trees, from which beech tree is the most dominant, present the great challenge for management under climate change. It is found that *Fagus silvatica* L. will face severe problems under increasing temperature (Lindner *et al.*, 2010). Furthermore it is expected that exothermic organisms will be enhanced with increasing temperatures, while most of the pests will be triggered by them (Seidl *et al.*, 2008). Managers of urban forests in Belgrade already noticed the higher presence of invasive species, and it was emphasized as one of the greatest problem for management.

This causal relationship between vulnerability of forests due to climate change and the provision of various ecosystem services from UPF forests was seen as important by all managers as an aspect that certainly needs much more attention in management process.

7 Conclusions

Like elsewhere, climate change poses a serious challenge to future management of UPF resources in Belgrade. Daily weather data interpolations proved that changes in climate parameters have occurred. In the last fifty years, an increase in mean annual temperature has been observed in all parts of Belgrade (up to 0.04 °C/y), as well as for precipitation (up to 1.7 mm/y). Looking at these historical data and future predictions of regional climate models (increase of temperature up to 3.4-3.8 °C, and decrease of precipitation to maximum -15% (A2 scenario)) leads to a clear demand for climate change adaptation strategies in UPF in Serbia and Belgrade.

In last decade, forestry sector in Serbia has been modernized and harmonized with international regulations (particularly with EU). The Forest Development Strategy (2006) and Low on Forests (2010) are much more advanced compared to previous documents, and it can be noted that SFM became the main concept of forestry in general. This leaves space for further improvements and modifications of forestry practices, towards integration of climate change adaptation aspects. The development of National Forest Program represents great potential that could integrate many adaptation measures and provide a good base for future forest management.

For better understanding of current state of UPF sector in Belgrade concerning the climate change, analysis of fulfilment of FAO guidelines[19] (2011) have been made (Table 25).

Table 25 shows that modest movement regarding scientific, as well as public awareness has been done regarding climate change so far, mainly on national level. In the forthcoming years it can be expected that such activities are continued. Anyhow, more concrete and comprehensive changes and adaptations of national forestry legislation have to be done. For such development, it is necessary that the overall economic and political situation in country is stable. Strengthening the scientific and expert capacities, followed by higher political will, are other aspects needed for integration of adaptation and mitigation measures in UPF policy-making.

It can be concluded that the management of UPF in Belgrade is facing many challenges (e.g. land use conflicts, governance issues, lack of information and technical assistance, ownership issues). Climate change adaptation is just one among those, but still it is not adequately placed on forest agendas. This study revealed that the problem of climate change has only been recognized in the past few years as an issue in forestry in general. However, it is still influenced by many assumptions and uncertainties, which are result of weak knowledge, lack of data on local impact, and lack of communication within authorities. Even though managers start to understand the complexity of the issue and are becoming aware of the need for action, they essentially have not been dealing with climate change as an issue in management of UPF so far. The level of experts' awareness needs to be significantly raised to set up the conditions for well-informed actions. Bottom-up initiatives by local actors (e.g. managers) addressing specific local risks to climate change are needed for tackling this issue.

Forest resources in Belgrade are facing similar problems as other forest resources in the temperate continental zone. *Fagus silvatica* L., the most common species in Serbia, and coniferous species are most heavily impacted by CC due to their high vulnerability to drought periods and low adaptive capacity. The increased number of invasive species is especially addressed by managers as a problem of management. Management of UPF resources experienced changes in management and maintenance practices, which led to increased costs of these operations. In addition, socio-economic factors such as lack of economic activities and traditional top-down management of forests have a hampering influence on the already low adaptive capacity of UPF systems.

[19] see page

Table 25 Analysis of fulfillment of FAO (2011) guidelines, based on the current situation of UPF sector in regards to climate change in Belgrade

FAO guidelines	Belgrade
Developing a programme and strategy of adaptation and mitigation in forestry practice, and identifying the necessary associated research tasks	Mitigation: Forest Development Strategy – contain some aspects of mitigation Afforestation Strategy of Belgrade Adaptation: Does not exist any strategy
Increasing scientific capacity for monitoring and analyzing the status of climate change	Project "Studying climate change and its influence on environment: impacts, adaptation and mitigation" has the aim to raise scientific awareness and bring insights of situation in Serbia concerning climate change Belgrade perspective of sustainable development and climate change. International Scientific Forum "Danube - River of Cooperation" (Stojović, 2011) Monitoring of climate change paramethers have not been done comperhensively Activities of South-East European Virtual Climate Change Center (SEEVCCC) and RHMZ are expected to improve the state-of –the–art in field of climate change.
Increasing interest in and capacity of state institutions to address the problem of climate change	Done partly through project activities and some workshops and trainings (just on national level) – still significant improvements are needed
Generally improve the flow of information about climate change at national and international level and especially local science–policy relationships	needs to be developed
Developing societal consciousness through active participation of the media and educational institutions in monitoring the problem of climate change at regional and local levels	Role of media need to be enforced Certain progress can be recognized (activities of NGOs and media) – still need to be increased

Climate change adaptation in urban forestry systems is faced with a multitude of needs and demands, of decisions and actors, facing many barriers and conflicts, and requires raised awareness among expert community, media and society. Due to this complexity adaptive management is increasingly seen as an adequate approach for urban forest management under climate change. Traditional management of urban forests with narrow, sector-specific focus cannot meet the increasing challenges that management of urban forests face nowadays. Some of the adaptation measures that could be done in future UPF management are stressed in Table 26. In practical terms, adapting urban and peri-urban forests to climate change should aim to reduce their vulnerability to adverse effects while preserving a full range of ecosystem services demanded by society. This mainly involves the reduction of urban forests' exposure to risk and increased urban forests' resilience to disturbances.

As the conclusion of this study the main weaknesses and constraints of management of UPF in Belgrade regarding the issue of climate change adaptation are addressed in Table 26.

Table 26 Weaknesses of UPF system towards climate change adaptation and possible adaptation measures

	Weaknesses	Adaptation measures
Policy	Weak content of forestry legislation and UPF management plans regarding climate change Absence of legislation regarding climate change adaptation Lack of political will Weak network of UPF actors Small number of actors involved in UPF management Weak communication between UPF actors Inadequate coordination of various UPF actors on national and local level Weak ties between policy, practice and science Insufficient interest of experts for rising the importance of the topic	Rising the importance of climate change adaptation issue on political level Revise forestry legislation, regulations and directives regarding climate change issue Adopt an adaptation plan for UPF sector Include climate change adaptation measures into UPF management plans Establish dialogue and communication means between various UPF actors Empowerment of various UPF actors (e.g. citizens, municipality bodies, NGOs) Establish proper means of communication between national actors (e.g. Ministry of Forestry, RHMZ, Ministry of Environment) and local actors (e.g. City Secretariat for environment, municipalities, management agencies) regarding CC Establishing regular cooperation between policy, practice and research regarding climate change issue Exhortation of expert involvement with the CC issue
Resources	Insufficient financial resources Lack of new financing mechanisms Low level of awareness regarding issue of climate change Lack of the research, information, data, knowledge and skills about climate change	Securing more funds from budget (national and city) for climate change adaptation Finding the new modes of financing for UPF sector, that could be used for conducting researches and implementing adaptation measures Capacity building in organizations responsible for UPF management (organization of workshops, trainings, seminars) Raising awareness of scientific community and UPF actors towards climate change Conducting research that can be applied locally
Management	Lack of data collection over time Lack of long-term planning in UPF management Insufficient skills regarding the climate change Application of old practices in UPF management	Detailed mapping of UPF resources Detailed vulnerability assessment of UPF resources to CC Establish monitoring system and early warning systems for UPF Develop modelling tools for UPF Introducing new measures in UPF management

The main weaknesses and constraints of management of UPF of Belgrade regarding the issue of climate change adaptation are application of old practices and slow process of adopting the new measures. This is combined with weak process of legislation change, which appears to be the crucial in management process. The network of existing actors in urban forestry of Belgrade is weak, and it showed that communication needs to be strengthened between all actors both on local and national level and between those. Furthermore, information exchange and education regarding climate change need to be fostered in forestry organizations. This need to be accompanied with improved financial resources, raising awareness and introduction of adequate tools and techniques, which are currently the main obstacles to the integration of climate change in UPF policy making. Furthermore, it can be noted that on city level (and state) some other economic and social problems have been identified

as urgent, due to which it is hard to mobilize will for acting in the field of climate change. Many of mentioned obstacles/barriers to local adaptation actions are identified in work of e.g. Corfee-Morlot *et al.* (2011, p.178), which illustrate that case of Belgrade is not an isolated case.

The integration of climate change adaptation in urban and peri-urban forestry of Belgrade will be a great challenge in future. It will need initiation of comprehensive and coordinated actions on various levels, strong leadership, involvement of various stakeholders, improvement of information and knowledge base, adaptation through learning and development of clear tools and guidelines.

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Appendices

Appendix 1

IN-DEPTH INTERVIEW GUIDE (for Urban Forestry Managers)

- **Introduction Key Components**

• Thank you
  – I want to thank you for taking the time to meet with me today, and that you are willing to take part in my master thesis research.
• Your name
  – My name is Ivana Gudurić and I am master student of European Forestry master program, at BOKU University, Vienna.
• Purpose
  – I would like to talk to you about climate change adaptation in urban and peri-urban forests of Belgrade.
• Confidentiality
  – All responses will be kept confidential. This means that your interview responses will only be shared with research team members and we will ensure that any information we include in our report does not identify you as the respondent.
  – Remember, you do not have to talk about anything you do not want to and you may end the interview at any time.
• Duration
  – The interview should take about an hour.
• How interview will be conducted
  – If that is all right with you, I will be taping the session because I do not want to miss any of your comments. Although I will be taking some notes during the session, I cannot possibly write fast enough to get it all down. Because we are on tape, please be sure to speak up so that we do not miss your comments.
• Opportunity for questions
  – Are there any questions about what I have just explained?

- **Questions**

1. In which way are you concerned with climate change in your work?

2. Do you think climate change is or should be an important issue in urban and peri-urban forest management?

3. Do you consider climate change adaptation in urban and peri-urban forests as important issue in designing management plans, and later on in their realization? What is the condition in this respect so far? Could you, please elaborate your opinion?

4. Which higher policy documents adequately address the issues of climate change, which are important for urban and peri-urban forest management?

5. With whom and how do you communicate regarding climate change adaptation?

6. How do you consider urban and peri-urban forest contribution to climate change in management plans? Is this function of urban forests recognized in past and current management plans? And how?

7. Have you identified vulnerability of urban and peri-urban forests to climate change in your work so far? If yes, how do you deal with this issue in management plans, or in the field?

8. Have you analyzed climate change impact on urban and peri-urban forests so far? If not, are there existing assumptions of potential negative/positive impact of climate change on urban forests?

9. What climate change adaptation actions (strategies) do you consider as important for management of urban and peri-urban forests in Belgrade? (are they considered so far/ or that are important for future)

10. What do you consider as main constraints that could influence development of climate change adaptation strategies?

11. Is there anything more you would like to add?

THANK YOU!

- Serbian version -

EKSPERTSKI INTERVJU (za Menadžere u urbanom šumarstvu)

- **Uvod**

• Zahvalnica
  - Želim da Vam se zahvalim što ste izdvojili vreme danas za mene, kao i što ste radi da mi pomognete u izradi mog master rada.
• Predstavljanje
  - Moje ime je Ivana Guduric. Ja sam master student na BOKU univerzitetu u Beču, a u okviru programa „Evropsko šumarstvo".
• Svrha
  - Htela bih sa Vama da razgovaram o adaptaciji ka klimatskim promenama u urbanim šumama Beograda.
• Poverljivost informacija
  - Sve odgovore koje budete dali biće povreljivi. To znači da će Vaši odgovori biti podeljeni jedino sa mojim mentorima i mi ćemo se potruditi da odgovori koji date, a budu se našli u radu, ne mogu biti direktno povezani sa Vama.
• Trajanje
  - Intervju bi trebao da traje oko sat vremena.
• Kako će intervju biti sproveden
  - Ukoliko se Vi slažete, ja bih intervju snimala, kako ne bih propustila neki od Vaših komentara. Iako ću uporedo hvatati beleške, moguće je da neću stići sve da zapišem. Zbog kvalitetnijeg snimka, molim Vas da dovoljno glasno govorite.
• Pitanja
  - Da li imate neko pitanje, pre nego što pređemo na intervju?

- **Pitanja**

1. Na koji način se Vi u vašem radu srećete sa pitanjem klimatskih promena?

2. Da li Vi mislite da su klimatske promene značajna tema u upravljanju urbanim šumama?

3. Da li Vi smatrate adaptaciju ka klimatskim promenama u urbanim šumama važnom temom u procesu izrade, kao i implementacije, planskih dokumenata za upravljanje urbanim šumama? Kakvo je trenutno stanje upravljanja po tom pitanju?

4. Koja dokumenta (zakoni, strategije, uredbe, itd.) se adekvatno bave temom klimatskih promena, a da su od značaja za upravljanje urbanim šumama?

5. Sa kim i na koji način vi komunicirate po pitanju adaptacije ka klimatskim promenama?

6. Da li ste u prethodnim, kao i sadašnjem planu upravljanja urbanim šumama, uzimali u obzir doprinos koji urbane šume imaju na klimatske promene? Da li je ova funkcija prepoznata u dosadašnjem planiranju, i kako?

7. Da li su do sada, u Vašem radu, identifikovane neke od osetljivosti urbanih šuma na klimatske promene? Ako jesu, kako se sa njima odnosilo u planovima upravljanja, ili na terenu?

8. Da li ste do sada pratili/vršili monitoring uticaja klimatskih promena na urbane šume? Ako niste, da li postoje neke pretpostavke o potencijalnom negativnom/pozitivnom uticaju?

9. Koje od mera u pogledu adaptacije ka klimatskim promenama u urbanim šumama vi smatrate kao važne, u dosadašnjem ili budućim planovima upravljanja?

10. Da li možete da izdvojite probleme koji utiču na sam proces uključivanja teme adaptacije ka klimatskim promenama u urbanim šumama?

11. Da li postoji još nešto što želite da spomenete, a čega se nismo dotakli u intervjuu?

HVALA!

Appendix 2

LIST OF INTERVIEWED MANAGERS

Manager No.	Organization	Department	Position	Date of interview	Length (min)
1	PUC 'Greenery Belgrade'	Working Unit for Forests	Head of the Unit	16.05.2012.	50
2	PUC 'Greenery Belgrade'	Department for Development of Plans and Projects for Green Areas of Belgrade	Responsible manager/designer	16.05.2012.	55
3	Faculty of Forestry	Department for Forest Management and Planning	Expert for development of forest management plans	31.05.2012.	45
4	PE 'Serbia Forests'	Forest Estate 'Belgrade'	Head of the unit for the marketing and projects	17.05.2012.	50
5	PE 'Serbia Forests'	Forest Estate 'Belgrade'	Responsible manager for forest management and planning	17.05.2012.	45
6	PE 'Serbia Forests'	Department for Project and Planning in Forestry	Responsible manager for forest management and planning	18.05.2012.	40

Appendix 3

INSTRUCTIONS TO THE Q METHODOLOGY SURVEY

RESPONDENT NUMBER: _____
Organization: _____
Position: _____

INSTRUCTIONS TO THE SURVEY

These instructions will guide the survey step by step.

1. I will give you the cards and the score sheet, which are needed for conduction of this survey.

- Lay down the score sheet in front of you.
- All 48 cards contain a statement about climate change issue in general, climate change adaptation. You should relate statements to urban forests of Belgrade, wherever appropriate.
- I will ask you to rank-order these statements from your own point of view. My question to you is: "To what extent do you agree with the following statements?". The numbers on the cards (from 1 to 48) have been assigned to the cards randomly and are only relevant for the administration of your response.

2. This research is part of my master thesis and is about climate change adaptation in urban forests in Belgrade. I am interested in your opinions, believes, perception and awareness towards climate change adaptation as an issue in general, and in urban and peri-urban forests in Belgrade.

3. Please, read the 48 statements carefully and split them up into three piles: a pile for statements you tend to disagree with, a pile for cards you tend to agree with, and a pile for cards you neither agree nor disagree with, or that are not relevant or applicable to you. Please use the three boxes "AGREE", "NEUTRAL OR NOT RELEVANT" and "DISAGREE" at the bottom left of the score sheet. Just to be clear, I am interested in your point of view. Therefore, there are no right or wrong answers. When you have finished laying down the cards in the three boxes on the score sheet, count the number of cards in each pile and write down this number in the corresponding box. Please check whether the numbers you entered in the three boxes add up to 48.

4. Take the cards from the "AGREE" pile and read them again. Select the 3 statements you most agree with and place them in the three last boxes on the right of the score sheet, below the "+4" (it does no matter which one goes on top or below). Next, from the remaining cards in the deck, select the 4 statements you most agree with and place them in the three boxes below the "+3". Follow this procedure for all cards from the "AGREE" pile.

5. Now take the cards from the "DISAGREE" pile and read them again. Just like before, select the three statements you most disagree and place them in the two last boxes on the left of the score sheet, below the "-4". Follow this procedure for all cards from the "DISAGREE" pile.

6. Finally, take the remaining cards and read them again. Arrange the cards in the remaining open boxes of the score sheet.

7. When you have placed all cards on the score sheet, please go over your distribution once more and shift cards if you want to.

8. Please explain why you agree most with the 3 statements you have placed below the "+4".
card nr.:

card nr.:

card nr.:

9. Please explain why you disagree most with the 3 statements you have placed below the "-4".
card nr.:

card nr.:

card nr.:

10. When you are finished, please write down the number of the cards in the boxes you placed them on (A4 format of score sheet provided).

Appendix 4

LIST OF Q- STATEMENTS (in English and Serbian)

1. Introducing monitoring system and modelling tools for forest management will be of great importance for adaptation to climate change.
1. Uvođenje sistema za praćenje i predviđanje klimatskih promena u upravljanju i gazdovanju šumama će biti od velike važnosti za adaptaciju na klimatskim promenama.

2. The establishment and development of dialogue between various actors about climate change adaptation is highly important for management of urban forests.
2. Uspostavljanje i razvoj dijaloga između različitih interesnih grupa o adaptaciji na klimatske promene je veoma važan za upravljanje gradskim šumama.

3. Scientific knowledge about adaptation of urban forests to climate change would help in adaptation process.
3. Naučna saznanja o adaptaciji gradskih šuma na klimatske promene bi pomogla procesu adaptacije.

4. Public institutional money is needed to deal with the adaptation of urban forests to climate change.
4. Potreban je novac iz gradskog budžeta da bi se bavili adaptacijom gradskih šuma na klimatske promene.

5. The protection of biodiversity and forest habitats will depend on how well we adapt the forests to climate change.
5. Zaštita biodivrziteta i šumskih staništa zavisi će od toga koliko dobro ćemo prilagoditi šume na klimatske promene.

6. Adaptation of the urban forests to climate change is important to preserve the forests for the future generations.
6. Adaptacija gradskih šuma na klimatske promene je važna kako bi se šume sačuvale za buduće generacije.

7. Management of urban forests should adapt on more frequent severe weather events that are consequence of climate change.
7. Upravljanje gradskih šuma treba prilagođavati iznenadnim vremenskim nepogodama koje su posledica klimatskih promena.

8. Public awareness about climate change is already high; there is no need for more educational programs and trainings.
8. Svest javnosti o klimatskim promenama je već visoka, nema potrebe za više obrazovnih programa i obuka.

9. Climate change adaptation actions in urban forests are too costly; it not makes sense to invest in it.
9. Mere adaptacije gradskih šuma na klimatske promene su veoma skupe, tako da nema potrebe u njih investirati.

10. Selection of climate-resilient species in management of urban forests is needed action for adaptation of urban forests to climate change.
10. Uvođenje klimatski-prilagodljivih vrsta u gradske šume je neophodno za adaptaciju gradskih šuma na klimatske promene.

11. Popularization of climate change topic can be done through greater involvement of experts.
11. Popularizacija teme klimatskih promena se može ostvariti kroz veće angažovanje stručne javnosti.

12. Consideration of adaptation to climate change in urban planning will help the process of adaptation.
12. Sagledavanje procesa adaptacije na klimatske promene prilikom planiranja gradova pomoći će procesu adaptacije.

13. Lack of interest of urban forestry actors toward climate change will not influence adaptation process.
13. Nezainteresovanost aktera u urbanom šumarstvu po pitanju klimatskih promena neće uticati na proces adaptacije.

14. In order to make forests resilient to climate change we should aim at planting as many different species as possible.
14. U cilju formiranja šuma otpornih na klimatske promene treba da težimo sadnji što većeg broja različitih vrsta drveća.

15. Climate change adaptation actions in urban forests are not needed because forests will naturally adjust to future climate variability.
15. Adaptacije na klimatske promene nisu potrebne u gradskim šumama, jer će se šume prirodno prilagoditi promenama klime.

16. Education of employees in urban forestry towards climate change is needed for adaptation process.
16. Edukacija zaposlenih u upravljanju i gazdovanju šumama o klimatskim promenama je potrebna za proces adaptacije.

17. Employees in forestry are informed about climate change only through informal sources (e.g. internet, newspapers).
17. Zaposleni u šumarstvu se o klimatskim promenama informišu samo putem neformalnih izvora (npr. internet, štampani mediji).

18. Actions oriented on reducing impacts of climate change are too expensive for companies and enterprises.
18. Aktivnosti koje su usmerene na smanjenje uticaja klimtskih promena su skupe za kompanije i preduzeća.

19. In adaptation of urban forests to climate change the enterprises/agencies that manage the forests should take the main decisions.
19. U procesu adaptacije gradskih šuma na klimatske promene preduzeća koja gazduju šumama trebaju da donose glavne odluke.

20. Stronger political leadership would be of great importance in initiating climate change adaptation actions.
20. Snažniji politički angažman bio bi od velike važnosti za iniciranje akcija vezanih za adaptacije na klimatske promene.

21. Local authorities should play a crucial role in developing climate change adaptation strategies in various sectors.
21. Lokalna uprava treba da ima glavnu ulogu u razvoju strategija za adaptacije na klimatske promene u različitim sektorima.

22. More funds from national budgets should be secured for doing research on climate change adaptation.
22. Više sredstava u nacionalnim fondovima treba obezbediti za istraživanje adaptacija na klimatske promene.

23. Companies and enterprises need to consider climate change in all activities (corporate social responsibility).
23. Kompanije i preduzeća treba da uzmu u obzir klimatske promene u svim svojim aktivnostima (odgovorno poslovanje).

24. We need improved legislation that addresses climate change adaptation in urban area.
24. Neohodno je unapredjenje zakonske regulative kojom bi se tretirala tema adaptacija na klimatske promene u gradskim sredinama.

25. There are many other competent problems in city, which should be solved, more important than climate change adaptation.
25. Postoje važniji problem u gradu koji se trebaju rešiti od pitanja adaptacija na klimatske promene.

26. Natural forests are best suited to adapt for climate change.
26. Prirodne šume su najpogodnije da se adaptiraju na klimatske promene.

27. It is already too late to do anything, as any action to adapt urban forests to climate change will take a long time to take effect.
27. Bilo koja mera da se gradske šume prilagode klimatskim promenama zahteva puno vremena kako bi bila vidljiva, stoga je kasno da se bilo šta uradi.

28. Everybody has to contribute in tackling climate change, through individual actions.
28. Svaki pojedinac treba da doprinese rešavanju problema klimatskih promena, kroz individualne aktivnosti.

29. Water supply will be endangered if nothing is done about adaptation of urban forests to climate change.
29. Vodosnabdevanje će biti ugroženo ukoliko se ništa ne uradi po pitanju adaptacije gradskih šuma na klimatske promene.

30. Failure to address climate change is the fault of political leaders.
30. Greška je političkih lidera što se temi klimatskih promena ne pridaje neophodan značaj.

31. As effect of climate change we have more trees that are drying now in urban forests.
31. Jedan od negativnih efekata klimatskih promena je veća učestalost sušenja drvenastih vrsta u gradskim šumama.

32. Climate variation is normal, so we cannot say that there is global climate change.
32. Klimatske varijacije su normalna pojava, tako da se ne može govoriti o globalnoj promeni klime.

33. In future invasive species will become a big problem with climate change.
33. Invazivne vrste će u budućnosti postati problem sa promenom klime.

34. Adaptations of urban forests to climate change cannot be considered separately from the sustainable development of the city.
34. Adaptacije gradskih šuma na klimatske promene se nemogu posmatrati odvojeno od razvoja grada.

35. There is not enough information to definitely say that climate change exists.
35. Ne postoji dovoljno informacija da bi se sa sigurnošću reklo da klimatske promene postoje.

36. Climate change adaptation in urban forests will not help in regulation of city microclimate.
36. Adaptacije gradskih šuma na klimatske promene neće poboljšati mikroklimu grada.

37. Urban scale and local adaptations are not an important part of national and international policy agendas to climate change.
37. Adaptacije na lokalnom nivou nisu važan deo nacionalnih i internacionalnih akcija vezanih za klimatske promene.

38. Only when negative effects of climate change become evident, actions will be taken.
38. Tek kada negativan efekat klimatskih promena bude vidljiv, delovaće se u pronalaženju rešenja.

39. Non-native (Alochtone) species in urban forests are not negatively influenced as consequence of climate change.
39. Negativan uticaj klimatskih promena nije izražen na alohtonim vrstama u gradskim šumama.

40. Media bring reports about climate change only insufficiently.
40. Medijska izveštavanja o temi klimatskim promenama su nedovoljna.

41. Urban forest management has other priorities than climate change adaptation at the moment.
41. Upravljanje i gazdovanje gradskim šumama ima drugih prioriteta od adaptacija na klimatske promene.

42. When schools/universities include climate change in their curriculum, young generations will know what to do in the end.
42. Kada škole i univerzitet uvrste klimatske promene u nastavni program, buduće generacije će znati kako da se sa ovim problemom odnose na pravi način.

43. Climate change adaptation in urban forests is urgent issue that asks for immediate change of management with forests.
43. Adaptacija gradskih šuma na klimatske promene je urgentna tema koja zahteva promene u načinu upravljanja i gazdovanja šumama.

44. Climate change adaptation policy for urban forests should be top-down mandated.
44. Politika za adaptacije ka kilmatskim promenama treba da bude diktirana od nacionalnog ka lokalnom nivou (top-down).

45. Adaptation to climate change in urban forest will not contribute minimizing climate change effects if other sectors in city (e.g. transport, energetic) are not adapted as well.
45. Adaptacije gradskih šuma na kimatske promene neće doprineti minimiziranju efekata klimatskih promena ukoliko se i ostali sektori u gradu (transport, energetika) ne adaptiraju.

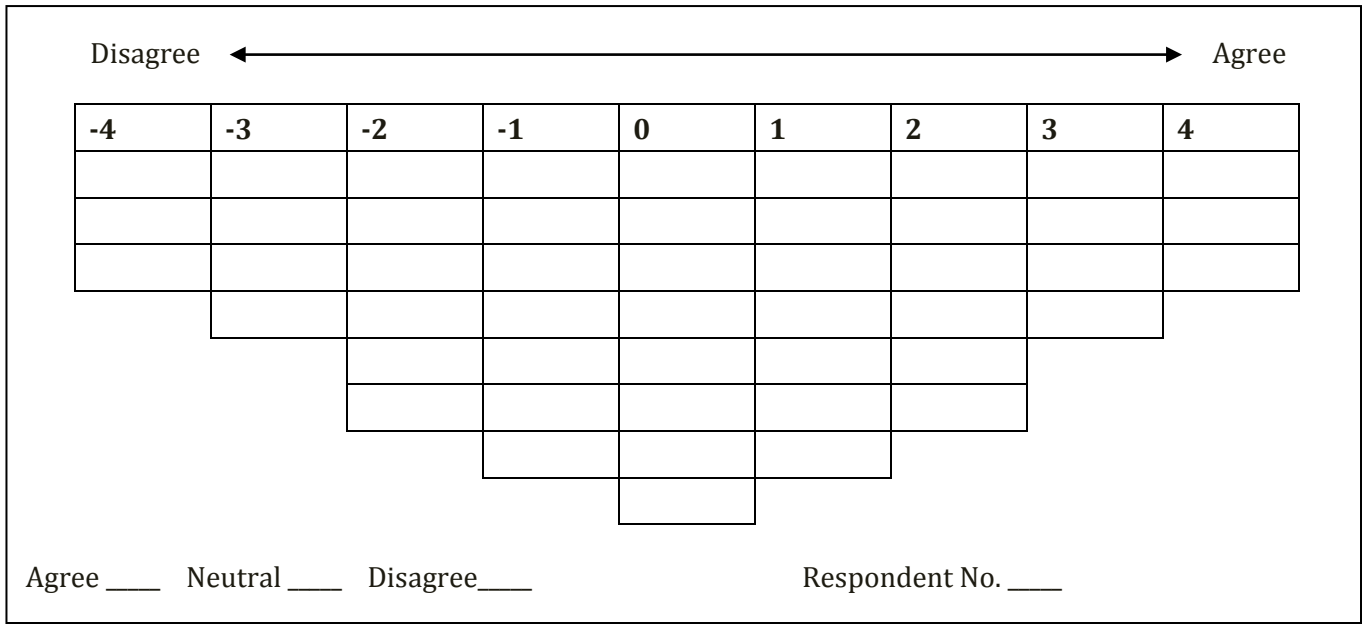
46. The cost and effects of climate change adaptation in urban forests need to be calculated before actions are taken.
46. Troškovi adaptacije gradskih šuma na klimatske promene i efekti koji se adaptacijom postižu treba da budu sagledani pre nego što se preduzmu konkretne aktivnosti.

47. The organizations responsible for issue of climate change and other enterprises involved in urban forestry have good communication about the issue.
47. Institucije koje se bave pitanjem klimatskih promena i ostala preduzeća uključena u urbano šumarstvo imaju dobru saradnju i komunikaciju po pitanju klimatskih promena.

48. Enforcement and implementation of international agreements on climate change is more important at the global level, rather than separately at the national or local level.
48. Sprovođenje i implementacija međunarodnih sporazuma po pitanju klimatskih promena je važnija na globalnom nivou, nego pojedinačno na nacionalnom ili lokalnom.

Appendix 5

SCORE SHEET (Q-Methodology)



Appendix 6

LIST OF Q-RESPONDENTS (P-SET)

Resp. No.	Organization	Department	Position	Date of interview	Length (min)
1	Ministry of Agriculture, Trade, Forestry and Water Management	Directorate of Forests	Senior advisor	07.06.2012.	55
2	Ministry of Agriculture, Trade, Forestry and Water Management	Directorate of Forests	Senior advisor	07.06.2012.	65
3	Ministry of Environment, Mining and Spatial Planning	Department for Climate Change	Head of the department	11.06.2012.	55
4	Ministry of Environment, Mining and Spatial Planning	Department for Climate Change	Technical support of the department	11.06.2012.	60
5	Institute of Urbanism Belgrade	Strategic Planning and Development Department	Landscape architect/planner	07.06.2012	70
6	Institute of Arch. and Urban & Spatial Planning of Serbia	Center for Spatial Development and Environment	Landscape architect, Ph.D., research fellow	14.06.2012.	65

7	Faculty of Forestry	Ecological Engineering for Soil and Water Resources Protection	Professor/ Leader of multidisciplinary project on climate change	11.06.2012.	55
8	Faculty of Forestry	Forestry department/Forest Management Planning	Professor/Dean	08.06.2012.	65
9	Faculty of Forestry	Landscape Architecture and Horticulture	Professor	14.06.2012.	50
10*	Faculty of Forestry	Forestry department/Forest Management Planning	Assistant (expert for development of FMP)	15.06.2012.	55
11	Institute of Forestry	Department of GIS and Forest Policy	Researcher	22.06.2012.	online
12	Institute of Forestry	Department of Protection and Improvement of Environment	Senior researcher	14.06.2012.	50
13	Secretariat for Environmental Protection	/	Senior advisor	18.06.2012.	65
14*	Public Enterprise "Serbia Forest"	Forest Estate "Belgrade"	Head of the Unit for the marketing and projects	15.06.2012.	60
15*	Public Enterprise "Serbia Forest"	Forest Estate "Belgrade"	Responsible manager for forest management and planning	15.06.2012.	55
16*	Public Enterprise "Serbia Forest"	Department for Project and Planning in Forestry	Responsible manager for forest management and planning	13.06.2012.	45
17*	Public Utility Company 'Greenery Belgrade'	Working Unit for Forests	Head of the Unit	08.06.2012.	65
18*	Public Utility Company 'Greenery Belgrade'	Department for Development of Plans and Projects for Green Areas of Belgrade	Responsible manager / designer	12.06.2012.	65
19	Citizen Initiative for Protection of Zvezdara Forest	/	Biologist/representative of initiative	12.06.2012.	60
20	The Regional Environmental Center for Central and Eastern Europe (REC)	Office for Serbia	Project assistant	14.06.2012.	55
21	Serbian Association of Landscape Architects	/	Representative of association	15.06.2012.	60
22	South-East European Virtual Climate Change Centre (SEEVCCC)	/	Project manager	23.06.2012.	online
23	Faculty of Agriculture	Department for Meteorology and Climatology	Assistant	28.06.2012.	online

* Managers and experts interviewed also in in-depth interviews