

DOI: 10.5937/SustFor2285001B

Review paper

URBAN FORESTS AND CLIMATE CHANGE

*Ljiljana BRAŠANAC-BOSANAC¹, Tatjana ĆIRKOVIĆ-MITROVIĆ¹,
Nevena ČULE¹, Goran ČESLJAR¹, Saša EREMIJA¹, Ilija ĐORĐEVIĆ¹*

Abstract: *Spatial and urban plans have recently given an increased focus to the sensitive issue of planning the urban resilience of existing and establishing new urban forests. Urban forests are recognised as an extremely important factor of environmental quality, while scientific studies indicate that the health condition of urban forests is threatened by present-day climate change. There have been relatively few systematic assessments of the causes of tree die-back in urban areas in Serbia. Research, forest establishment planning and tree monitoring to estimate possible consequences to existing trees will enable city authorities and managing bodies to raise the issue of urban forest resilience to climate change to a higher level and incorporate it into urban planning. Future scenarios in which urban forests are resistant to potential adverse climate change will depend on the scope of activities of adaptive planning of urban forest establishment and adaptive management of existing ones. Therefore, it is necessary to conduct long-term studies of monitoring the condition of urban forests in the large cities of Serbia (Belgrade, Novi Sad, Niš, Subotica, etc.) in the coming period in order to identify specific problems and remediate the consequences such as deteriorated tree health condition and die-back.*

Keywords: urban planning, urban green space, adverse effects of climate factors, environmental protection.

¹Ph.D. Ljiljana Brašanac-Bosanac, Senior Research Associate, Ph.D. Tatjana Ćirković-Mitrović, Senior Research Associate, Ph.D. Nevena Čule, Senior Research Associate, Ph.D. Goran Česljar, Research Associate, Ph.D. Saša Eremija, Senior Research Associate, Ph.D. Ilija Đorđević, Research Associate, Institute of Forestry, Kneza Višeslava 3, Belgrade, Serbia.

Corresponding author: Ljiljana Brašanac-Bosanac, e-mail: brasanlj@yahoo.com

URBANE ŠUME I KLIMATSKE PROMENE

Izvod: *Prilikom izrade prostornih i urbanističkih planova poslednjih godina posebna pažnja poklanja se veoma osetljivoj i važnoj problematici planiranja otpornosti postojećih i podizanja novih urbanih šuma. Urbane šume su prepoznate kao izuzetno važan faktor poboljšanja kvaliteta životne sredine, a naučne studije ukazuju da je zdravstveno stanje urbanih šuma ugroženo novonastalim klimatskim promenama. Sistematske procene uzroka odumiranja stabala u urbanim sredinama u Srbiji su retke. Istraživanje, planiranje podizanja novih, kao i praćenje i sistematsko predviđanje mogućih posledica na postojećim stablima omogućiće upravljačima i gradskim vlastima da problematiku otpornosti urbanih šuma na klimatske promene podignu na viši nivo i inkorporiraju je u urbano planiranje. Budući scenariji u kojima su urbane šume otporne na moguće negativne klimatske promene zavisiće od sprovedenih aktivnosti adaptivnog planiranja podizanja novih urbanih šuma i adaptivnog upravljanja postojećim. Iz tog razloga potrebno je u narednom periodu sprovesti dugoročne studije monitoringa stanja urbanih šuma u većim gradovima Srbije (Beograd, Novi Sad, Niš, Subotica i dr.) kako bi se identifikovali konkretni problemi i sanirale posledice u vidu pogoršanja zdravstvenog stanja i sušenja stabala.*

Ključne reči: urbano planiranje, urbano zelenilo, negativan uticaj klimatskih faktora, zaštita životne sredine.

1. INTRODUCTION

According to data from the World Urbanization Prospects revision, about 50% of the world's population lives in urban areas (UN, 2018). By 2050, this proportion is expected to increase to 68%, and 6.6 billion people are then expected to live in urban areas. Spatial plans define urban forests and forest lands as areas under forest in or around human settlements. Considering the growing trend of urban population, urban forests and urban forestry as a branch of forestry are becoming increasingly important, especially in terms of the quality of life of urban residents.

According to projections of the impact of global climate change (IPCC 2000, 2007, 2009, 2014, 2014a, 2018), the Balkans will be characterised by more frequent temperature extremes, less precipitation in the summer, more river floods in the winter, variability in cereal yields, greater risk of forest fires and threatened stability of forest ecosystems. The Republic of Serbia is one of the countries in the hinterland of the Mediterranean region considered to be particularly affected by global climate change (Đurđević, 2018).

Extreme weather events are becoming increasingly frequent and serious, leaving devastating consequences behind. Numerous research results have revealed a range of potential risks and impacts reflected in urban forests and caused, above all, by climate change (Brune, 2016; Steenberg et al., 2017; Hilbert et al., 2019; Czaja et al., 2020; Esperson-Rodriguez et al., 2021). These consequences put additional pressure on existing social challenges such as poverty, social stratification, and endangered environment (deforestation, air, water and soil pollution etc.).

Remediation and prevention of the climate change effects in urban areas, including floods (due to increased intensity of precipitation), landslides and land subsidence, increased energy consumption for both cooling and heating, damage caused by storms, intense winds, and other weather disasters require effective measures and carefully selected activities at all decision-making levels. The so-called green infrastructure and urban forests within it play a prominent role in reducing and mitigating the adverse effects of climate change within urban areas (Kazmierczak 2010; Hirons 2019).

2. METHODOLOGY

The purpose of the research was to point out the vulnerability of urban forests to climate change, on the one hand, and the importance of healthy, resilient urban forests in the fight against climate change, on the other hand. If we raise the issue this way, it becomes clear that we are facing the effects of climate change that pose new kinds of structural challenges. These challenges cannot be dealt with independently within one area or a sector (e.g., forestry, environmental protection, urbanism, spatial planning, etc.). Therefore, this research applied a problem-based, integral and participative approach.

The problem-based approach to the importance of urban forests for the development and quality of life in large urban centers involved the use of numerous analytical instruments in order to clearly identify (target) existing problems, limitations and possible conflicts within urban areas and define measures to solve them.

The integral approach involved looking at current regulations, guidelines and recommendations regarding the adaptation to climate change in urban areas as defined by various international, EU and national institutions. The application of an integral approach further implied the introduction of new standards, i.e., harmonization with new global and European frameworks, policies and planning practices at all levels of decision-making in Serbia.

Urban environments are characterised by complex conditions and a myriad of conflicting interests and factors present in a given area. Therefore, to get a deeper insight and assess the feasibility of planning solutions, we had to apply a participatory approach. This approach was achieved through an analysis of the legal and planning provisions on different aspects and sectors of spatial planning at the local level.

The conclusions presented in the paper are based on findings from a variety of literature sources and examples of good practice.

3. RESULTS AND DISCUSSION

3.1. Urban forests – concept, significance, functions

Cities share a similar physical structure, consisting of “grey infrastructure” (residential and industrial buildings, roads, parking spaces), “blue infrastructure” (rivers, lakes, waterways) and “green infrastructure” (trees, shrubs, grasses and flowering plants). According to Miller et al. (2015), *green infrastructure* is a

strategically planned network of green areas of various categories designed to provide a wide range of ecosystem services and biodiversity protection in urban and peri-urban environments.

Urban forests are critical components of urban environments. They include trees, shrubs with the accompanying soil and green belt vegetation in a variety of settings. They are the “backbone” that supports green infrastructure as they connect rural and urban areas and improve the ecological footprint of cities. They provide ecological diversity and form the main structural and functional elements that make cities and urban regions better places to live (Figure 1).



Figure 1. *Urban forests, 2022 (Orig.)*

3.2. Urban forests and climate change

Urban forest functions are most often classified as environmental, sanitary, hygienic, recreational and decorative-aesthetic (Lješević, 2005).

In recent years, urban forests have been gaining increasing importance and multi-purpose benefits, especially in the context of climate change, because they improve the urban microclimate, make conditions favourable for outdoor recreation and protect soil, buildings and sidewalks from overheating. Besides increasing the total area under vegetation, they improve the quality and quantity of stormwater, regulate the wind rose, reduce the effect of urban heat islands, reduce the total energy used to heat or cool buildings, etc.

Due to the large quantities of concrete, asphalt and metal built in urban structures and the high concentration of transport systems and industrial activities in and around the urban area, the average city temperature values are higher (“heat island effect”), the air is drier and often polluted, precipitation is less efficiently absorbed, and the noise is significantly higher than in rural areas.

Urban forests contribute to mitigating adverse climate effects in the following ways:

- Modification and mitigation of temperature extremes. Urban greenery can lower summer temperatures and heat in cities by 3-4°C (Vogt et al., 2017). Tree canopies create a specific forest microclimate that moderates weather extremes, which is important for the daily temperature variation, especially in summer and winter (Aram et al., 2019). Trees reduce the heating and radiation of buildings, sidewalks and roadways and help regulate the temperature in the urban environment by modifying solar radiation. According to Dawson (2007), a shade made by a large tree can reduce the temperature in buildings by as many degrees as 15 air conditioners (about 4220 kJ) would do in a similar but unshaded building.
- Increase in relative air humidity in the urban environment. Maintaining the humidity regime is one of the important ecological roles of green areas. In summer, plants exude a greater amount of moisture through the process of evapotranspiration. According to Lješević (2005), wide-crown trees and shrubs planted along sidewalks improve the street microclimate since 200 gr of water evaporates from 1 m² of a lawn, which significantly increases air humidity.
- The wind protection role. Greenery is more elastic than buildings, and thus withstands wind blows more easily than buildings. Within the greenery, the wind speed is reduced by 40-50%, and in a wide green zone with dense planting, the wind can be completely calmed. The best protection against the wind is provided by mixed stands of trees, shrubs, bushes and lawns, of different widths, but not less than 50 m (Lješević, 2005).
- Better quality and cleaner air. Trees improve air quality by releasing oxygen and removing air pollutants. Keller's (1979) research and measurements show that lead is reduced by about 85% behind shelterbelts. Trees absorb gaseous pollutants (such as carbon monoxide, nitrogen oxides, ozone and sulfur oxides) and filter fine particles, such as dust, dirt or smoke, from the air by trapping them on their leaves and bark. The same author states that one mature tree can absorb 48 lbs of CO₂ a year and release an amount of oxygen into the atmosphere enough for the life of two people.
- Energy saving. Proper design of tree planting around buildings can reduce the need for air conditioning by 30% and reduce winter heating bills by 20-50% The energy saved by planting trees around buildings is 10-50% for cooling and 4-22% for heating (Dawson, 2007).

Table 1. *The role of urban forests in climate change mitigation*

Issue	Benefits of urban forests
Emission of greenhouse gases	They sequester carbon and mitigate climate change.
Extreme weather events	They mitigate extreme events and have positive effects on the microclimate.
The "heat island" effect	They make shade and lower the temperature.
Floods	They mitigate torrential waters and reduce flooding.
Exposure to harmful sun rays	They provide shade.
Lack of energy	Energy saving through shading/cooling, firewood production.

3.3. The impact of climate change on urban forests and possible adaptation

The occurrence and survival of vegetation in an area, its distribution and altitude differentiation depend on a range of environmental conditions, including the climate characteristics of the area, primarily the air temperature and amount of precipitation. Climate change, caused by natural variations or human activity, increases the frequency and consequences of extreme weather events such as heat waves, droughts, floods, strong winds, etc., and negatively affects both individual trees and larger areas of urban forests (Brandt et al., 2016, Hilbert et al., 2019, Esperon-Rodriguez et al., 2021).

Tree decline in urban areas often results from the long-term, continuous accumulation of effects of various stress factors (Czaja et al, 2020) and interactions between them (extreme weather, pests and diseases, herbivores, unplanned construction and usurpation of green areas). Tree decline can also be caused by improper forest management, selection of inappropriate plant species, poor quality planting stock, inappropriate place or planting technique, poor site preparation, lack of maintenance, etc. Due to some forest disturbance, caused either by human activity (forest cutting, etc.), or a natural cycle (environmental disruption, death of old trees, pest attacks and diseases, etc.), forest ecosystems can start releasing stored CO₂ back into the atmosphere (Brašanac-Bosanac, 2013) and instead of purifying the air, they emit harmful substances.

Drought has a particularly harmful effect on forest ecosystems, as it can cause damage, diseases and dieback of both individual trees and larger areas. The changes and consequences observed through the analysis of numerous indicators of the state and changes in the urban greenery can give us a long-term perspective and guidelines for managers of resources on how to achieve adaptation and preventive protection (Figure 2).

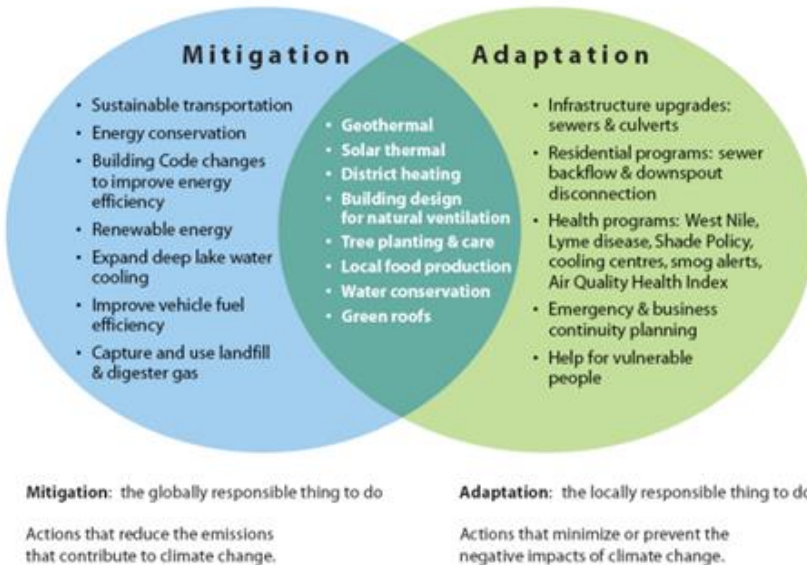


Figure 2. Green spaces as means to both mitigate and adapt to climate change (Source: Kazmierczak, A., Carter, J., 2010)

3.4. Legislation regulating the issue of urban forests

The issues of green infrastructure, environmental protection of urban areas and the impact of climate change on life in them are analysed have been defined by numerous strategic documents and regulations of the European Union. Particularly significant documents and regulations are *Paris Agreement 2015* (UNFCCC, 2015), *European Green Deal 2019-2024* (EU Commission, 2019), *Forging a climate-resilient Europe – the new EU Strategy on Adaptation to Climate Change 2021* (EUR-Lex, 2021), *Cooling buildings sustainably in Europe: exploring the links between climate change mitigation and adaptation, and their social impacts* and others (EEA 2022). Serbia has legislation related to climate change and adaptation to it (Brašanac-Bosanac, 2014). However, there are no regulations and strategies directly relating to the importance and condition of urban forests and green infrastructure in terms of adaptation to climate change (Marić et al., 2015).

4. CONCLUSIONS

Urbanization has occurred relatively rapidly around the world. Cities cover only 2% of the world's land area, but their inhabitants consume over 75% of natural resources, causing numerous and diverse problems. As of 2008, more than 50% of the world's population lives in cities, and this is expected to rise to 70% by 2050. In most cases, the rapid expansion of cities takes place without any land use planning strategy, and the pressure caused by migration leaves harmful effects on the entire environment, climate, forests and green spaces in and around cities. The effectiveness of the urban green space system depends on the mutual relationship with its environment, especially with the suburban forest areas and the greenery in them. That is why it is necessary to consider the city and its suburban zone as a unique spatial planning and regional unit.

The results of numerous research studies indicate that unfavorable climatic conditions caused by rising temperatures, decreasing precipitation and other extreme weather events may have long-term consequences on the distribution, function and production of urban forests.

The mere existence of regulations, both international and national, is not enough to use green infrastructure to combat climate change and implement adaptation measures. It is necessary to manage forests and other categories of greenery in urban and peri-urban areas in a planned and sustainable manner (respecting the principles of sustainable development and adopting a stricter approach to prevention). Such an approach would improve the quality of life of city residents, enable the adaptation of urban forests and greenery to the existing climate change and prevent future adverse effects.

Implementing sustainable management of urban greenery will:

- ***reduce detrimental effects of climate change*** (by mitigating weather extremes, reducing torrential rainfall, lowering the impact of wind and sandstorms, lessening the “heat island” effect);
- ***create a healthier living environment*** (by filtering air and improving air quality);

- ***create a more diverse and attractive environment*** (by providing a natural experience for residents of urban and peri-urban environments);
- ***provide a more pleasant living environment*** (space for recreation and various social events);
- ***increase biodiversity*** (by creating different landscapes and maintaining cultural traditions).

Based on the obtained research results, it is recommended to have trees in all urban street rows (especially in large cities burdened with air pollution from various sources, such as Belgrade, Novi Sad, Niš, Subotica, etc.) inspected once or twice a year to record problems and propose remedial measures. The application of bio-climatic principles in urban areas is limited, but by promoting the establishment of urban forests and other forms of green infrastructure in the coming period, we can achieve the results we have hoped to achieve. Monitoring, protection, restoration of existing and establishment of new urban forests are only some of the measures to reduce the negative effects of climate change in cities. These measures require certain financial investments to be provided by the local community. They can be partly obtained from different programs and actions that stimulate or subsidize investors (expedited building permitting, discounts on utility services or a financial bonus when building a certain type of green infrastructure, horizontal or vertical greens, etc.).

With the aim of providing conditions for the promotion of larger urban forests in the Republic of Serbia, our recommendations are as follows:

- innovating the proposal of the Draft Law on the Protection and Improvement of Green Areas in accordance with new trends while respecting climate change and the role of green infrastructure;
- establishing legal and planning frameworks in spatial and urban planning in terms of recognising the role of urban forests in achieving energy efficiency;
- drafting the Rulebook for the establishment of monitoring, criteria, assessment of the condition of urban forests in Serbia and recommendations for their improvement, as well as other necessary accompanying regulations;
- promoting research on the health status of trees in urban areas, as well as research that quantifies the positive impacts achieved by urban forests: reducing air temperature, mitigating the impact of “heat islands”, stormwater runoff, air purification, etc.;
- due to the high costs of financing and implementing projects for monitoring and protecting the existing green infrastructure and projects for afforestation of newly-established plantations, it is necessary to achieve mutual cooperation of all stakeholders in the area, while respecting the autonomy of local authorities.

Acknowledgments: *The paper is the result of research within the project COST Action CA20132 “Urban Tree Guard” (European Cooperation in Science and Technology) (2021-2025).*

REFERENCES

- Aram, F., Higuera García, E., Solgi, E., Mansournia, S. (2019): Urban green space cooling effect in cities, ScienceDirect, Heliyon, Volume 5, Issue 4, e01339. <https://doi.org/10.1016/j.heliyon.2019.e01339>
- Brandt, L., Lewis, A. D., Fahey, R., Scott, L., Darling, L., & Swanston, C. (2016): A framework for adapting urban forests to climate change. Environmental Science & Policy, 66, 393-402. <https://doi.org/10.1016/j.envsci.2016.06.005>
- Brašanac-Bosanac, Lj. (2013): Forest ecosystems of Serbia in the function of environmental protection from negative climate changes impact, doctoral dissertation, University of Belgrade, Faculty of Geography – Belgrade, Serbia (In original: *Brašanac-Bosanac, Lj (2013): Šumski ekosistemi Srbije u funkciji zaštite životne sredine od negativnog uticaja klimatskih promena, doktorska disertacija, Univerzitet u Beogradu Geografski fakultet, Beograd*).
- Brašanac-Bosanac, Lj. (2014): Climate changes – Strategies and Legislation in Serbia, Sustainable Forestry, Vol. 69-70, Institute of Forestry, 7-15, Belgrade. <https://scindeks-clanci.ceon.rs/data/pdf/1821-1046/2014/1821-10461469007B.pdf>
- Brune, M. (2016): Urban trees under climate change. Potential impacts of dry spells and heat waves in three German regions in the 2050s. Rep. 24. Germany CSC, Hamburg. <https://www.climate-service-center.de/imperia/md/content/csc/report24.pdf>
- Czaja, M., Kołton, A., Muras, P. (2020): The complex issue of urban trees – stress factor accumulation and ecological service possibilities. Forests, 11(9), 932. <https://doi.org/10.3390/f11090932>
- Dawson, R. (2007): Re-engineering cities: a framework for adaptation to global change, Royal society publishing 365: 3085-3098. <https://doi.org/10.1098/rsta.2007.0008>
- Đurđević, V., Vuković, A., Vujadinović Mandić, M. (2018): Climate changes observed in Serbia and future climate projections based on different scenarios of future emissions, United Nations Development Programme, 6-20. <https://www.klimatskepromene.rs/wp-content/uploads/2021/08/Observed-Climate-Change-and-Projections.pdf>
- EEA (2022): Cooling buildings sustainably in Europe: exploring the links between climate change mitigation and adaptation, and their social impacts. <https://www.eea.europa.eu/publications/cooling-buildings-sustainably-in-europe/> Accessed on 25 November 2022.
- Esperon-Rodriguez, M., Baumgartner, J., Beaumont, L., Lenoir, J., Nipperess, N., Power, S., Richard, B., Rymer, P., Tjoelker, M., & Gallagher, R. V. (2021): Climate-change risk analysis for global urban forests, BioRxiv, The preprint server for biology; <https://doi.org/10.1101/2021.05.09.443030>
- EU Commission (2019): A European Green Deal; Striving to be the first climate-neutral continent; https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en/ Accessed on 25 November 2022.

EUR-Lex (2016): <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52013DC16/> Accessed on 25 November 2022.

EUR-Lex (2021): <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2021:82:FIN> Accessed on 25 November 2022.

Hilbert, D., Roman, L., Koeser, A. K., Vogt, J., & van Doorn, N. S. (2019): Urban tree mortality: A literature review. *Arboriculture & Urban Forestry*, 45(5), 167-200.

Hirons, A., Sjöman, H. (2019): Tree species selection for green infrastructure: A guide for specifiers, issue 1.3. Group TDA.

<http://danida.vnu.edu.vn/cpis/files/References/Vulnerability/assessing%20vulnerability%20to%20climate%20change%20and%20adapting%20through%20green%20infrastructure.pdf>
https://www.ipcc.ch/site/assets/uploads/sites/2/2022/06/SR15_Chapter_1_HR.pdf

IPCC (2000): Land Use, Land-Use Change and Forestry. Watson, R. T., Noble, I. R., Bolin, B., Ravindranath, N. H., Verardo, D. J., Dokken, D. J. (eds.). Cambridge University Press, UK, p. 375.

IPCC (2007): Fourth Assessment Report - Climate change 2007: The Physical Science Basis – Summary for Policymakers, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, <http://www.ipcc.ch>.

IPCC (2009): Meeting Report, Expert Meeting on Detection and Attribution Related to Anthropogenic Climate Change, The World Meteorological Organization, 14–16 September 2009, Geneva, Switzerland, <http://www.ipcc.ch>.

IPCC (2014): Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. [Core Writing Team, R.K. Pachauri, and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151.

IPCC (2014a): Summary for Policymakers. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1–32.

IPCC (2018): An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty, Cambridge University Press, Cambridge, UK and New York, NY, USA, 49-92. doi.org/10.1017/9781009157940.003.

Kazmierczak, A., Carter, J. (2010): Adaptation to climate change using green and blue infrastructure, A database of case studies, The Interreg IVC Green and Blue Space Adaptation for Urban Areas and Eco Towns project (GraBS) http://www.grabseu.org/downloads/Case_Studies_Database_Executive_Summary_FINAL.pdf.

Keeler, B. L., Hamel, P., McPhearson, T., Hamann, M. H., Donahue, M. L., Prado, K. A. M., Arkema, K. K., Bratman, G. N., Brauman, K. A., & Finlay, J. C. (2019): Social-ecological and technological factors moderate the value of urban nature. *Nature Sustainability*, 2(1), 29–38. <https://doi.org/10.1038/s41893-018-0202-1>

Lješević, M. (2005): Urban greenspaces, In: *Urban ecology*, University of Belgrade, Faculty of Geography – Belgrade, Serbia, Institute for environmental protection and GIS, 199-222. (In original: *Lješević, M. (2005): Gradsko zelenilo, U: Urbana ekologija, Univerzitet u Beogradu, Geografski fakultet, Institut za životnu sredinu i GIS, 199-222*).

Marić, I., Crnčević, T., Cvejić, J. (2015): Green infrastructure planning for cooling urban communities: Overview of the contemporary approaches with special reference to Serbian experiences, *Spatium* 2015 Issue 33, pp. 55-61, <https://doi.org/10.2298/SPAT1533055M>

Miller, R. W., Hauer, R. J., & Werner, L. P. (2015). *Urban forestry: Planning and managing urban greenspaces*. Waveland Press, Inc.

Steenberg, J. W., Millward, A. A., Nowak, D. J., Robinson, P. J. (2017): A conceptual framework of urban forest ecosystem vulnerability. *Environmental Reviews*, 25(1), 115–126. <https://doi.org/10.1139/er-2016-0022>

UNFCCC (2015): The Paris Agreement; <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement/> Accessed on 25 November 2022.

UN (2018): The 2018 Revision of World Urbanization Prospects, United Nations, Department of Economic and Social Affairs; <https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html>

Vogt, J., Gillner, S., Hofmann, M., Tharang, A., Dettmann, S., Gerstenberg, T., Schmidt, C., Gebauer, H., Van de Riet, K., & Berger, U. (2017). Citree: A database supporting tree selection for urban areas in temperate climate. *Landscape and Urban Planning*, 157, 14–25. <https://doi.org/10.1016/j.landurbplan.2016.06.005>

URBAN FORESTS AND CLIMATE CHANGES

*Ljiljana BRAŠANAC-BOSANAC, Tatjana ĆIRKOVIĆ-MITROVIĆ,
Nevena ČULE, Goran ČESLJAR, Saša EREMIJA, Ilija ĐORĐEVIĆ*

Summary

The impacts of climate change on urban forests are still poorly understood and quantified. Complex interactions within multifunctional urban systems, such as infrastructural corridors, roads and park areas force us to view space as an integrated whole and adjust the interest of individual sectors to the general interest of environmental protection. Due to the increasingly dynamic urban development trends and their impact on the environment, the modern approach to planning urban areas is increasingly turning to strategic planning of urban forest and green infrastructure establishment as a way of combating climate change effectively. An inventory of the condition of urban trees and continuous monitoring are necessary to provide essential information about urban forests and their ability to adapt to future climate changes.

URBANE ŠUME I KLIMATSKE PROMENE

*Ljiljana BRAŠANAC-BOSANAC, Tatjana ĆIRKOVIĆ-MITROVIĆ,
Nevena ČULE, Goran ČEŠLJAR, Saša EREMIJA, Ilija ĐORĐEVIĆ*

Rezime

Efekti klimatskih promena na urbane šume još uvek su nedovoljno shvaćeni i kvantifikovani. Složene interakcije unutar višenamenskih urbanih sistema, poput infrastrukturnih koridora, saobraćajnica i parkovskih površina nameće potrebu za integrativnim sagledavanjem prostora, u kojem se sektorski interesi prilagođavaju potrebama opšteg interesa zaštite životne sredine. Kao posledica sve dinamičnijih razvojnih trendova gradova i njihovog uticaja na životnu sredinu, savremeni pristup planiranja urbanih celina sve se više okreće strateškom planiranju podizanja urbanih šuma i zelene infrastrukture kao načinu efikasne borbe protiv klimatskih promena. Da bi se dobile potrebne informacije o urbanim šumama i njihovoj sposobnosti da se prilagode budućim klimatskim promenama neophodno je izvršiti popis stanja gradskog drveća i kontinuirano pratiti sve promene.