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**DEVELOPMENT OF RESEARCH ON THE EFFECT OF
GREEN INFRASTRUCTURE ON THERMAL
CONDITIONS IN CITIES OF EUROPE: AALBORG,
BRAGA, STUTTGART AND LESKOVAC**

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FOREWORD

Landscape architecture represents a profession that is not only focused on shaping and aesthetics of cities and populated areas but also influences the improvement of environmental factors. A geographic information system represents an organized set of computer hardware, software, data, personnel, and networks for the efficient collection, storage, updating, handling, analysis, modeling, transmission, and display of all forms of spatial information - geospatial data. Seemingly two separate disciplines intertwine and complement each other in various ways.

As a graduate landscape architect with many years of experience in a public enterprise engaged in urban planning and the arrangement of public green spaces, I found it necessary to complement my future plans and projects with a clear, reliable, and accurate database system in which the data is spatially indexed, that is, to connect GIS, landscape architecture, and urbanism. What this work demonstrates is the integration of urbanism, landscape architecture, and GIS in terms of improving the environment with an emphasis on thermal conditions. This is just one aspect of the connection.

By implementing geographic information systems into my future profession, I believe I can enhance my further professional activity as an urban planner. The work utilized material from a program addressing the issue of social housing in four countries - Denmark, Portugal, Germany, and Serbia - Deliver safe and Social Housing - Horizon Europe MSCA Staff Exchange, of which I am an active participant and thanks to which I visited the mentioned countries and gained insight into their planning and urban systems.

1. INTRODUCTION

1.1. THE IMPORTANCE OF GREEN SPACES IN CITIES

"Establishing and maintaining an urban green system is extremely important in contemporary urban planning theory and practice. An optimal green system should fulfill a complex ecological, bioclimatic, functional, and aesthetic role, simultaneously uniting different functional zones into a cohesive compositional whole and establishing a connection between the city and the surrounding nature through suburban greenery" (Anastasijević, 1987).

There are various methods for grouping the functions of green spaces in the city. The division that encompasses most of the functions performed by greenery in the city:

1. Ecological-protective role - depends on the area covered by greenery, the type and size of plants, and the size of the city (Đukanović, 1991):

a) wind protection role - trees are more elastic than buildings, thus they more effectively absorb wind impacts. The presence of greenery reduces wind speed by 40-50%, and in a wide green zone with dense plantings, it is possible to completely eliminate wind strength. At a distance of 50 m from a green belt of average width and height, wind speed decreases by up to 50%;

b) thermal protection - greenery reduces summer heat by 3-5°C, decreasing radiation from buildings, sidewalks, and roadways;

c) preservation of humidity regime - greenery emits a greater amount of moisture during the summer. The relative humidity of a forest is 7-15% higher than in surrounding areas;

d) reduction of air pollution - plants absorb polluting gases and dust. In parts of the city with large areas of greenery, air pollution is 2-3 times lower;

e) protection from radioactive radiation - plants have the ability to absorb radioactive materials, so forested areas can reduce the amount of radioactive materials in the air by 25-50%;

d) Noise reduction - it has been proven that vegetation lowers urban noise levels by up to 25% and weakens sound fluctuations. Behind greenery positioned directly facing the street, noise is reduced by 7-18 dB. Protective tree belts around highways reduce noise levels by 5 dB, while shrubbery reduces it by 10 dB;

e) Oxygen enrichment - during the process of photosynthesis, plants produce oxygen while consuming carbon dioxide. Cities with industry are the largest consumers of oxygen (human metabolism, energy supply, technological processes);

ž) Bioindicator of air pollution - plant organisms are extremely sensitive to adverse effects from the surrounding environment. Lichens are most commonly used, but some woody plants are also utilized;

2. Health role - in a large city, the human organism is under constant pressure, and nature provides the best way to restore psycho-physical energy. In this sense, greenery:

a) creates more comfortable living conditions in the city - modifies microclimatic conditions by reducing surface runoff, daily and annual temperature amplitudes, and increasing air humidity while alleviating the "urban heat island" effect;

b) air ionizer - green plantings increase the amount of light ions threefold, which positively affects the human organism; phytoncidal (bactericidal) properties - many plants release phytoncides, airborne substances that destroy pathogenic bacteria. In the forest, especially coniferous, there are 200 times fewer bacteria than on the streets of the city;

3. Emotional-psychological role - vegetation affects all senses, soothing tension and reducing mental fatigue;

4. Aesthetic function - the diversity of decorative plants provides unlimited possibilities in the formation of green spaces; they beautify dilapidated buildings or aesthetically insufficiently quality parts of the city; the shapes and colors of green plantings evoke various feelings; a part of the city's identity;

5. Architectural-urban function - creates spatial form and silhouette of the city, beautifying it and contributing to diversity. An essential element around architectural structures, it is used to reduce or enlarge the space between individual buildings, articulating undefined space;

6. Engineering-technical function:

a) prevention of soil erosion - prevents aeolian and water erosion (flash floods);

b) Traffic control - separates pedestrian from vehicular traffic; c)

Protection from snow drifts - from wind that carries snow;

d) Reflex control - many buildings have reflective surfaces, which negatively affect health, so proper plant arrangement is important; e) Landslide stabilization - strong roots can prevent landslides

of smaller and medium scale;

f) Fire protection function - plants mitigate urban fires as they burn slower than buildings and reduce wind strength. Therefore, they are a mandatory part of the infrastructure in cities in warm areas and in settlements with flammable industries;

g) Wastewater purification - together with the soil, they represent a "natural filter" for wastewater as they have the ability to renew the biosystem;

7. Educational function - familiarizing residents with the plant world, where the size of green areas is the most important;

8. Sociological and cultural function - parks are significant for establishing interpersonal contacts, such as organizing events, concerts, and various types of entertainment and competitions;

9. Economic function - they increase the value of real estate located nearby;

10. Specific functions of greenery:

a) Recreational - active and passive recreation,

b) The function in war and disasters — during war, the presence of dense greenery is significant. In times of disaster, the population often gathers in parks.

Based on the mentioned functions, it can be concluded how comprehensive the role of vegetation is in the city. Its significance in the proper functioning of the urban ecosystem is irreplaceable, thus representing a necessary element for polluted urban environments and a prerequisite for a better quality of life and work.

In every urban area, it is essential to form a connected network of natural landscapes, protected areas, agricultural landscapes, and other green spaces that enable the survival of indigenous species, maintain natural ecological processes, provide opportunities for recreation, and contribute to improving health and quality of life. In zones where the natural and ecological framework overlaps, the stability of the system is preserved. In places where elements of the ecological framework and anthropogenic structures intertwine, conflict zones with pronounced degradation of the natural system are formed. To avoid this, the basic architectural-urban development zones should be planned in other locations (Ong, 2003).

1.2. CLASSIFICATION OF THE GREEN SYSTEM

The extent to which greenery in the city will succeed in fulfilling all the mentioned functions is conditioned by the spatial arrangement of its elements. There are many classifications of green systems, and the following division is most commonly used (Vujković, 1988).

- The ring (belt) system of greenery is characterized by the creation of concentric green belts that encircle the city. It originated in the 17th century and was most formed around European cities in the 19th century, on the site of destroyed defensive walls and fortifications or moats. A characteristic example includes the circular boulevards in Paris, Cologne, the ring around Vienna, etc. In cities with strong air currents, these belts can improve microclimatic conditions, especially if two or three rings are formed.

- The radial (wedge) system of greenery is formed in cities with a significant influence of physical-geographical conditions (river valleys, gorges, etc.) on the structure of settlements, and thus the green system. In the form of wedges, greenery reaches the very center of the city, often following the river flow. At the same time, it is connected with green plantings on the periphery, ensuring natural ventilation of the city. The radial system can be seen in Hanover and Dresden.

- The mosaic system (the "green spots" system) implies a free arrangement of green areas throughout the entire city. Greenery is evenly distributed in all parts of the settlement, regardless of the different needs in the center and on the periphery. The advantage of this model is its small service radius, but it often does not provide the necessary amounts of greenery. Spatial disconnection reduces its ecological and microclimatic functionality. It was planned at the end of the 19th century and can be functional in smaller non-industrial cities.

- The linear (strip) system was most commonly formed at the end of the 19th century in settlements with a geometric street network, characteristic of American cities. It has also found application in the model of the linear city.

The mentioned models of green surface systems only address certain problems in the city, while the overall problem of greening can be solved by applying a combined system. This comprehensive approach means connecting evenly distributed green areas of residential blocks with green corridors, boulevards, and protective belts. Thus, it is possible to maximize all the functions of greenery (Vujković, 1995). The wedge model of the green system has been implemented in urban and planning documents of a number of cities in Europe.

1.3. ELEMENTS OF THE GREEN SYSTEM AND THEIR CLASSIFICATION

The system of green spaces in the city is complex and diverse. It is formed by elements of different functions, shapes, sizes, compositions, vegetation compositions, as well as architectural objects and other elements that are located within them.

Classification of all types of green spaces can be performed based on various criteria. Today, classifications based solely on the size of green spaces or based on the nature of leisure and recreation (active and passive leisure) have obvious shortcomings. A more comprehensive classification is based on the position of green spaces in relation to the settlement (urban, suburban, and exurban).

1. It is acknowledged that private green spaces are not only used by their owners, but they also have multiple positive effects on the environment. Based on this criterion, the German literature has accepted the division into public open spaces, private open spaces, and green elements. A different division is proposed by authors from Eastern European countries (Vujković, 1995), who distinguish the following categories:

1. public green spaces,
2. green spaces of limited purpose, and
3. green spaces of special purpose.

As the aforementioned classification does not encompass certain forms of greenery, different from others by their location or by the technology of establishment, Anastasijević proposes a fourth category of "specific green spaces."

According to Vujković, urban green spaces are divided into two large groups: a)
green spaces within the settlement — urban greenery
b) green spaces outside the settlement — exurban greenery.

In this sense, all previously mentioned green spaces within the settlement are classified as follows:

1. green surfaces of a protective nature,
2. Park-forest and forest-parks, and
3. green areas along traffic routes outside settlements.

The best effect is achieved by connecting all green areas of different uses and sizes into a unique and functional green system. The green system of cities represents Green Infrastructure, which the Law on Planning and Construction, in its latest amendment from 2023, recognized as a "strategically planned network of functionally connected natural and near-natural elements, whose design, establishment, use, and maintenance are carried out in a way that ensures ecological, economic, and social benefits through natural, biodiversity-based solutions. The formation of green infrastructure is based on the green system, whose goal is to protect and connect the green ring around the city and the urban greenery and their networking with linear greenery to enable the realization of all planned functions" (Law on Planning and Construction "Official Gazette of RS", No. 72/09, 81/09 - corrected, 64/10 - decision of the Constitutional Court, 24/11, 121/12, 42/13 - decision of the Constitutional Court, 50/13 - decision of the Constitutional Court, 98/13 - decision of the Constitutional Court, 132/14, 145/14, 83/18, 31/19, 37/19 - other law, 9/20 and 52/21).

To better see the impact of green infrastructure, it is necessary to include information that can be obtained through remote sensing of satellite images, with the aim of studying the thermal living conditions in cities whose green area systems - green infrastructure are being analyzed.

Research topic/problem: Before the planning process, and then the implementation of Green Infrastructure, it is necessary to monitor the existing state. One type of monitoring that has not been applied so far is the use of satellite images for studying thermal conditions. In this way, the most problematic points in the city will be identified, and where it is advisable to form a park, tree-lined avenue, or at least an individual garden or green wall to reduce temperature extremes. At the same time, the state of green infrastructure and thermal conditions in four medium-sized cities in Denmark, Germany, and Portugal was studied. The research will show the development of their green infrastructure and its impact on the microclimate, with an emphasis on temperature. These examples can demonstrate how a developed system of green areas can affect the environment. The paper will present the possibility of their application in the case of cities in Serbia, along with recording and addressing errors and deficiencies.

Subject of the work: Analysis of the impact of the green infrastructure system on thermal conditions in medium-sized cities.

Objective of the work: Presenting a concept that highlights the importance of having a developed green infrastructure in cities, aimed at contributing to better living conditions through various solutions.

Task of the work: Indicating the possibilities for the development of green infrastructure considering its positive impact on the environment.

Methods of work: The methods to be used for the preparation of this master's thesis are: research of various literature sources and sources in electronic form, statistical, comparative, and cartographic methods.

2. LEGAL AND PLANNING BASIS

The planning system represents a set of general legal acts that define the way space is managed; it is common for most of them to be based on a single law, a general legal act, which regulates planning by establishing a hierarchical series of strategies and plans.

Urban and spatial planning is more than a technical instrument; it is an integrative and participatory decision-making process that deals with conflicting interests and is connected to a common vision, an overall development strategy, and national, regional, and local urban development policies.

National governments, in collaboration with other administrative bodies and relevant partners, should develop a legal and institutional framework for urban and spatial planning that ensures that the instruments and cycles of economic planning and national sectoral policies are taken into account when preparing urban and spatial plans and vice versa, that the key economic role of cities and territories is clearly reflected in plans at the national level" (UN-Habitat, 2020).

Although planning systems differ from country to country, the legal and institutional framework referred to by UN Habitat begins at the national level: it is usually composed of one or more legal acts that establish the planning system as a hierarchically arranged series of strategies and plans, defining their content, method of preparation, and verification or legal activation.

The national level, in addition to laws, usually has a spatial development strategy that is often elaborated through the spatial plan of a state. The national spatial plan is almost invariably not the only document of such broad scope; often, at the national level, development projects of significance for the entire country are defined and planned through infrastructure plans as well as plans for the use of natural resources of national importance.

The regional level of the planning system usually elaborates on the plans of the national level, implementing strategic points of development important for the region in more detail.

Community plans are generally urbanistic: they start from strategies for urban development through general planning of a certain time perspective, elaborated through plans that define zones of predominant use, culminating in detailed urban plans that consider space down to the level of individual parcels.

2.1. PLANNING SYSTEM OF DENMARK

The planning system of Denmark is described by the basic Planning Act (Planloven) (internet source 20), which was adopted in 1992 and has since been amended multiple times to adapt to the needs of societal development in general.

It defines the hierarchy of spatial and urban plans, rules of compliance, and procedures for public participation. Its primary goal, described in Article 1, is "to ensure coherent planning that integrates public interests in land use, protects nature, the environment, and climate, and creates good frameworks for growth and development throughout the country. Planning should be sustainable, respecting the living conditions of people, preserving plant and animal life, and enhancing economic well-being" (internet source 20).

Denmark is divided into three zones according to the Planloven: byzone (urban zone), landzone (rural or countryside zone), and sommerhusområde (holiday home zone). The main goal of zoning is to prevent (or control) inconsistent, unplanned development and construction in open spaces (rural areas). Additionally, zoning defines where a city can expand and where development must be restricted. Changes in land use, construction, and parceling in urban zones or in holiday home zones are subject to zoning conditions that are

included in the municipal (kommune) and local plan. The law mandates hierarchical consistency: a lower-order plan, or one with a smaller scope, must not contradict a higher-order plan, or one with a broader scope. It also imposes a requirement for public consultations, as well as access to all phases of planning. Local governments have the authority to develop and adopt municipal and local plans. It should be noted that the planning system looked different before the municipal reform of 2007. Denmark then reduced the number of municipalities (kommune) from 271 to 98, mainly by merging smaller ones into larger ones, the counties (amter) were abolished, and instead, 5 regions (regioner) were established - but with very limited powers. In the field of spatial planning and development, significant changes occurred, primarily the abolition of classical regional planning. Before 2007, each county (amt) had a regional plan that coordinated spatial development over a wider geographical area (e.g., the layout of new urban zones, major traffic routes, nature protection). After the reform, the regions have no authority for spatial planning. Their role is mainly reduced to certain regional development strategies, thus practically eliminating the entire intermediate level of planning between the state and the municipality. The municipalities have taken on the main role in planning; they now have the key responsibility for kommuneplan (municipal plan) and lokalplaner (local plans), having received much greater authority in determining how land will be used, where development will occur, and which areas will be protected.

2.1.1. PROGRAMS, STRATEGIES, AND PLANS

o NATIONAL PLANS AND NATIONAL DIRECTIVES (LANDSPLANDIREKTIVER - NATIONAL PLANNING DIRECTIVES)

This legislation (Landsplandirektiver - National planning directives) is enacted by the Government, specifically the competent ministry for the environment and planning. They set binding frameworks (e.g., nature protection, transport corridors, major infrastructure projects) for all lower plans that must comply with them. The minister responsible for planning has the right to issue directives or to appeal against municipal plans if they are not in accordance with national interests (such as coastal protection, cultural heritage sites, infrastructure). In short, their function is to coordinate strategic, intersectoral goals (e.g., nature protection, infrastructure, major urban projects). A characteristic plan is the Finger Plan 2019 (Internet source 1), an important directive that defines the directions for the development of a large urban area and how municipalities within the area should plan development.

o MUNICIPAL PLAN (KOMMUNEPLAN / MUNICIPAL PLAN)

It is the obligation of municipalities to have a municipal plan (kommuneplan), which must be revised at certain intervals and which provides a framework for local plans. The municipal plan determines long-term development directions, as well as basic urban policies, land use and purpose, planned infrastructure, residential and commercial zones, and the protection of natural areas. It is adopted by the municipal council and covers the entire territory of the municipality.

o LOCAL PLAN (LOCAL PLAN)

This is the most detailed level of planning – it regulates the appearance and use of land down to the level of individual parcels, building heights, purposes, and deals with the protection of cultural heritage. It is mandatory when a project significantly changes the existing state, parceling, or land use, or when it involves a change (construction) within urban zones. According to the hierarchy of plans, it must comply with the municipal plan.

Municipal and local plans are developed by the administrations of local governments, and in the process between the developer and the local executive body that adopts it, there are no expert commissions or other bodies, but it can be influenced by the public.

2.1.2. AALBORG

In accordance with the obligations of the Planning Act (Planloven), the city of Aalborg has its Kommuneplan (municipal plan) (internet source 1).

Municipality	Plan name / tillæg-a	Dates of adoption / consideration
Aalborg	Kommuneplantillæg 3.025 (Sofiendal Enge)	September 2017 - plan for a specific location .apps.aalborgkommune.dk+1
Aalborg	Kommuneplantillæg 5.025 (new housing in the northern part of Vadum)	November 2017 - specific location apps.aalborgkommune.dk+1

Table 1. Planning System of Olborg

Source: Ivana Momić, for the needs of Deliver Safe and Social Housing, <https://www.dashousing.eu/>

2.2. PLANNING SYSTEM OF PORTUGAL

The system of spatial and urban planning in Portugal is based on a hierarchically defined structure of plans at the national, regional, and local levels. This system was established by a unique law that regulates the area of spatial planning: Lei de Bases da Política de Ordenamento do Território e de Urbanismo – the Law on the Basics of Spatial and Urban Planning from 2015, which amended the older law No. 48/98 from 1998.

As key objectives, the Law states:

- Sustainable territorial development, through promoting a balanced relationship between development and the preservation of natural resources,
- Territorial cohesion, which should lead to a reduction of regional inequalities,
- Democratic participation, or the active involvement of citizens and civil society in planning,
- Transparency and accountability through the responsibility of institutions for the implementation of the Law and its provisions, as well as the public presentation of plans, strategies, and policies,
- Integration of sectoral policies, through aligning spatial planning with transport, environmental protection, housing policies, etc.

2.2.1. PROGRAMS, STRATEGIES, AND PLANS

NATIONAL LEVEL

PNPOT, National Program for Spatial Planning is a national strategic program for spatial organization. It is an instrument that defines the goals and strategic options for spatial planning in Portugal, serving as a framework document that acts as a starting point for all other plans and programs, both at the regional and municipal levels. It includes strategies and models for organizing territory, as well as an Action Program with measures to be implemented. Its role is to

guide and coordinate public policies that have a spatial aspect - infrastructure, natural resource protection, transport, urbanization, risks (floods, climate change), demographic changes, etc.

National Strategy for Territory (Estratégia Nacional para o Ordenamento do Território – ENOT). It is adopted by the Government of Portugal (Ministry of Territorial Cohesion). It defines the long-term development goals of the country, territorial balance, and priorities for intervention. It serves as a guide for the preparation of plans at the regional and local levels.

Between the national and regional level documents, there are two programs; Sectoral Programs (PS) and Special Programs (PE / PEOT). These two programs are adopted by the Government of Portugal and can address both national and regional levels.

- o **SECTORAL PROGRAMS (PS)**

Sectoral programs, PS, relate to sectoral policies of national significance (transport, energy, water, nature protection, agriculture, etc.), and their approval falls under the jurisdiction of central authorities, meaning they are instruments at the national level in the territorial planning management system (Sistema de Gestão Territorial).

- o **SPECIAL PROGRAMS (PE / PEOT)**

Special programs, PE, regulate areas of public interest and national significance (coastal zone, estuaries, public reservoirs, natural protected areas), and their adoption must occur at the state level. The development of these programs is handled by specialized institutions – e.g., the Portuguese Environment Agency (Agência Portuguesa do Ambiente) for coastal programs (POC), or another relevant national institution.

- o **REGIONAL LEVEL - SPATIAL PLANNING PROGRAMS (PROGRAMAS REGIONAIS DE ORDENAMENTO DO TERRITÓRIO – PROT)**

It covers the continental regions of Portugal (e.g., Alentejo, Algarve, Norte). It develops objectives from the ESDP. It does not make detailed urban planning, but sets frameworks for development and space protection.

- o **LOCAL LEVEL (KEY PLANNING LEVEL)**

Local authorities (municipalities) have the greatest operational role in urban planning. They develop and adopt the following plans:

- a) Municipal directive plan (Plano Diretor Municipal – PDM) represents the Strategic plan for the entire territory of the municipality, determining zones for urbanization, rural areas, as well as agricultural, forest, water land, protected areas, etc.

- b) Urbanization plan (Plano de Urbanização – PU) is a more detailed plan for parts of the municipality (e.g., urban centers). It determines urban parameters, infrastructure networks, and land regulation.

- c) Detailed planning plan (Plano de Pormenor – PP) is the most detailed plan, often related to specific projects or development zones. It prescribes specific dimensions for buildings, roadways, and green areas.

There are also special spatial tools, namely documents and procedures used in special cases, as well as instruments for territorial cohesion funded by European Union funds.

Instrument	Level	Who develops	Who adopts
PNPOT – National Program for Land Use Policy of the Territory	National	General Directorate for Territory (Direção-Geral do Território)	Assembly of the Republic (Parliament)
PS – Sectoral Programs	National (sectoral)	Competent ministry for a specific sector (e.g., transport, energy, ecology)	Council of Ministers (Government)
PE – Special Programs (formerly PEOT)	National / special zone	Competent state agency (e.g. Portuguese Environment Agency)	Council of Ministers (Government)
PROT – Regional Spatial Planning Plans	Regional	Commission for Regional Coordination and Development (CCDR)	Council of Ministers (Government)
PDM – Municipal Master Plans	Municipal	<i>Municipality (City Council)</i>	Municipal Assembly
PU / PP – Urbanization Plans / Detailed Plans	Municipal / Urban Planning	<i>Municipality (City Council)</i>	Municipal Assembly

Table 2. Planning System of Portugal

Source: Ivana Momić, for the needs of Deliver Safe and Social Housing, <https://www.dashousing.eu/>

2.2.2. CITY OF BRAGA (BRAGA)

o PROT-NORTE

PROT-NORTE is a regional spatial planning scheme for Northern Portugal, aimed at implementing the NORTE 2030 Development Strategy as a key instrument. It contains a vision of cohesion, inclusion, sustainability, and better access to housing services.

o MUNICIPAL DIRECTORATE PLAN (PDM) BRAGA

The PDM of Braga consists of: Regulations (Regulamento), Land Use Plan (Planta de Ordenamento), which defines classification, zoning, and construction conditions, Land Use and Restriction Plan (Planta de Condicionantes) such as restrictions related to agricultural land, fire protection, noise, etc., as well as supplementary studies and reports – annexes, plans, analyses, environmental studies, and public participation.

2.3. PLANNING SYSTEM OF GERMANY

2.3.1. PROGRAMS, STRATEGIES, AND PLANS

Generally, it can be said that the planning system of the Federal Republic of Germany is the most complex compared to the other observed countries: Denmark, Portugal, and Serbia. This is primarily due to the complex state structure of the Federal Republic of Germany. According to data from Destatis (Federal Statistical Office, Wiesbaden, Germany), as of December 31, 2018 (fourth quarter), Germany had 16 federal states, 19 administrative districts, 294 counties, 107

independent cities (including city-states), 1,245 municipal associations, and 11,014 municipalities (excluding uninhabited unincorporated areas).

The planning system is described in a unique, overarching planning law: Raumordnungsgesetz (ROG). The first article of the law, § 1: "The entire territory of the Federal Republic of Germany and its subregions is developed, organized, and secured through comprehensive, supra-local, and interdisciplinary spatial development plans, through cooperation in spatial planning, and through coordination of spatially significant plans and measures" (Raumordnungsgesetz (ROG) — Federal Law on Spatial Planning, December 22, 2008, Berlin, Germany).

Similar to spatial organization, planning takes place at the following levels: federal, provincial, regional, and local levels.

o *FEDERAL LEVEL (BUNDESEBENE)*

Based on the federal law Raumordnungsgesetz (ROG), the Federal Ministry for Spatial Development and Construction (Bundesministerium für Wohnen, Stadtentwicklung und Bauwesen - BMWSB) issues the Raumordnungsbericht (Spatial Development Report) approximately every 4 to 5 years, informing the Federal Government (Bundesregierung) and Parliament (Bundestag) about the state and trends of spatial development in Germany. The document is not legally binding but serves as a basis for planning and political decisions at higher levels.

The second document at the federal level is Leitbilder und Handlungsstrategien der Raumordnung des Bundes (Guidelines and Strategies for Spatial Development at the Federal Level). It defines the general goals of spatial development (balanced development, sustainability, nature protection, decentralization, etc.), and while it does not impose direct legal obligations on local plans, it sets framework guidelines for all lower levels. It is jointly issued by federal and state authorities within the Conference of Ministers for Spatial Planning (Ministerkonferenz für Raumordnung – MKRO). This document is crucial as it aligns the views of the federal level and the 16 states (Länder) on the priorities of spatial development and serves as a strategic framework for state plans (Landesentwicklungsplan).

o *STATE LEVEL (LÄNDER / LANDESEBENE)*

Since spatial and urban planning is not explicitly under the jurisdiction of the federation, it follows that each state has its own planning law, meaning the federal government sets the framework while the states regulate the application in detail.

The basic documents at this level are Landesentwicklungsplan and Landesraumordnungsprogramm (State Development Plan / Spatial Plan of the State). The plan determines: spatial priorities within the state, main infrastructure corridors, areas for nature protection, and rural development, in compliance with federal guidelines.

o *REGIONAL LEVEL (REGIONALPLANUNGSEBENE)*

A region consists of multiple municipalities, and the basic document at this level is the Regional Plan (Regionalplan). It primarily establishes the spatial structure of the region, the distribution of settlements, transportation and infrastructure networks, and areas for industry, agriculture, and recreation. It is aligned with the state plan and is mandatory for local urban planning. The regional plan is adopted by the competent regional planning authority, which depends on the organization of each federal state (Land), such as regional associations (Regionalverbände), and in some states, it may be administrative districts (Regierungsbezirke) or state authorities.

According to the German Raumordnungsgesetz (ROG), the overarching federal planning law and state planning laws: the Regional Plan is developed and adopted

by the regional planning body (Träger der Regionalplanung) that operates within the jurisdiction of the state but is independent in terms of expertise.

A model of the province of Baden-Württemberg is presented: The competent authority for adoption is the Regionalverband (regional association). It consists of twelve planning regions (e.g., Region Stuttgart, Region Rhein-Neckar, Region Schwarzwald-Baar-Heuberg, etc.). The plan is adopted by the Regionalversammlung (regional assembly), i.e., the representative body of the Regionalverband, and it becomes legally valid upon receiving the consent of the provincial ministry (Ministerium für Landesentwicklung und Wohnen BW) and publication in the Regionalem Amtsblatt.

o *LOCAL LEVEL*

The local, municipal level (Kommunale Ebene) has two types of plans, differing in scope and detail.

Flächennutzungsplan (FNP) – Land Use Plan

This is a general plan that covers the entire territory of the municipality, defining land use, i.e., dividing it into residential, industrial, agricultural, green areas, water land, land intended for infrastructure, and similar categories.

Bebauungsplan (B-Plan) – Development Plan

This is a classic detailed urban plan for a specific area (e.g., neighborhood, block, street). It is legally binding for investors and citizens, aligned with the Land Use Plan. It determines: the type and density of construction, number of floors, building or regulatory lines, land use, and the arrangement of traffic and green areas.

2.3.2. CITY OF STUTTGART

The vertical structure of hierarchically defined laws and plans in the example of the province of Baden-Württemberg, the Stuttgart region, and the city of Stuttgart would look like this:

Level	Document Name (DE)	Title in Serbian	Body that adopts / enacts	Note
1. Federal level	Spatial Planning Act (ROG)	Law on Spatial Planning of the Federal Republic of	German Bundestag (Federal Parliament) and Bundesrat (Federal Council)	Basic Law
2. Provincial level – law	State Planning Act of Baden-Württemberg (LplG BW)	Law of the Province of Baden-Württemberg	Landtag of Baden-Württemberg (Provincial Assembly)	Regulates the organization of provincial planning
3. Provincial level – plan	State Development Plan of Baden-Württemberg (LEP BW)	Provincial Spatial Planning Plan	Provincial Government (Landesregierung Baden-Württemberg) – on	Main Strategic Development Plan of the Province
4. Regional level	Regional plan of the Stuttgart Region	Regional plan for the Stuttgart Region	Regional Assembly of the Association Region Stuttgart (Regional Assembly of the Regional Association Stuttgart)	Binding plan for all municipalities in the Stuttgart region
5. Municipal level (strategic)	Land use plan of the state capital Stuttgart (FNP Stuttgart)	Land use plan of the city of Stuttgart	Municipal Council of the state capital Stuttgart (City Council of Stuttgart)	sets the framework for detailed urban planning
6. Municipal level (thematic)	Landschaftsplan Stuttgart (“LSP”)			
Nature and Landscape Plan of the City of Stuttgart	Municipal Council of the State Capital Stuttgart (City Council of Stuttgart)	A plan that develops measures for the protection of nature and		

Table 3. Planning System of Germany

Source: Ivana Momić, for the needs of Deliver Safe and Social Housing, <https://www.dashousing.eu/>

2.4. PLANNING SYSTEM OF SERBIA

2.4.1. PROGRAMS, STRATEGIES, AND PLANS

o NATIONAL LEVEL

The fundamental law that establishes and defines the planning system in Serbia is the Law on Planning and Construction, along with other regulations significant for spatial and urban planning, as well as the Regulation on the Content, Method, and Procedure for the Development of Spatial and Urban Planning Documents (“Official Gazette of the Republic of Serbia”, No. 32/19) with other regulations significant for spatial and urban planning.

The documents of spatial and urban planning are:

- 1) planning documents;
- 2) Documents for the implementation of spatial plans;
- 3) Urban-technical documents;
- 4) Strategy for Sustainable Urban Development of the Republic of Serbia;
- 5) National Architectural Strategy.

Planning documents are spatial and urban plans. Spatial plans are:

- 1) Spatial Plan of the Republic of Serbia;
- 2) Regional Spatial Plan;
- 3) Spatial Plan of the local self-government unit;
- 4) Spatial Plan of the area of special purpose.

Urban plans are:

- 1) General Urban Plan;
- 2) General Regulation Plan;
- 3) Detailed Regulation Plan.

The preparation and adoption of planning documents are of public interest for the Republic of Serbia. Planning documents are prepared for a period of no more than 25 years.

2. Spatial Plans

2.1. Spatial Plan of the Republic of Serbia

The Spatial Plan of the Republic of Serbia is adopted for the territory of the Republic of Serbia and is the basic planning document for spatial planning and development in the Republic.

Other planning documents must be in accordance with the Spatial Plan of the Republic of Serbia.

The Spatial Plan of the Republic of Serbia has a strategic-development and general regulatory function.

The Spatial Plan of the Republic of Serbia is adopted for a period of at least 10 years and no more than 25 years.

REGIONAL LEVEL - REGIONAL SPATIAL PLAN

The regional spatial plan is developed for larger spatial units of an administrative, functional, geographical, or statistical nature, aimed at common goals and projects of regional development. The regional spatial plan is a planning document that, while considering the specific needs arising from regional particularities, elaborates on the objectives of spatial planning and determines the rational use of space, in accordance with neighboring regions and municipalities.

The regional spatial plan contains the following:

- 1) the starting basis for the development of the plan;
- 2) an assessment of the existing state;
- 3) the goals and principles of regional spatial development;
- 4) the concept of regional spatial development;

- 5) the principles and propositions for the protection, arrangement, and development of nature and natural systems;
- 6) the concept and propositions for spatial development and distribution of the population, the network of populated areas, and public services;
- 7) functional connectivity of populated areas;
- 8) the principles and propositions for spatial development of the economy, distribution of activities, and land use;
- 9) spatial development of transportation, regional infrastructure systems, and connectivity with infrastructure systems of significance for the Republic of Serbia;
- 10) Measures for the protection, arrangement, and enhancement of natural resources and immovable cultural assets;
- 11) Defining interregional and intraregional functional connections and cross-border cooperation;
- 12) Measures for environmental protection;
- 13) Measures to promote regional development;
- 14) Measures for balanced territorial development of the region;
- 15) Measures and instruments for the implementation of the regional spatial plan and priority planning solutions, as well as strategic development projects for the first phase of implementation;
- 16) Measures for the implementation of the regional spatial plan.

LOCAL LEVEL - SPATIAL PLAN OF THE LOCAL SELF- GOVERNMENT UNIT

The spatial plan of the local self-government unit is adopted for the territory of the local self-government unit and determines guidelines for the development of activities and land use, as well as conditions for sustainable and balanced development in the territory of the local self-government unit.

- The spatial plan of the local self-government unit contains, in particular:
- 1) the circumference of the construction area;
 - 2) spatial planning;
 - 3) settlement network and distribution of services and activities;
 - 4) spatial development of traffic and infrastructure systems;
 - 5) parts of the territory for which the preparation of an urban plan or urban project is envisaged;
 - 6) planning bases for villages;
 - 7) planned protection, arrangement, use, and development of natural and cultural goods and the environment;
 - 8) regulations for arrangement and construction rules for parts of the territory for which the preparation of an urban plan is not envisaged;
 - 9) measures and instruments for plan implementation;
 - 10) measures for balanced territorial development of the local self-government unit.

GENERAL URBAN PLAN

The General Urban Plan is adopted as a strategic development plan, with general elements of spatial development.

The General Urban Plan is adopted for a populated area, which is established as a city in accordance with the Law on Territorial Organization of the Republic of Serbia ("Official Gazette of RS", No. 129/07), specifically the city of Belgrade.

The General Urban Plan particularly contains:

- 1) the boundaries of the plan and the scope of the construction area;
- 2) general urban solutions with designated uses of areas predominantly planned in the construction area;

- 3) general directions and corridors for traffic, energy, water management, communal, and other infrastructure;
- 4) division into units for further planning development with general regulation plans for the entire construction area;
- 5) other elements that are significant for further planning development of the urban plan (Law on Planning and Construction "Official Gazette of RS", No. 72/09, 81/09 - corrected, 64/10 - decision of the Constitutional Court, 24/11, 121/12, 42/13 - decision of the Constitutional Court, 50/13 - decision of the Constitutional Court, 98/13 - decision of the Constitutional Court, 132/14, 145/14, 83/18, 31/19, 37/19 - other law, 9/20 and 52/21).

2.4.2. CITY OF LESKOVAC

"The planning basis for the development of the General Urban Plan of Leskovac consists of solutions and guidelines from higher-order plans, or broader areas, primarily:

- o The Law on the Spatial Plan of the Republic of Serbia from 2010 to 2020 ("Official Gazette of the RS", no. 88/10);
- o Regulation on the establishment of the regional spatial plan for the municipalities of Southern Pomoravlje ("Official Gazette of the RS", No. 83/10);
- o Regulation on the establishment of the implementation program for the regional spatial plan of the municipalities of Southern Pomoravlje for the period until 2018 ("Official Gazette of the RS", No. 4/15);
- o Regulation on the establishment of the spatial plan for the infrastructure corridor Niš - border of the Republic of North Macedonia ("Official Gazette of the RS", No. 77/02, 127/14, 102/17 - other regulation, 100/21);
- o Spatial plan for the area of special purpose for the infrastructure corridor of the high-voltage power line 110 kV No. 113/x from TC Niš 1 to Vrlja 3 ("Official Gazette of the RS", No. 93/16);
- o Spatial plan of the city of Leskovac ("Official Gazette of the city of Leskovac", No. 12/2011);
- o General urban plan of Leskovac ("Official Gazette of the city of Leskovac No. 35/22").

LAW ON THE SPATIAL PLAN OF THE REPUBLIC OF SERBIA FROM 2010 TO 2020 ("Official Gazette of the RS", No. 88/10)

"In the regional organization of the Republic of Serbia, the Spatial Plan of the Republic of Serbia from 2010 to 2020, Leskovac represents the seat of the Jablanica administrative district within the Region of Southern and Eastern Serbia, while in the field of economy it is classified among the former industrial centers-cities, where long-term economic stagnation and the restructuring process of the industrial sector have resulted in economic/production devastation and a drastic reduction in the number of employees. In a three-tier categorization of areas with special development problems, Leskovac belongs to the devastated area. In a six-tier categorization of the network and functions of centers, Leskovac is defined as one of national significance. The city of Leskovac, in terms of functional urban significance with a population between 100,000 and 250,000 inhabitants, is defined as an urban center of state significance, where 3% of the Republic's population lives on 2.4% of the national territory. At the conceptual level, Leskovac, together with the cities of Niš, Vranje, and Pirot (conditionally also Prokuplje), forms an urban cluster for the area of Southern Serbia. Leskovac falls into the category of medium-sized industrial centers, employing between 5,000 and 10,000 workers. The concept of territorial development of the industry in Serbia is based on a polycentric organization of industry and the diffusion of spatial models, where, in addition to the type of industrial zone, an industrial park is also planned. Within the development of tourism, the city of Leskovac belongs to the cluster of Southern Serbia.

In terms of potentials for urban renewal and recycling, Leskovac is in the second group. The attractiveness is based on traffic (Corridor 10) and agricultural-tourism potential.

Urban renewal of ambient units and "brownfield industrial sites" is necessary.

- o REGULATION ON ESTABLISHING THE REGIONAL SPATIAL PLAN OF THE MUNICIPALITY OF SOUTH MORAVA ("Official Gazette of RS", No. 83/10), REGULATION ON ESTABLISHING THE IMPLEMENTATION PROGRAM OF THE REGIONAL SPATIAL PLAN OF THE MUNICIPALITY OF SOUTH MORAVA FOR THE PERIOD UNTIL 2018 ("Official Gazette of RS", No. 4/15)

The vision and principles of regional spatial development of South Morava are to be more evenly regionally developed, more competitive, and better integrated with the environment (neighboring functional areas of southern, eastern, and central Serbia, as well as with neighboring border municipalities and regions in the Republic of Bulgaria and the Republic of North Macedonia), more energy-efficient, and attractive for investment. In order to achieve vertical and horizontal connectivity, the spatial hierarchy of the settlement network consists of regional centers (Leskovac and Vranje) with an influence zone that crosses regional borders. The further development of Leskovac will be based on providing a higher quality of regional urban functions, especially in industry, services, education, healthcare, culture, etc. The future placement of economic activities will respect existing economic-industrial centers and zones.

For the development of economic activities, the activation of new locations and spatial models (industrial zones/parks, business incubators) within existing and planned centers is planned. The spatial plan defines specific goals for the protection of immovable cultural goods.

- o SPATIAL PLAN OF THE CITY OF LESKOVAC ("Official Gazette of the City of Leskovac", No. 12/2011)

According to the settlement hierarchical structure, Leskovac has the category of a City and Regional Center. The vision for the spatial development of the city of Leskovac is for it to be an urban center of national significance that will make a special contribution to the development of southern Serbia, mitigate disparities in development in this area, be functionally more connected with the rural environment, halt negative demographic trends, and achieve sustainable development based on local resources and values, as well as greater accessibility to transport and other infrastructure.

The spatial plan of the city of Leskovac is implemented through the development of urban plans, namely: the General Urban Plan – for the area of Leskovac and adopted general regulation plans – for the settlements of Grdelica, Vuče, Predejan, Brestovac, and Pečenjevce.

- o EXTRACT FROM THE STRATEGY FOR SUSTAINABLE URBAN DEVELOPMENT OF THE REPUBLIC OF SERBIA UNTIL 2030

The strategy represents the basic public policy document that defines the long-term concept of sustainable spatial development of Serbia and the long-term strategic framework for integrating development in all areas and sectors, with the aim of optimally utilizing territorial capital and comparative advantages, as well as integrating Serbia spatially and functionally into the European environment. The strategy is adopted for the first time in the Republic of Serbia in accordance with the needs for urban space arrangement, addressing urban development issues, and the potentials that urban settlements carry as generators of development activities.

Considering the timeframe of the Sustainable Development Goals from the 2030 Agenda for Sustainable Development, the validity period of the Strategy is until the year 2030. For monitoring the achievement of Goal 11 at the global level, 15 urban development indicators have been established, which are aligned with the national indicators defined by the Strategy. These goals and tasks are integrated and inseparable, evenly encompassing the three key dimensions of sustainable development: economic growth, social inclusion, and environmental protection.

Based on the identified problems of urban development, the Strategy defines 6 potential areas for urban intervention: brownfield locations and industrial, economic, and commercial zones; areas of uncontrolled urban sprawl and rural area degradation; endangered urban structures and central urban zones; parts of urban settlements with a concentration of social problems; settlements and parts of settlements exposed to environmental protection issues and climate change; spatial units with immovable cultural goods, architectural and urban heritage.

The directions of urban development in the Republic of Serbia are established by the Strategy for Sustainable Urban Development of the Republic of Serbia as a striving for: achieved sustainable development of urban settlements, ensured by improving economic, social, and cultural development, the quality of urban space arrangement, environmental protection, and adaptation to climate change, improving social well-being (quality of life, health of the population, and safety), affordable and quality housing, preservation and affirmation of architectural heritage and urban identity.

Considering the specificity of spatial and socio-economic characteristics of the area, the Strategy designates priority areas for intervention as guiding for local strategies of sustainable and integrated development of urban settlements:

- o Industrial/production and commercial zones and brownfield locations;
- o Illegally built and unregulated peripheral urban zones (urban sprawl) and degradation of rural areas;
- o Endangered urban structures, urban matrices, and central urban zones;
- o Parts of urban settlements with a concentration of social problems – social inclusion and poverty reduction;
- o Settlements or parts of settlements exposed to environmental protection issues and climate change;
- o Spatial units with cultural and architectural heritage, important features of cultural and historical development of urban settlements/groups of urban settlements.

These strategic directions will be implemented through general and specific development goals, which are an integral part of the starting basis of the General Urban Plan of Leskovac, the Strategy for Sustainable Urban Development of the Republic of Serbia until 2030. ("Official Gazette of the RS", No. 47/19).

SEPARATE ON TECHNICAL CONDITIONS FOR THE CONSTRUCTION OF PUBLIC GREEN

THE SURFACE IN THE TERRITORY OF THE CITY OF LESKOVAC ("Official Gazette of the City of Leskovac No. 19/24")

"The separate technical conditions for construction is a document that the holder of public authority issues within their jurisdiction when the planning document does not contain the conditions or data for the preparation of technical documentation, which includes the appropriate conditions and data for the preparation of technical documentation, particularly the capacity and connection point to communal and other infrastructure according to the classes of objects and parts of the area for which it is issued, in accordance with the law on planning and construction."

JP "Urbanism and Construction Leskovac" as the holder of public authorizations within its competencies, adopts a Separate on technical conditions for construction based on the Law on Planning and Construction and the Regulation on the content, method, procedure, and deadlines for the preparation and publication of separations.

The green system of the city of Leskovac represents Green Infrastructure, which the Law on Planning and Construction, in its latest amendment from 2023, recognized as a "strategically planned network of functionally connected natural and closely natural elements, whose design, establishment, use, and maintenance are carried out in a way that ensures ecological, economic, and social benefits through natural, biodiversity-based solutions."

The formation of green infrastructure is based on the system of greenery in the city of Leskovac, whose goal is to protect and connect the green ring around the city and the urban greenery, as well as to network them with linear greenery to enable the realization of all planned functions.

The green infrastructure consists of various components, natural and nature-related ecosystems, characterized as ecologically functional spaces. This includes public green areas: parks - urban and block parks, squares; protective green areas; as well as green spaces within parcels of other public purposes. Through a system of interconnected green spaces, a whole range of ecological, economic, and social benefits of ecosystems is provided.

The separate technical conditions for the construction of public green areas is a document issued by the holder of public authority within their jurisdiction when the planning document does not contain conditions or data for the preparation of technical documentation for public green areas, protective green areas, as well as for the formation of green areas within other predominant purposes on public and other land.

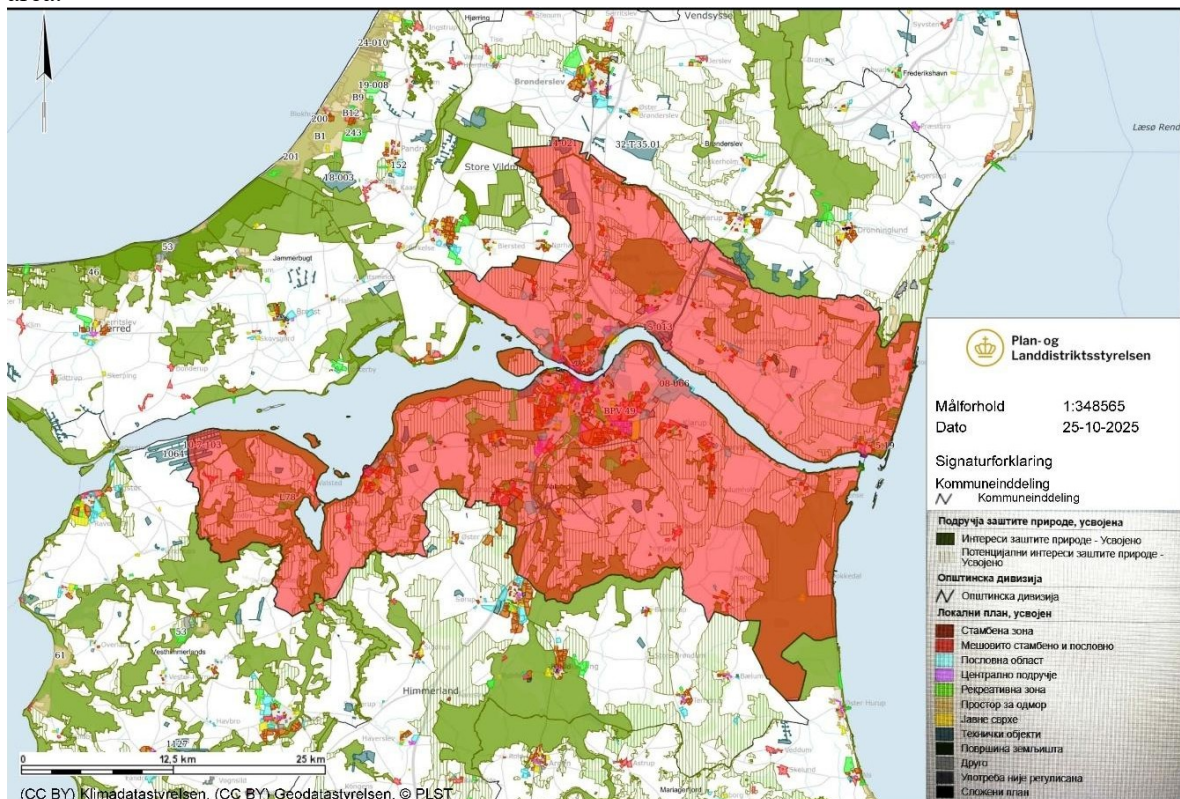
The supplement is applied as an addition to the planning document to define the conditions for the preparation of technical documentation in the procedure for issuing location conditions or the need for the development of an urban project, planning documents, and the issuance of a Decision on Approval for the execution of works in accordance with Article 145 of the Law on Planning and Construction.

The separation is presented as a general document for the public green spaces system in the territory of the city of Leskovac, which is defined by planning documents in application: the Spatial Plan of the City of Leskovac ("Official Gazette of the City of Leskovac" No. 12/2011), the General Urban Plan of Leskovac from 2022 to 2032 ("Official Gazette of the City of Leskovac" No. 35/2022), the general regulation plans from 1-19 within its scope, and the General Regulation Plan for humane cemeteries in the area of the General Urban Plan of Leskovac, the general regulation plans for the settlements of Brestovac, Pečenjevce, Grdelica, Vuče, and Predejan, the detailed regulation plans for the area of the General Urban Plan of Leskovac, the detailed regulation plans for the area of the Spatial Plan, and urban projects for the construction of public purpose linear infrastructure facilities.

3. GREEN INFRASTRUCTURE IN EXAMPLES OF CITIES IN SERBIA AND EUROPE

3.1. GREEN INFRASTRUCTURE OF THE CITY OF AALBORG – DENMARK

Aalborg is a local metropolis in the urban region of Northern Denmark, an urban area with potential. It has a population of 143,598 over an area of 61.3 km², representing 2.4% of Denmark's population. According to the Municipal Plan (Internet source 19), Aalborg is much more than a physical framework such as a city, landscape, and infrastructure. Strong national and international connections, an innovative business and educational environment, as well as strong traditions of cooperation, are also key to creating a sustainable foundation for the development of the described area.



Map 1. Land use plan of the city of Aalborg from the National Plan of Denmark (LANDSPLANDIREKTIVER)

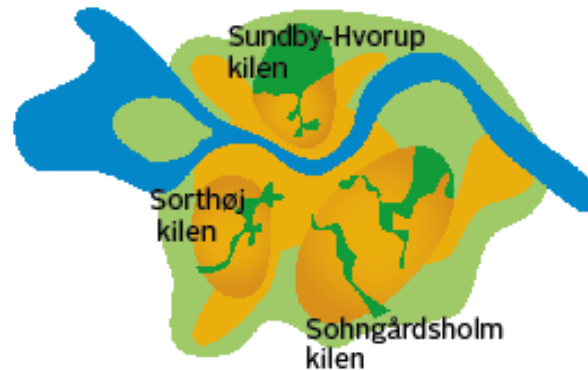
Source: <https://kort.plandata.dk/spatialmap>

According to the Plan, Aalborg is a city designed for people with a global mindset, developed in harmony with the landscape.

As seen in Map 1, the city is a starting point for urban development, which consists of creating attractive and sustainable residential and urban areas. The fjord landscape, river valleys, and hilly islands set the framework of the landscape and, together with the cultural heritage, define the character of the city. The growing population continues to create a demand for housing and urban development. The topography and landscape in and around Aalborg mean that the city primarily needs to develop through transformation and densification within existing urban boundaries. The river valleys lie like clear traces in the landscape and create a clear and well-defined boundary between the city and the countryside. At the same time, the river valleys are low areas that are further affected by climate change. On the other hand, they are suitable for new parks, recreation, and future water management solutions.

The transformation of Aalborg from an industrial city, where industry spread along the coasts and in central districts, into a modern knowledge city also creates space for urban change. Urban transformation and densification are sustainable ways to develop the city, as they limit sprawl, land use, and energy consumption for transport and heating.

Aalborg is a Green City, as can be seen in Appendix 1.



Appendix 1. Schematic representation of the green city of Aalborg

Source <https://aalborgkommune.viewer.dkplan.niras.dk/plan/18#/87118>

By maintaining urban growth in Aalborg within existing boundaries and on the hills, the surrounding landscape is secured for nature, recreation, and water management.

The wooded hills aim to emphasize the city's recognizable landscape.

Existing green and recreational qualities are maintained and renewed, while new urban nature with a high degree of biodiversity is created in a coherent network of green links as part of Denmark's Green Map.

Green links should function as attractive corridors for movement and provide access to urban functions, local recreational opportunities, and open rural settlements.

This means that the landscape around Aalborg and the green wedges are protected from development and designated for nature and recreation, with a focus on the mental and physical health of residents. Low-lying areas on the outskirts of the city must be maintained for nature, recreation, and water management. The municipality of Aalborg is preparing a climate budget and climate accounts to ensure that planning and the use of budgetary resources are optimal in relation to climate and sustainable development.

Aalborg researchers and companies are in the green transition and must be focused on developing new innovative solutions to anticipate future ecological and climate challenges by reducing resource consumption and lowering CO₂ emissions and other greenhouse gases.

Aalborg is Denmark's test zone for green energy, as shown in Appendix 2. This means that the municipality of Aalborg is a leader in the green transition, which requires innovation and development, as well as the courage and determination to prioritize green and sustainable solutions. The municipality is part of a strong public-private partnership – the Green Center Denmark, based in Aalborg. The Green Center Denmark works on green innovations, sustainable business models, large-scale testing and demonstrations to address climate challenges and contribute to meeting the government's ambitious CO₂ emission reduction targets.



Appendix 2. Incubator for Sustainable Solutions and Business Models in the Field of Environmental Protection

Source <https://aalborgkommune.viewer.dkplan.niras.dk/plan/18#/87118>

The Green Center of Denmark builds bridges between companies, consumers, researchers, and authorities to collaboratively create the best platform for world-class green growth.

REFORESTATION

Forests contribute to the character of the landscape and represent a type of habitat that potentially has the greatest biological diversity, and thus the possibility of providing the highest biodiversity. Forests strengthen the coherence and accessibility of outdoor life and nature and represent an important foundational element in connecting Denmark's Green Map.

Specific areas for reforestation are areas where the establishment of new forests is particularly encouraged. The plan will expand and connect the forested area in the municipality from 7% to 14% based on the following principles:

- o create synergy with richer nature by working on larger forest clearings, opportunities for grazing in forests, natural hydrology, and areas of untouched forest,
- o designate areas for reforestation with the aim of protecting groundwater and ensuring clean drinking water for future citizens, reducing CO2 emissions, and creating local recreational areas in urban communities of the municipality,
- o mark reforestation areas that enhance the landscape and protect against disruptive construction, facilities, etc., as well as where it can reduce noise on major roads,
- o expand, connect, and improve recreational links in new forests, thereby creating good access to new forests, as well as focusing on identifying urban forests,
- o prioritize the construction of recreational facilities such as primitive camps, observation points, rest areas, and parking lots when creating new forest areas,
- o Ensure an appropriate distance from existing and planned buildings and maintain cultural traces, viewpoints, etc., that are valuable for preservation without obstacles and
- o mark areas where afforestation is undesirable.

Within the areas designated for afforestation, as indicated on the map, no technical facilities or buildings may be established, nor may the areas be used for purposes that could jeopardize the possibilities for afforestation.

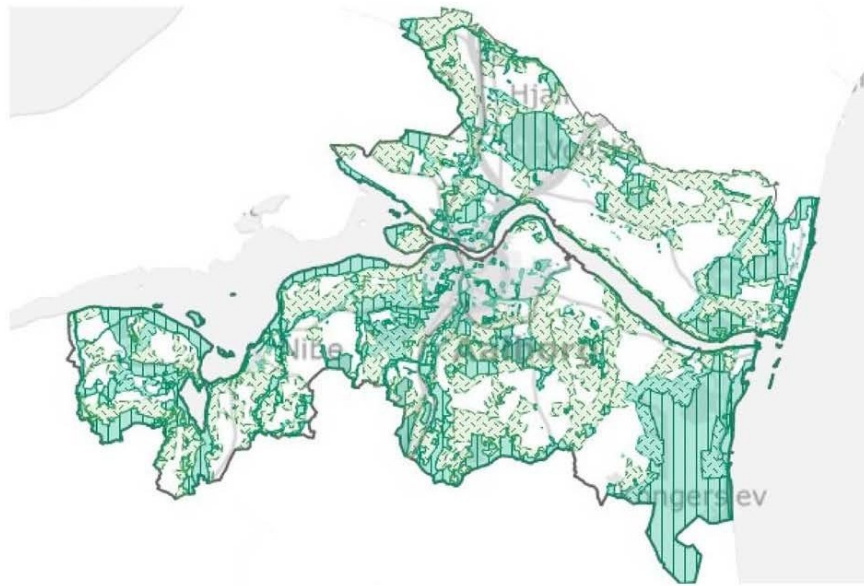
By designating areas for afforestation, the city council aims to strengthen the coherence and accessibility of outdoor activities and nature as a key part of the municipality's green structure. The designation of afforestation areas in the municipal plan has been primarily done with the goal of creating larger, integrated forest and open natural areas, connecting existing recreational areas, and creating local recreational areas near cities.

The designated afforestation areas are those where the establishment of new forests is particularly encouraged. Planting is voluntary for landowners and does not precede agricultural activities. This means that new buildings can be constructed and facilities necessary for the continuation of agricultural work can be established.

The total area of afforestation is predominantly distributed on the slopes of moraines to highlight the contours of the landscape. The areas are based on the character of the landscape, where forests are used to emphasize and contrast specific landscape features. Forests can thus serve, for example, to highlight the peaks of hills.

Areas of special interest for groundwater, especially watershed areas, are designated as afforestation areas to the greatest extent possible, as carefully managed forests represent a lasting guarantee of clean drinking water.

The climatic and ecological impact of forests in terms of CO₂ absorption and nitrogen fixation also plays an important role. Forest owners are therefore advised to work with continuous forest cover, without fertilizers and pesticides, which ensures continuous CO₂ storage and reduces the release and leakage of undesirable substances into groundwater and watercourses. Afforestation of areas near cities and connections to them must ensure that the urban population has good opportunities for daily recreation and experiences in nature. Generally, nearby recreational forest areas should be considered and integrated into new urban areas - even where they are not specifically designated as afforestation areas. Forests should be established with good access conditions that ensure the movement of animals and people and are connected to the existing network of recreational trails. Afforestation is planned with different characteristics and species composition, so that forests are robust, future-ready, rich in experience and nature. The use of indigenous species is recommended, including dense forests, as well as bright open spaces. In low areas, forests can be established in the form of, for example, swamp forests, and natural vegetation can also be utilized. Additionally, experiential values must be taken into account, including those related to design, layout, and variations. When designing afforestation projects, interests such as landscape character, archaeology, cultural-historical elements, energy facilities, and valuable nature, etc., must be included in a special assessment and planning. For example, burial mounds, existing forest edges, old coastal slopes, foothills, rhymed double landscapes, special views, and experiential values must be taken into account to ensure that afforestation occurs in a way that preserves the landscape and is in synergy with the development of nature and recreation. Aalborg has many attractive landscapes, as seen in Appendix 3, and this is something that citizens value. The preservation of landscape values does not happen by itself - it requires conscious planning. The landscape is under increasing pressure, and its values are vulnerable to many types of influences. Therefore, the landscape must be preserved, and a balance must be found between the use and protection of the special characteristics of the landscape, so that valuable landscapes continue to look beautiful and rich in experiences. The landscape must meet many needs and purposes, and it is of great importance for the daily lives of citizens and the identity of municipalities and cities. It should provide beautiful and unobstructed experiences of life close to nature, good conditions for a healthy and active lifestyle, and recreation.

Retningslinjer*Appendix 3. The Green Map of Aalborg*

Source <https://aalborgkommune.viewer.dkplan.niras.dk/plan/18#/87118>

At the same time, the landscape must be able to accommodate businesses and agriculture to create conditions for their development, as well as space for new roads, technical facilities, urban development, etc.

LOWLAND AREAS

Lowland areas include, in addition to areas with currently high groundwater levels, former wetland areas, including artificially drained river valleys, marshes, lakes, and saline marshes. Many of the former wetland areas could be developed or restored into valuable natural areas if drainage were stopped or reduced.

Regarding the climate, there are significant benefits to restoring lowland areas, as they can bind carbon dioxide in the peat layer and store and retain large amounts of water in natural retention areas during major floods and heavy rainfall.

Guidelines therefore apply to all lowland areas in general, as such areas offer the possibility for the restoration of natural areas, reduction of nitrogen, and establishment of areas that can mitigate climate change.

o MAIN CHARACTERISTICS OF THE LANDSCAPE

In the municipality of Aalborg, the landscape and nature are present everywhere. Even in the inner part of the city of Aalborg, Appendix 4, the Limfjord winds through and creates a connection between the city, land, and water.

The Limfjord is the most significant element of the landscape. It simultaneously separates and unites the city. The coast of the Kattegat also plays an important role. Together with the Limfjord, it contributes to the identity and makes the coasts and coastal landscapes present in large parts of the municipality.

The coastal line, the interaction between flat, marine landscapes and characteristic hilly landscapes contributes to the landscape in the municipality of Aalborg gaining a special character. In the flat, expansive plains of the elevated seabed, large hills lie like recognizable islands creating a contrast, while from the flat foothills near the Limfjord, morainic landscapes rise. In the north, the landscapes are open, harsh, and raw, while in the south they are gentler and more lush. The eastern parts are dominated by flat, marine plains, while the hilly areas are in the west.



Appendix 4. Block greenery within social housing

Source: 2023. year from the archive Deliver safe and Social Housing, <https://www.dashousing.eu/>

3.2. GREEN INFRASTRUCTURE OF THE CITY OF BRAGA – PORTUGAL

According to the Regional Spatial Planning Plan NORTE 2030, the city of Braga covers an area of 183.2 km² and has a population of 181,490, located in the very north of Portugal. Appendix 5. The planning model is based on the following strategic domains and their corresponding specific objectives:

- Promoting the city's image,
- Reorganizing the territory (without increasing the total area of urban land),
- Ensuring adequate planning of urban settlements,
- Protecting and enhancing the ecological structure of the municipality,
- Protecting and enhancing the viewpoint system,
- Improvement of landscape units,
- Strengthening the identity of peripheral urban centers.

1. The Municipal Ecological Framework (MEF) consists of the Basic Ecological Framework (BEF) and the Urban Ecological Framework (UEF). Its primary goal is to contribute to the ecological, environmental, and landscape balance of rural and urban systems.

2. MEF does not represent an independent category, as it encompasses various categories of urban and rural land.

3. The definition of MEF includes a comprehensive territorial approach, aimed at protecting the landscape and integrating the concept of a network into these areas, which have the capacity to connect urban and rural land. This network, based on green communication channels between the city and the surrounding rural area, thus supports the maintenance of biological flows that contribute to the sustainability and balance of the entire urban system.

4. The following areas, considered essential for the overall balance of the territory, are part of the Basic Ecological Framework:

- a) High productivity land - Includes land classified as National Agricultural Reserves;



Appendix 5. Location of the city of Braga

Source: *Estudo temáticos, Caracterização social, económica e biofísica do concelho de Braga, 2020.*
(thematic study - Social, economic and biophysical characterization of the municipality of Braga)

b) Wetland system - Includes areas of the National Ecological Reserve that are directly related to drainage processes, water retention, and the replenishment of the aquifer of the river system;

c) Dry system - Includes areas of the National Ecological Reserve most sensitive to natural erosion and areas located upstream of the natural drainage network, necessary for the initial infiltration of rainwater and its gradual discharge into the river network;

d) The ecological corridor Cavaido-Ave - with a maximum width of 3,000 m, a strip of 1,500 m that extends along the Cavaido River covers the municipality of Braga and contributes to the formation of metapopulations of faunal and plant communities;

e) In the corridor described in the previous subsection, forestry standards for the purposes of protection and conservation.

The sub-function of protecting the hydrographic network, as well as the sub-function of conserving genetic resources, are defined in Baixo Minho PROF.

5- The urban-ecological structure proposes a balance of the urban system through an appropriate balance between built areas and urban voids, providing an opportunity to improve the quality of urban life.

6- The EEU consists of:

a) Urban parks - radially distributed from the center and connected to the urban bypass (Park Ponte, Park Monte Pikoto, Park Sete Fontes, Park Oeste-Fereiros/Lomar, and Park Norte);

b) Agricultural parks - green decompression areas currently used for agricultural purposes, activities considered important for maintenance and promotion (UOPG da Granja and UOPG de Cones, east and west of the city);

c) The main green structure – the most significant urban gardens and green spaces (Park Ponte, Park Monte Pikoto, Park Sete Fontes, Park Oeste-Fereiros/Lomar, and Park Norte, with a sports

hub of the highway, areas surrounding Bom Jesus, Sameiro, and the chapel of Santa Maria, forest, and gardens of Tibaes);

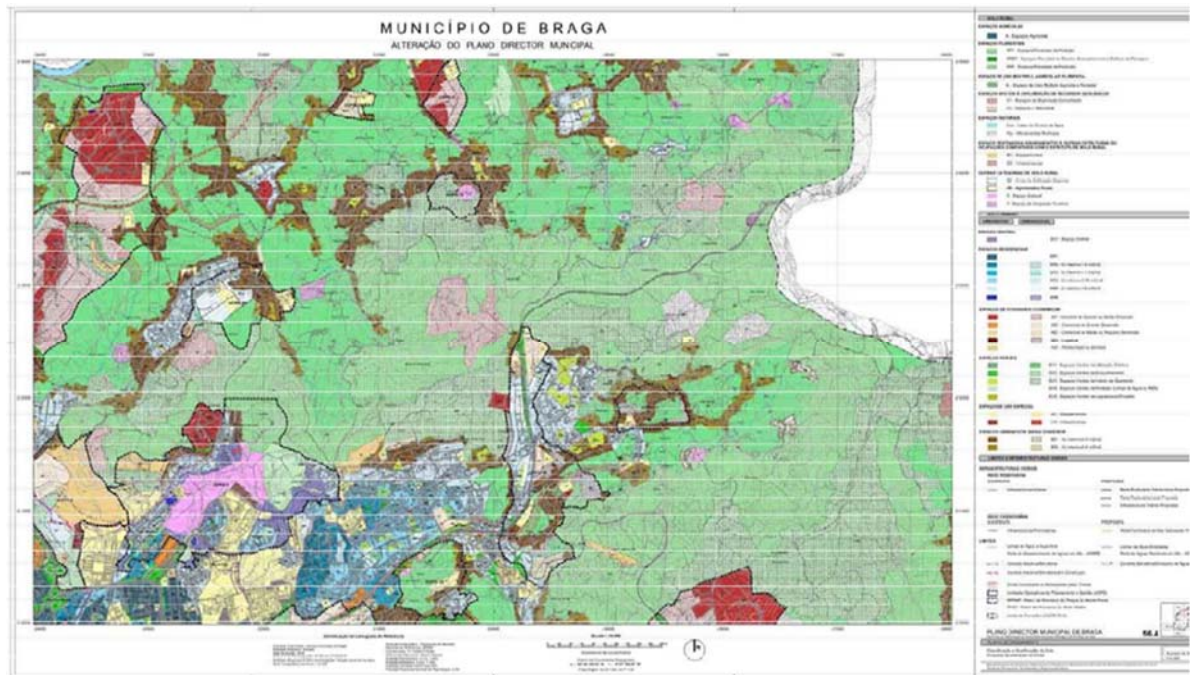
Complementary green structure - gardens and green areas around buildings;

e) Public spaces and private gardens – this includes the interiors of blocks that, due to their size and location, are considered essential for the balance and sustainability of the urban fabric;

f) Structural corridors - promote interconnectivity between the spaces considered in the urban ecological structure and between this structure and the rural environment, in order to promote and consolidate biophysical flows and their circulation through the structure;

g) Natural corridors - Follow the flow of main waterways within the municipal territory;

h) Green corridors - Linear development structures, bordered by trees and predominantly covered with vegetation, which form spaces for road and pedestrian routes (Regulamento do PDM Atualizado (August 2021).



Map 2. Land Use of Braga

Source: *Estudo temáticos, Caracterização social, económica e biofísica do concelho de Braga, 2020. (thematic study - Social, economic and biophysical characterization of the municipality of Braga)*

The general plan of the municipality of Braga establishes the strategy for territorial development and the municipal policy for land use and urban planning, integrating and articulating the guidelines established in higher-level territorial management instruments, that is, broader frameworks, and establishes a model of spatial organization for the municipal territory, Map 2.

The plan applies to the entire municipal territory, as defined within the boundaries of the Official Administrative Charter of Portugal from 2023. The urban system of the municipality of Braga is structured by:

- a) A central area that dominates the entire territory and consists of small local centers, defined by the most significant centers of individual urban neighborhoods;
- b) Areas of significant economic activity;
- c) A heritage system;

- d) Municipal ecological structures, which play a significant role in the urban system due to their ability to integrate and articulate various systems;
- e) Networks of green spaces;
- f) Networks of facilities;
- g) Circulation and mobility systems that ensure territorial integration and sustainable development of the municipality.

Green spaces correspond to areas that promote ecological and urban balance and improve the quality of life, representing areas for recreation and leisure, socializing, or for the protection and enhancement of landscapes. They encompass two subcategories:

- a) Urban green spaces;
- b) Surrounding green spaces.

Urban green spaces refer to existing or planned areas of green parks for public use, intended for use by the population. Cultural, recreational, and leisure facilities, restaurants, and drinking establishments, as well as sports facilities, are permitted.

Surrounding green spaces correspond to areas that are at risk or have situational limitations preventing construction, close to the urban environment, and, in the case of planned areas, when the return of land to its previous state is expected due to a lack of planning within a defined timeframe.



Appendix 6. City of Braga, viewpoint

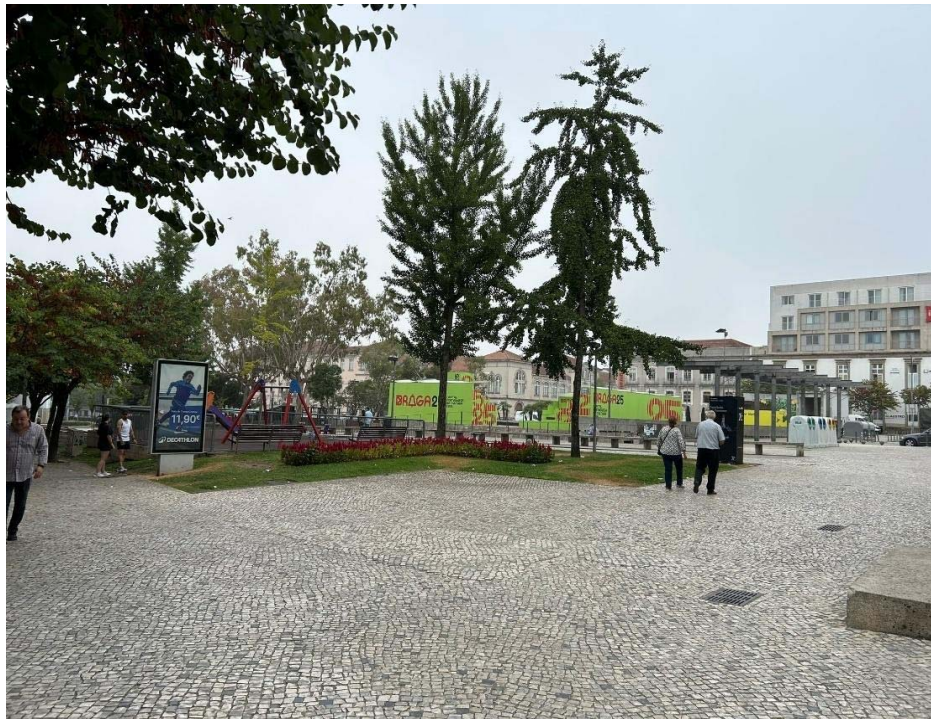
Source: Ivana Momić photograph, 2025, from the archive Deliver safe and Social Housing, <https://www.dashousing.eu/>

o CONSTRUCTION REGULATIONS

1. In these areas, it is preferable to use native plant species or those that are well adapted to the soil and climatic conditions.
2. In urban green areas, the following conditions must be met:
 - a) Buildings must ensure that their size, configuration, location, and volume do not jeopardize the characteristics and primary function of these spaces;
 - b) Interventions or buildings must meet a maximum waterproofing index of 10%.

3. Buildings are not allowed in surrounding green areas. In the municipality of Braga, four territorial units have been defined based on landscape units, which are further divided into territorial subunits. The assessment of each of them took into account the following aspects:

- Assessment of biophysical and cultural components;
- Assessment of the dynamics of landscape transformation over time;
- Assessment of current and potential functionalities;
- Assessment of vulnerability.



Appendix 7. City of Braga, city center

Source: Ivana Momić photograph, 2025, from the archive Deliver safe and Social Housing, <https://www.dashousing.eu/>

Each landscape was assessed to identify its character, specifically the uniqueness of the interaction between its natural and human components, which allows it to be distinguished from other neighboring landscapes. The result of this study is the basis for the territorial units defined within the proposal for the development of the General Plan.

LANDSCAPE STRATEGY

According to a study prepared in 2023, within four landscape units, subunits of the landscape have been defined, as the functional characteristics of the territory justify this. The landscape units and subunits defined for the municipality of Braga are: UP1 – Dolina Cavado, UP2 – Vale de Leste, UP3 – Veigas de Braga, UP4 – Encosta dos Santuários. The quality landscape objectives represent a central component of the methodology for defining the landscape strategy, serving as a link between the results of the landscape assessment, as analysis/diagnosis, and the establishment of a participatory strategic vision, which can serve as a basis for developing scenarios for the desired landscape.

The landscape design supports the concept of green and blue infrastructure. The goal of these infrastructures is to ensure the provision of ecosystem services, such as the benefits that

the population derives from natural capital, which can be attributed economic value. These approaches are recommended by the European Union, aiming to respond to the challenges of the New Urban Agenda and the sustainable development goals, defined as solutions with reduced costs, nature-inspired, and sustainable (New Urban Agenda, 2016).

These solutions simultaneously provide benefits for the environment, society, and the economy, promoting increased resilience. They are implemented through systemic interventions, locally adapted to the territory, ensuring a better cost-benefit ratio.

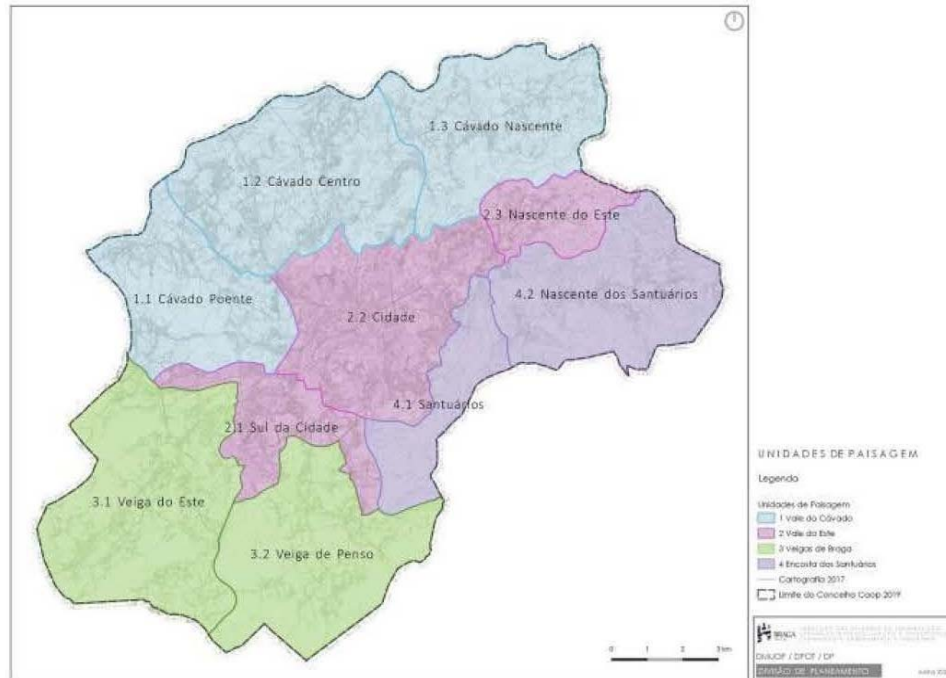


Appendix 8. City of Braga, in front of the church Bom Jesus

Source: Ivana Momić photograph, 2025, from the archive Deliver safe and Social Housing, <https://www.dashousing.eu/>

Examples of nature-based solutions include:

- Construction of retention basins to reduce flood risk;
- Ecological restoration of degraded areas, such as quarries and basic systems for regulating the water cycle or soil conservation;
- Application of agroforestry and compartmental forestry to reduce fire risk;
- Establishing urban gardens for social and recreational purposes;
- Creation of eco-trails that promote unobstructed mobility;
- Enhancement of heritage sites with indigenous vegetation.



Appendix 9: Map of landscape unit boundaries.

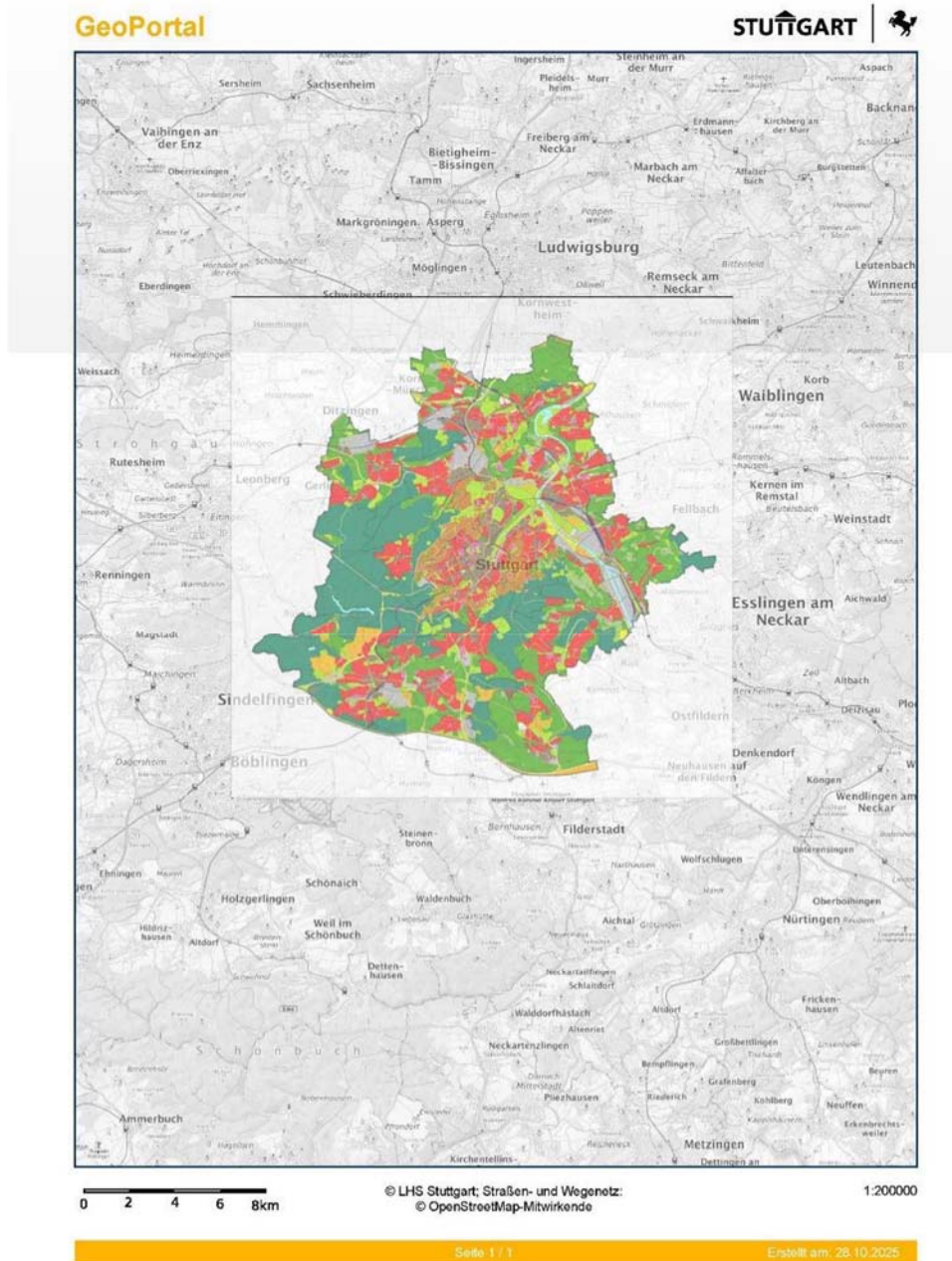
*Source: Estudo temáticos, Caracterização social, económica e biofísica do concelho de Braga, 2020.
(thematic study - Social, economic and biophysical characterization of the municipality of Braga)*

The landscape model aims to contribute to the territorial model and corresponds to the schematization of territories, where strategic goals are within the landscape (Regulamento do PDM Atualizado (August 2021)).

3.3. GREEN INFRASTRUCTURE OF THE CITY OF STUTTGART – GERMANY

According to the Regional Plan for the Stuttgart region, the area has about 609,000 inhabitants. Through balanced development throughout the Stuttgart region, sustainable development of the city center with the surrounding area, which is closely interconnected, is possible. Their independent development and networking is an important part of the urban fabric and requires planning with the same attention as central settlements have received so far. The development of Stuttgart's city center, with increasing demands on the limited resources of the area, is constrained. Internal development should take priority over expansions "on green spaces." Through balanced development throughout the Stuttgart region, sustainable development of the city center is possible. One of the central issues of urban future is the conscious design of urban peripheries. When determining work areas and recreational areas, attention should be paid to the functionally reasonable distribution of these areas to residential zones and the diverse needs of all population groups, especially women, families, and people with disabilities.

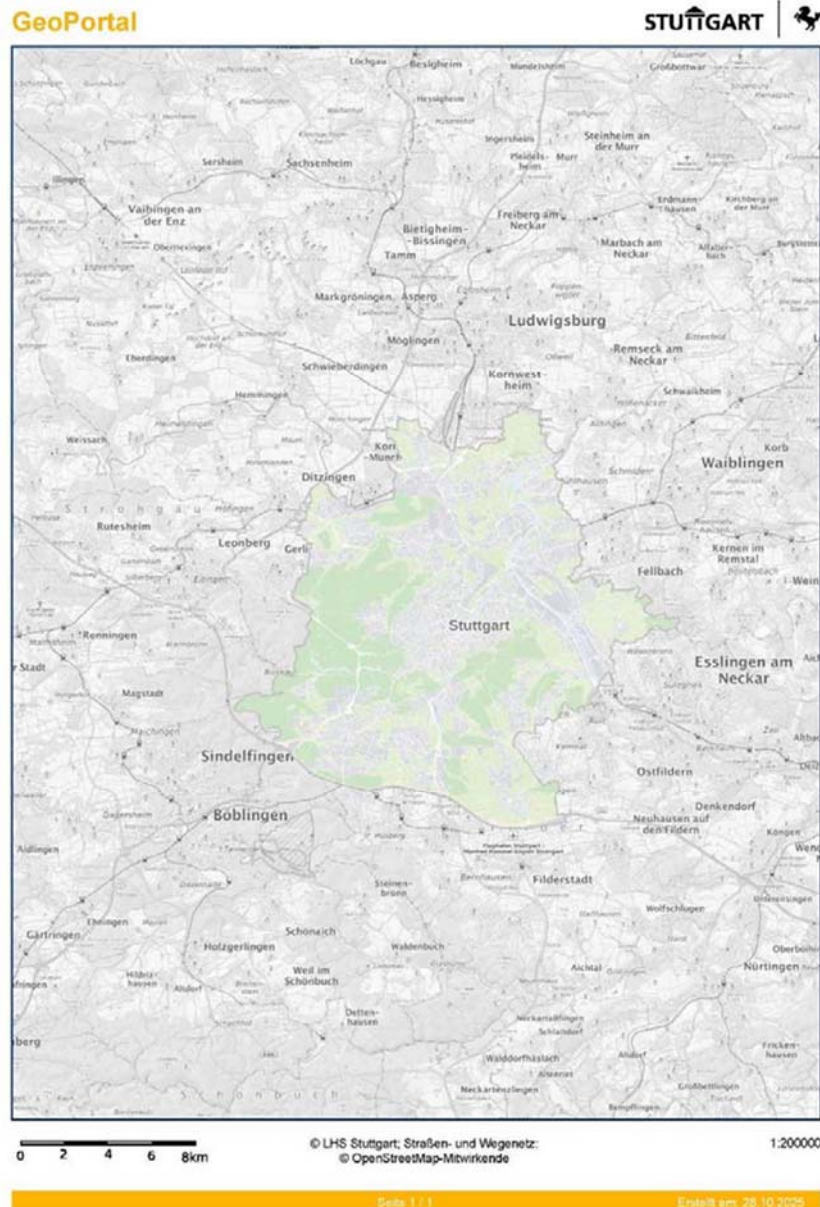
The land use plan shows areas that are particularly important for recreation near settlements as green spaces/parks. This aims to provide local recreation for the population close to their homes. These areas include green spaces within the city, which are designed and developed in the spirit of traditional parks; on the other hand, green spaces that are mainly used for agricultural purposes, taking into account the specific landscape situation and the priority of recreational services. Since the preservation of the existing landscape is the goal, it is planned to present green spaces - outdoor parks - as existing areas.



Map 3: Land use map of Stuttgart
 Source <https://maps.stuttgart.de/stadtplan/#>

The boundary of the urban area in Stuttgart is approximately 50% of the 207 km² municipal area that is residential. If the forest area of approximately 25% is subtracted from the total area, only a quarter of the district remains as open space, which means, for example, that there is a need to improve green spaces in the city as well as measures for traffic calming. In newly designated areas for "land, nature, and landscape development," appropriate areas for compensatory measures should be implemented (Flächennutzungsplan der Landeshauptstadt Stuttgart (FNP Stuttgart), Land use plan of the city of Stuttgart, Amtsblatt der Landeshauptstadt Stuttgart, number 48/2001 of 30.

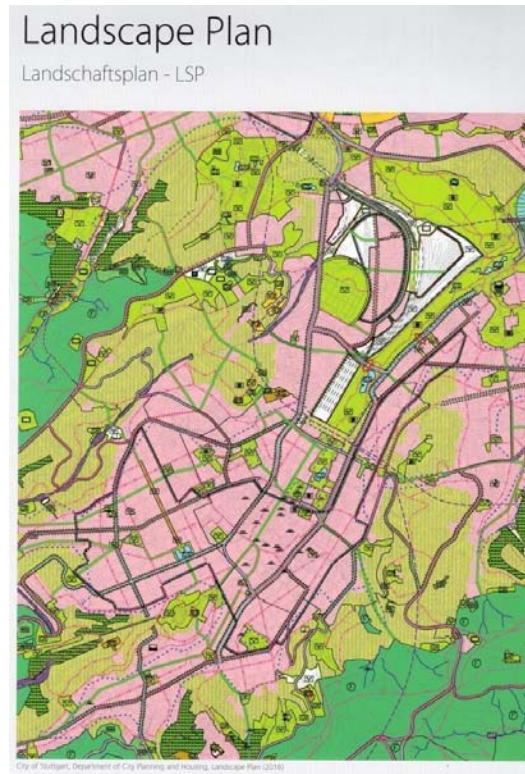
November 2001). The green spaces in Stuttgart are protected by local regulations. The motto for the land use plan is urban-compact. More than 60% of Stuttgart's area is green space, and over 39% is protected, which is the highest percentage in Germany. The city has 5,000 hectares of forest, with 65,000 trees in parks and 35,000 along streets. Since the 1970s, the city has integrated green spaces into a large green "Y," which now allows passage through park areas from the central royal gardens to the forests on the outskirts of the city.



Map 4: Green Spaces in Stuttgart
 Source <https://maps.stuttgart.de/stadtplan/#>

In addition to the previously known representation of public green spaces/parks, green corridors and areas for renovation are symbolically represented or marked in the land use plan of 2010. Green corridors identify areas where the connection between open spaces through built-up areas is improved by measures such as tree planting, greening a series of squares, paths, etc.

Restored green areas include areas where there is an overall lack of green spaces in cities. In these areas, green spaces should be improved through as many measures as possible, including selective ones, such as greening blocks and courtyards, greening facades/roofs, creating playgrounds, and landscaping.



Appendix 10: Landscape Planning Map of Stuttgart

Source: <https://www.stuttgart.de/leben/stadtentwicklung/stadtplanung/stadt--und-freiraumentwicklung/flaechennutzungsplanung>

In the land use plan, planned construction projects with a total area greater than 60 hectares have been suspended due to the protection of green spaces. By using green ventilation corridors and a construction ban in strategic locations, Stuttgart has not only protected its climate from winds that prevent overheating but has also improved air quality and increased resilience to global warming.

The city is located in the basin of two river valleys and therefore has problems with overheating and air quality. The fact that the city is also the center of the German automotive industry does not improve matters. In 1992, Stuttgart published its first climate atlas. It showed how topography and buildings affect air flow. It was clear that the surrounding hills, rising up to 300 meters, nearby forests, and agricultural areas are the main sources of fresh air for the city. The topographical profile of Stuttgart creates thermal winds at night down the slopes and through the city. Problems were caused by increased construction on the hills, which replaced vineyards and trees, thereby blocking air flow.



Appendix 11. (left image): View of Stuttgart, tower

Appendix 12. (right image) City of Stuttgart, city center

*Source: Ivana Momić photograph, 2025, from the archive Deliver safe and Social Housing,
<https://www.dashousing.eu/>*

Based on the climate atlas, Stuttgart established an environmental protection office tasked with assessing the impact of planned buildings on the local climate and developing control systems to protect key areas and increase green spaces in the city.



Appendix 13. City of Stuttgart, view from the lookout

*Source: Ivana Momić photograph, 2025, from the archive Deliver safe and Social Housing,
<https://www.dashousing.eu/>*

The Office for Environmental Protection could utilize support from national and regional legislation that protects green spaces, as well as national building laws that, after the 2004 revision, integrated sustainability principles, including paragraphs on green spaces and air quality.

The latest climate atlas from 2008 covers the entire Stuttgart region with 2.7 million inhabitants and details the flows of cold air and concentrations of air pollutants. It also categorizes the local environment into eight types based on their significance for the climate. New construction is not permitted in ventilation corridors for cold air and other open areas that are of great importance for the climate.



Appendix 14. City of Stuttgart, urban gardens

Source: Ivana Momić photograph, 2025, from the archive Deliver safe and Social Housing, <https://www.dashousing.eu/>

In built-up areas of great significance for the climate, increased vegetation and green spaces are recommended. Additionally, the following principles guide planning: green spaces should surround buildings, larger interconnected green spaces should be protected and created, valleys, hills, and slopes should not be built upon, urban sprawl should be avoided, and in relation to industrial construction, air pollutants in surrounding settlements should be avoided (Internet source 10).

3.4. GREEN INFRASTRUCTURE OF THE CITY OF LESKOVAC – SERBIA

SPATIAL PLAN OF THE CITY OF LESKOVAC ('Official Gazette of the City of Leskovac', No.12/2011)

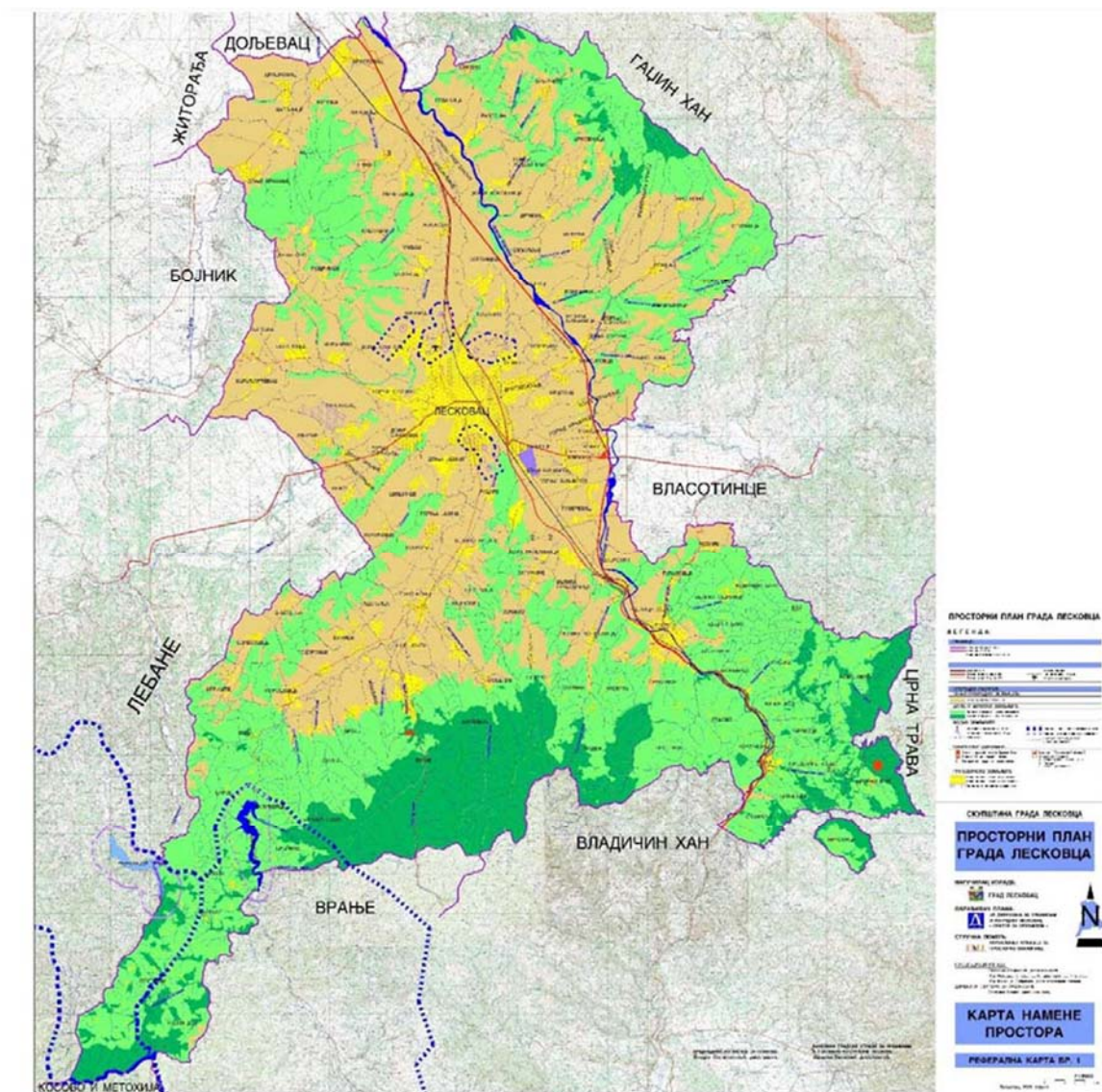
There are a total of 144 populated places in the territory of the city, including one urban center Leskovac, two urban settlements Grdelica and Vuče, as well as 141 rural settlements.

The territory of the city of Leskovac is located in the southeastern part of Serbia and borders the autonomous province of Kosovo and Metohija in part. The city is situated in the Leskovac Basin, the largest morphotectonic basin in Serbia. The total area of the city is 1024 km², and according to the 2022 census, the city of Leskovac (territorial unit) has 123,950 inhabitants, while the urban settlement of Leskovac has 58,338 inhabitants.

Agricultural land covers 57% of the total area of the planning region. In terms of quality classes, only 1500 ha fall under the first class, while the second and part

Third place occupies about 37%, while fourth and fifth place account for around 45 to 47%. The land of the seventh and eighth classes, as well as part of the sixth class, occupies about 20% of agricultural land area. In pedological terms, about ten types of soil have been registered: alluvium, smonice, podgajnica, podzol, eluviated, and deluviated.

Forests and forest land: The vegetation types represented include meadow-pasture (valley, hilly, and mountain pastures and meadows) and forest types. Four complexes of forests have been identified: the complex of alluvial-hygrophilous forest types (willow and poplar forests); the complex of xerothermophilous sweet chestnut-oak and other forest types; the complex of xerothermophilous hornbeam, oak, and beech forest types; and the complex of mesophilous beech and beech-coniferous forest types. Forests and forest areas cover 36% of the total area of the city of Leskovac, which includes: state forests and forest land accounting for about 33.3% and private forests covering 66.7% of the total forested area. The share of high forest stands by area is 43%, coppice 47%, artificial 7%, and scrub and thicket 3%.



Map 5. Spatial Planning Map
Source: Spatial Plan of the City of Leskovac

The green areas outside the city or spatial landscape objects within populated areas (parks and other arranged and undeveloped areas in settlements, in production complexes, in public service complexes, in cemeteries, individual gardens, etc.) that are connected by linear belts of greenery around watercourses and traffic routes, along with forests and forest land, form a unique system of green spaces with basic functions: decorative-shaping, social-community, and sanitary-hygienic. Larger places stand out for their arrangement, having larger and more organized centers, park areas, and tree-lined streets: Vuče, Grdelica, Predejan, Brestovac, and Pečenjevce, but also some smaller ones: Strojkovce, Beli Potok, Tulovo, Slatina, V. Kopašnica, Dobrotin, Orašac, Biljanica, Petrovac, Lipovica, etc. The green areas outside the city that do not have a production character are well arranged and interconnected, and there is a positive trend in the arrangement of individual household yards. (Spatial Plan of the City of Leskovac, 2011)



*Appendix 15. The Vučjanka River with one of the oldest hydroelectric power plants in Serbia
Source: Spatial Plan of the City of Leskovac*

The area of the territory within the boundaries of the General Urban Plan of Leskovac is 4113.63 ha.

The vision for spatial development of the city of Leskovac is: for the city of Leskovac to be an urban center of national significance that will make a special contribution to the development of southern Serbia, mitigate the disparities in development in this area, be functionally better connected with the rural environment, halt negative demographic trends, and promote sustainable development based on local resources and values, as well as greater accessibility to transportation and other infrastructure. The general goals of planning and construction should be in accordance with the Sustainable Development Strategy of the city of Leskovac, which aims for Leskovac to be a local self-government integrated into modern European trends, full employment, eliminated extreme poverty, strong entrepreneurship, efficient local administration, rich cultural tradition and offerings, preserved environment, and developed interethnic tolerance.



*Appendix 16. View of Leskovac from the Hisar Hill
Source: Spatial Plan of the City of Leskovac*

Special goals of planning, usage, arrangement, and protection of the planning area are:

Protection: controlled and sustainable use of nature, natural resources, and natural and cultural heritage; improvement of quality of life;

Sports and recreation: ensuring even territorial coverage of sports facilities by engaging new spaces and improving existing ones; promoting the banks of the Veternica River for sports and recreation;

Greenery: improvement and development of the green space system while preserving and enhancing existing areas and planning new ones with even spatial coverage;

o GREEN SPACES

The planning solution ensures adequate even representation, integrity, and continuity of various types of green spaces. Within the Plan, there is a system of green spaces, the backbone of which consists of public green areas that intertwine with protective green areas.

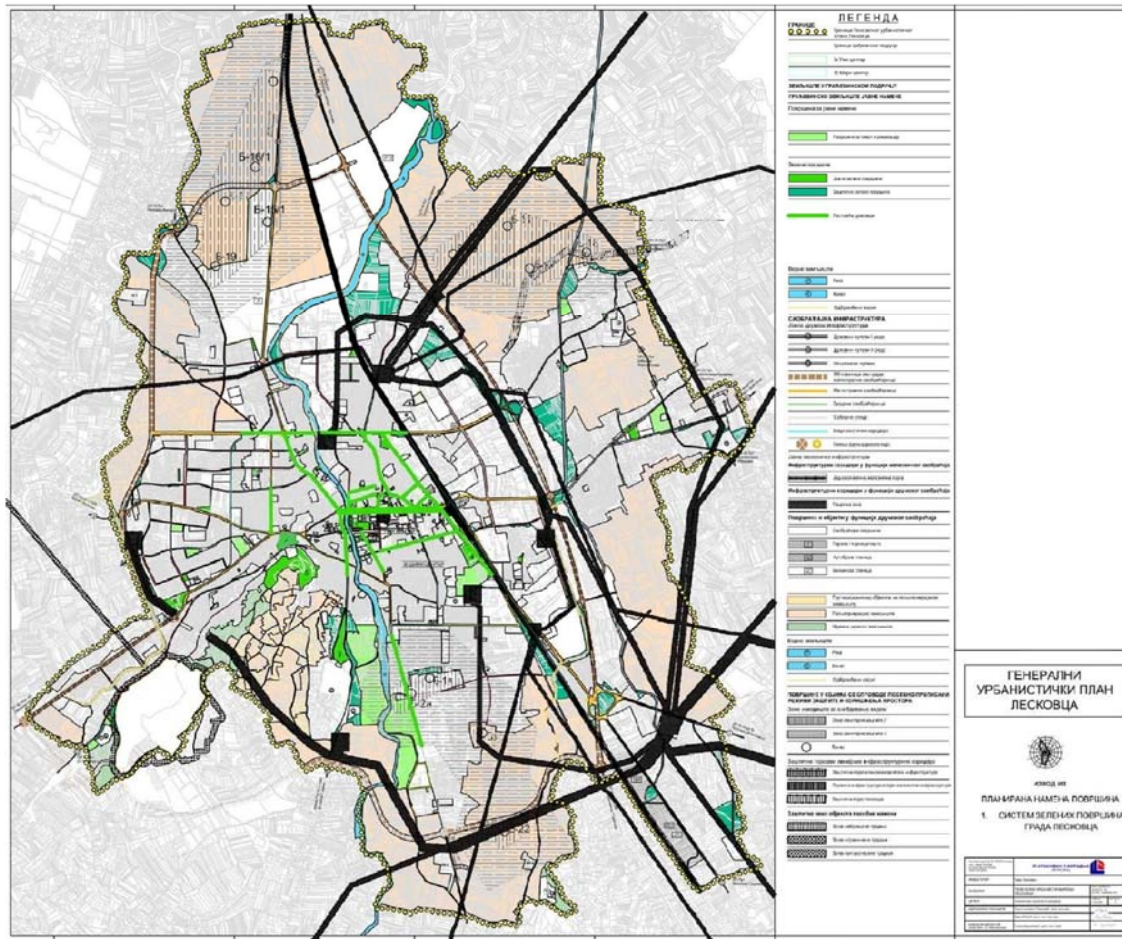
A total of 173 ha of green spaces is planned (public green spaces or green areas for public use on 32.39 ha and protective green areas on 140.61 ha). The area of greenery within other purposes is about 135 ha, which makes a total area of 308 ha.

General conditions: All existing green spaces need to be regularly maintained and reconstructed as necessary in cases of appearance disruption, degradation, devastation, etc. In existing areas, the following is allowed: reconstruction and establishment of new garden-architectural elements, paths, as well as children's playgrounds, fencing of parks. The ratio of paving and lawns depends on the type of green spaces. It is possible to install elements of urban furniture.

Special conditions according to categorization:

I Public green areas, i.e., green areas for public use: parks, squares, and block parks

Parks (green areas usually larger than 1 ha) are mostly multifunctional for various types of recreation, sports activities, and other cultural and educational activities. Different zones are distinguished in parks according to their function - zones for quiet and active recreation - playgrounds. In the overall park layout, paths should occupy 5-20% of the area. At least 70% of the park area should be covered with vegetation. Parks can be equipped with standard infrastructure and an irrigation system.



Map 6. Green area system of the city of Leskovac

Source: General Urban Plan of Leskovac

When improving existing parks, it is mandatory to preserve the park within its existing boundaries and to carry out reconstruction in the style in which the park was originally established.

In newly planned and existing parks, the construction of recreational facilities (open sports fields, children's playgrounds, fitness trails, health trails, bicycle paths, etc.) is allowed on a maximum of 2% of the park's territory, as well as infrastructure facilities of general interest determined by law. The exception is the ethno-archaeological park Hisar, which is primarily intended for archaeology and ethno content and where facilities with that purpose can be found.

The planned park is located between Stanoja Glavaša Street and the southern bypass, and in the settlement of Bratmilovce, between the children's kindergarten and the primary school. The total area of the parks is 25 ha, of which 4.4 ha is planned.



Appendix 17. City of Leskovac, city center
Source: Ivana Momić photograph, 2023.

Squares (publicly arranged green areas smaller than 1 ha) are planned in squares and along traffic routes and mainly serve decorative and sanitary-hygienic functions, as well as supplementary traffic regulation. Existing squares in the city: Masarik Square - Shop Đokić Complex, the square near "Rakićeva kafana," by the Veternica River, the square "Rupe," etc. are retained. When establishing new squares, it is necessary to consider pedestrian movement directions. Paths and platforms occupy up to 35% of the square; garden-architectural elements should be planned according to the type of square. The construction of buildings is not allowed in the squares. The total area of the squares is about 1.6 ha.

Block or regional parks (block greenery that frames residential purposes) are retained in the settlements: Dubočica, Zele Veljković, Suva Reka, Toma Kostić, near Rakićeva café, between Bojnička and Lebanska roads, in the settlement of Kovanluk, Vaskovo settlement, Radničko settlement, Bobište, Sinkovac. New ones are planned with the formation of new residential zones. The total area of block greenery is about 13 ha.

II Protective green areas have a special purpose and task with specific functions. Protective green areas are planned to meet the needs of environmental protection or specific endangered elements - such as unstable slopes, protection against erosion, noise protection, and the protection of air, water, soil, visual protection, etc. Another role is to connect urban greenery with the surrounding areas into a system of green spaces, as well as to facilitate active and passive recreation for the population. Within protective belts, it is possible to carry out vegetation work, create walking paths, cycling and jogging trails, open sports fields, and equip them with standard infrastructure and furniture (benches, canopies, etc.).

The green corridor represents a linear form of built or naturally greened areas.

The space that extends around the area of the Plan and through the city itself. Depending on the position and

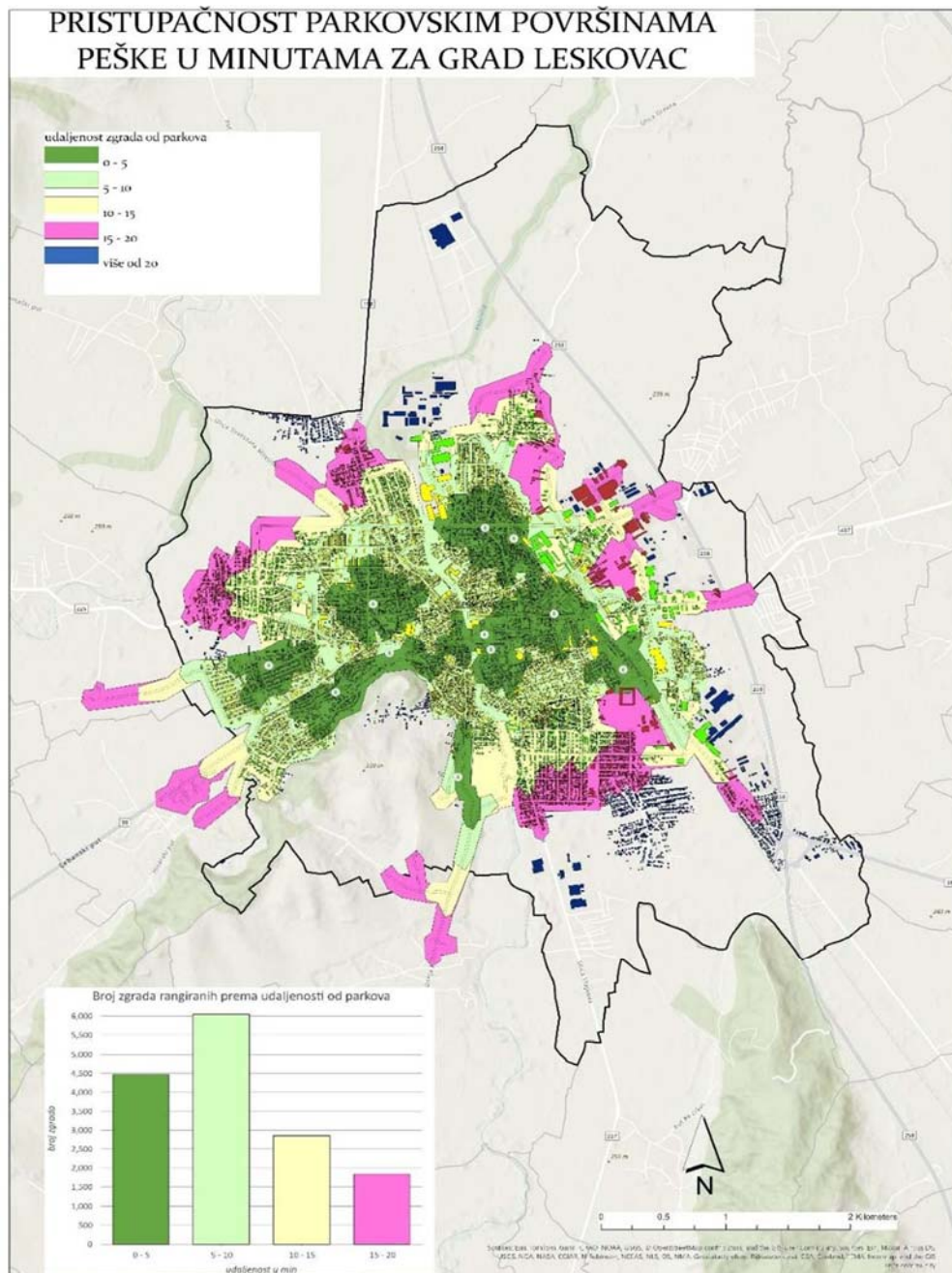
In terms of degree of organization, there are peripheral and central corridors. The peripheral corridor is formed as a green ring around the city. Green corridors are planned along the banks of the Veternica River. They are intended for public use in the function of recreation for the population and the preservation of the city's biodiversity. Parts of the green corridor (peripheral and central) can be arranged as park areas and as park-forests. Within the corridor, extensive agricultural production (orchards, meadows) can be maintained, especially in the peripheral corridor. The protective green areas are also planned as sanitary protection zones in: unstable and conditionally stable terrains - on

the slopes of Hisar as protection against landslides and reinforcement of conditionally stable and unstable terrains (according to the engineering-geological suitability of the terrain for construction); then between economic activities and other purposes (mainly housing); at the contact between housing and cemeteries; within the protective belt of the electrical infrastructure, in the source areas for water supply, etc.

The protective greenery along traffic routes is planned along existing and newly designed streets, railway tracks, city bypasses, and state roads. The planting of tall vegetation is possible outside the protective road zone, at a distance of 20 meters from first-class state roads; 10 meters from second-class state roads; and 5 meters from municipal roads. The protective green belt can be planned at a minimum distance of 10 meters from the railway line. In areas outside the protective zone, where the width of the protective belt is appropriate, park landscaping is allowed.

It is planned to retain and enhance existing protective green areas, reconstructing within existing boundaries while removing temporary structures. The newly planned greenery largely encompasses existing undeveloped and agricultural areas within the construction area along traffic routes and waterways, as well as low vegetation in the airport protective zones. This will be realized through the formation of combined plantings and the maintenance of natural and existing vegetation. Combined plantings can be formed by incorporating existing agricultural areas into the protective belt, and their management is a form of landscape maintenance with possible agricultural production. Nurseries can be established in the protective greenery areas.

III Green areas as a supplementary purpose within other predominant uses are classified into a special group due to limited use by various user groups. This includes areas within public purposes: schools, kindergartens, social and health care, administrative buildings, cemeteries, etc., as well as linear greenery along traffic routes and the Veternica River, as well as the Hisar Canal. They are also mandatory within residential, commercial, and religious complex purposes. The minimum percentage of greenery on parcels of other purposes, public and otherwise, is 10% in the planned state, and their precise values will be defined by lower-level plans. Considering the physical structure, the size of the city, and the existing green fund in the city, a form of a combined greenery system is planned. It is a combination of several types of greenery systems: radial (wedge-shaped), mosaic (green patch system), and linear (strip) types. The combined system consists of green areas in residential zones, social centers, and industry, more or less evenly distributed, connected by green corridors with parks and protective belts. (General Urban Plan of Leskovac, 2023)



Map 7. Accessibility of green areas in Leskovac

Source: Ivana Momić, created in ArcGIS Pro

This established system is the most effective for ensuring favorable climatic and hygienic conditions in the settlement area and providing residents with places for rest and recreation, as well as for a more decorative appearance and better connectivity with the suburban green zone. (Strategy for the Development of the Urban Area of the City of Leskovac, 2024).

In Map 7, created in ArcGIS Pro, the accessibility for residents of the combined greenery system can be observed.

4CLIMATIC INDICATORS

4.1. CLIMATE OF CITIES

4.1.1. CLIMATE OF THE CITY OF OLDBORG – DENMARK

Denmark has variable weather because it is located in a temperate zone at the meeting point of different air masses from the Atlantic, the Arctic, and Eastern Europe. The western coast faces the North Sea, but the final part of the warm Gulf Stream (North Atlantic Current) moderates the climate. Lakes can freeze, snow often falls during cold winters, but the average temperature in February, the coldest month, is around 0°C, which is approximately 7°C higher than the global average for that latitude. Summers are mild, with episodes of cloudy weather interrupted by sunny days. The average temperature in July, the warmest month, is approximately 16°C. Rain falls throughout the year, but it is relatively light in winter and spring, with the heaviest rainfall occurring from late summer to autumn. The annual precipitation amount of approximately 635 mm ranges from about 810 mm in southwestern Jutland to around 405 mm in parts of the archipelago (Internet source 11).

In Aalborg, summers are pleasant and partly cloudy; winters are long, very cold, snowy, and mostly cloudy; and it is windy throughout the year. During the year, temperatures typically range from -2°C to 21°C and are rarely below -9°C or above 26°C. The warmest month of the year in Aalborg is July, with an average maximum temperature of 22°C and a minimum temperature of 6°C. The cold season lasts 3.9 months, from November 21 to March 19, with an average daily maximum temperature below 5°C. The coldest month of the year in Aalborg is January, with an average minimum temperature of -2°C and a maximum temperature of 0°C. In Aalborg, the average percentage of the sky covered by clouds experiences significant seasonal variations throughout the year. The clear, sunny part of the year in Aalborg begins around April 20 and lasts for 5.6 months, ending around October 6. The sunniest month of the year in Aalborg is July, during which the sky is clear, mostly clear, or partly cloudy 56% of the time. The cloudier part of the year begins around October 6 and lasts for 6.4 months, ending around April 20. The cloudiest month of the year in Aalborg is December, during which the sky is cloudy or mostly cloudy 66% of the time. A rainy day is defined as having at least 1 mm of precipitation. The month with the most wet days in Aalborg is November, with an average of 10.3 days with at least 1 mm of precipitation. The month with the least wet days in Aalborg is April, with an average of 6.8 days with at least 1 mm of precipitation. The month with the most days of only rain is October, with an average of 10.5 days. Based on this categorization, the most common form of precipitation throughout the year is rain only, with the highest probability of 36% on October 31 (Internet source 9).

4.1.2. CLIMATE OF THE CITY OF BRAGA – PORTUGAL

The Atlantic climate predominates overall, placing most of the country in the humid zone of the Iberian Peninsula; this is particularly pronounced in the northwest, which includes Braga, where the climate is mild and rainy. Summer temperatures near sea level can average 24 °C, but are considerably lower at exposed higher altitudes. Winter temperatures average 3 to 4 °C, but are usually milder south of the Douro.

Winters are mild, with average temperatures in January around 9°, and summers are hot, but not scorching, as they are moderated by the ocean: average temperatures in August are around 25°. Rainfall is abundant from autumn to early spring, significantly decreasing between May and June and being quite rare from June to September. Snow is almost unknown. The wind is almost constant: it blows very strongly in the winter months, while in summer it is a pleasant breeze. The rainiest months of the year are February, October, and December, during which the average monthly precipitation reaches 180 mm. On the other hand, the driest months are June, July, and August when the average precipitation decreases to 20 mm per month (Internet source 12). In Braga, summers are

short, hot, dry, and mostly clear, while winters are cold, wet, and partly cloudy. Throughout the year, temperatures typically range from 6°C to 27°C and are rarely below 3°C or above 27°C. The warmest month of the year in Braga is August, with an average maximum temperature of 37°C and a minimum temperature of 21°C. The coldest month of the year in Braga is January, with an average minimum temperature of 6°C and a maximum temperature of 15°C. The clear, sunny part of the year in Braga begins around June 8 and lasts for 3.3 months, ending around

September 17. A rainy day is defined as having at least 1 mm of precipitation. The probability of wet days in Braga varies significantly throughout the year. The wet season lasts 8.2 months, from September 25 to May 30, with a greater than 23% chance that a given day will be a wet day. The month with the most wet days in Braga is November, with an average of 11.2 days with at least 1 mm of precipitation. The month with the least wet days in Braga is July, with an average of 2.2 days with at least 1 mm of precipitation. The month with the most days of only rain in Braga is November, with an average of 11.2 days. The most common form of precipitation throughout the year is rain only, with the highest probability of 40% on October 29. The sunniest month of the year in Braga is July, during which the sky is clear, mostly clear, or partly cloudy 82% of the time. The cloudiest month of the year in Braga is December, during which the sky is cloudy or mostly cloudy 58% of the time (Internet source 8).

4.1.3. CLIMATE OF THE CITY OF STUTTGART – GERMANY

Germany generally has a temperate climate, especially considering the distance of larger parts of its territory from the influence of the North Atlantic current. While the open coastal areas near the North and Baltic Seas are dominated by a maritime component, continental elements gain significance moving east and southeast (Internet source 17).

Stuttgart is located in the continental part, in the south of the country, so it has a continental climate. Winters can be unusually cold or long, especially at higher altitudes in the south, or mild, with temperatures ranging only two or three degrees above or below freezing. Spring is always interrupted by a frost drop in May, popularly known as *die drei Eisheligen* ("the three ice saints") - it can arrive so late that it goes unnoticed and is accompanied by a cold, rainy summer.

The climate of Stuttgart is characterized by its position in the wide basin of the Neckar River, protected by the Black Forest to the west, the Swabian Jura to the south, the Schurwald to the east, and the Stromberg and Hohenzollern region to the northwest. The average number of sunshine hours per year is relatively significant (1,720 hours). While the sun shines for less than 60 hours in December, it shines for more than 230 hours in July.

The climate of Stuttgart is mild, with an average annual temperature of around 10°C in the urban basin and about 8.4°C in the elevated peripheries located at about 400 m above sea level. Along the Upper Rhine Valley, Greater Stuttgart is one of the warmest regions in Germany. July is the warmest month with an average temperature of 18.8°C, while the average temperature in January is only 1.3°C. The center of Stuttgart has about 150 days above zero. Thanks to the generally mild climate, viticulture has long been important here, and that trend continues today. The Stuttgart region has very little precipitation compared to other regions in Germany (Internet source 10).

4.1.4. CLIMATE OF THE CITY OF LESKOVAC – SERBIA

The climate of Serbia is continental, with cold, relatively dry winters and warm, humid summers. Average July temperatures are around 22°C, while January averages around -1°C. Summer

temperatures in the mountainous regions of Serbia are significantly cooler, averaging around 18°C. Air masses from Eastern and Northern Europe prevail throughout the year. Only occasionally do Mediterranean air masses reach Serbia from the southeast or south. The highest precipitation occurs during the warm half of the year, peaking in late spring and late autumn. Winter precipitation usually falls as snow, with 40 days of snow cover in the northern lowlands and 120 days in the mountains.

The climate of the city of Leskovac is moderately continental, characterized by extremely or moderately warm summers and moderately cold winters, as well as two transitional periods, spring and autumn. The average annual air temperature in the planning area is 11.6°C, the coldest month is January with an average temperature of 2°C, the warmest is July with an average daily temperature of 22°C, and the annual amplitude is 22.3°C. The average precipitation for Leskovac is 630 mm, for Grdelica 795 mm, for Predejan 811 mm, for Crkovnica 744 mm, for Vucje 764 mm, and for Kukavica 934 mm. The maximum annual precipitation in Leskovac is 917 mm and the minimum is 470 mm, in Predejan the maximum is 1043 mm and the minimum is 596 mm, in Kukavica the maximum is 1126 mm and the minimum is 764 mm. The dominant winds in the area are from the west and north, while the highest average speed of the northern and southwestern wind is 3.2 m/s, of the southwestern 3.8 m/s, and of the northern 3.4 m/s in Predejan, while in Kukavica the southwestern wind is 3.8 m/s and the western wind is 3.6 m/s (Spatial Plan of the City of Leskovac, 2012).

4.2. ANALYSIS OF LAND COVER TEMPERATURE USING DISTANCE DETECTION METHOD AND COMPUTER PROCESSING OF SATELLITE IMAGERY

4.2.1. LANDSAT – THERMAL BANDS

The Landsat satellite program enables the determination of land surface temperature. The first satellite of the Landsat mission was launched in 1972. Landsat 8 was launched on February 11, 2013, and consists of two instruments - Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS). These two sensors allow for seasonal coverage of land with a spatial resolution of 30m (visible range, near-infrared range, shortwave-infrared range), 100 m (thermal range), and 15 m (panchromatic range). OLI and TIRS collect images of global land surfaces, including coastal areas.

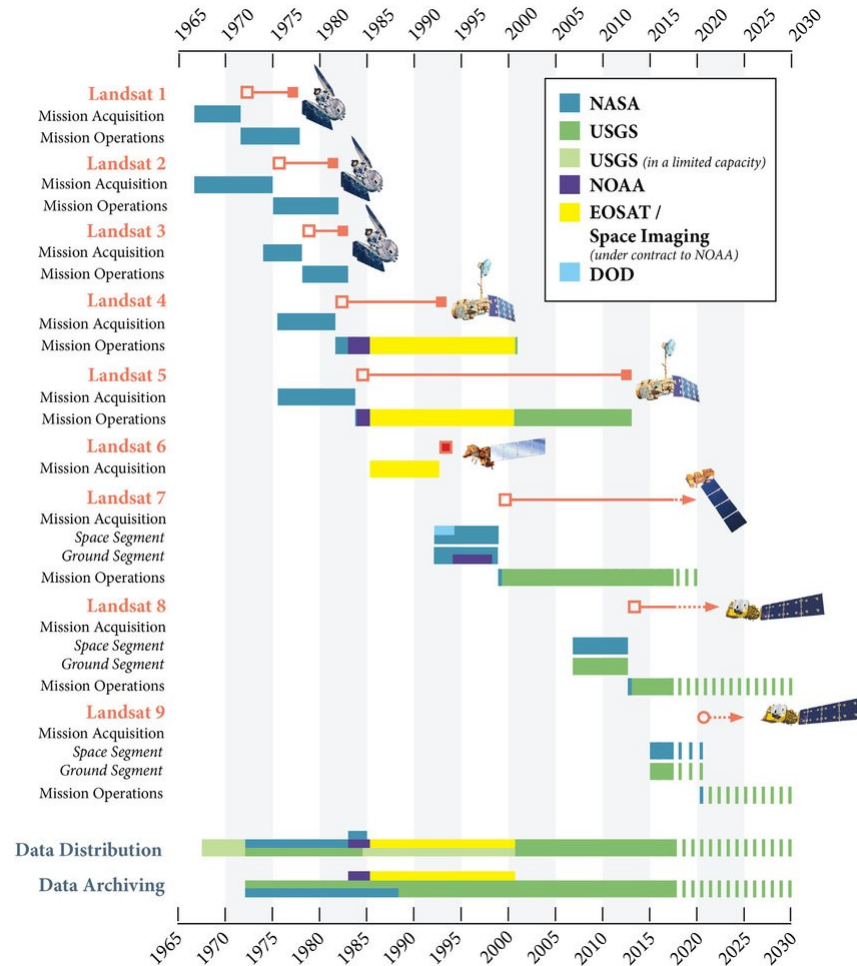
areas, polar ice, islands, and continental areas.

- o OLI provides two new spectral ranges - one specifically designed for detecting high clouds, and the other for coastal areas and water quality monitoring.
- o TIRS collects data for two additional narrow spectral ranges in the thermal region, previously covered by only one broader spectral band from Landsat 4-7 satellites for measuring Earth's thermal energy.

Collection 1 consists of three categories: Level 1, Level 2, and Real-Time. Landsat scenes with the highest available data quality are placed in Level 1 and are considered suitable for multi-temporal analyses. Radiometrically calibrated and orthorectified images using ground control points and DEM elevation models. These are the highest quality data in Level 1 processing.

The limitation of the first five Landsat missions and the Landsat 7 mission is the single-channel thermal infrared sensor. The thermal infrared sensor detects most of the energy from the part of the spectrum in which it is emitted from the surface, allowing for the collection of information about the thermal characteristics of the Earth's surface (soil).

TIRS channels register adjacent parts of the electromagnetic spectrum from approximately 10 to 12 μm , and with such data, it is possible to implement an algorithm for dual-channel sensors (Split-Window, SW), which allows for the removal of atmospheric effects on the images. Landsat is the oldest existing system for Earth observation from space, created in collaboration between the United States Geological Survey (USGS) and NASA for the purpose of capturing Earth's surface from space.



Appendix 18: Chronological launch of Landsat satellites, timeline
Source: Dušan Jovanović and collaborators, 2020

4.2.2. LAND SURFACE TEMPERATURE (LST)

Land Surface Temperature (LST) refers to the temperature of the surface layer of the soil, which differs from air temperature. Landsat Thematic Mapper (TM) and Thermal Infrared Sensor (TIRS) collect temperature data and store this information as a digital number ranging from 0 to 255 (8-bit radiometric resolution for Landsat 5), or from 0 to 65,535 (16-bit radiometric resolution for Landsat 8). The TIRS Landsat 8 instrument has two thermal bands that operate on technology based on quantum physics.

There are several methods for obtaining LST:

- Radiative transfer equation,
- Mono-window,
- Split-window,
- Single channel.

4.2.3. CREATION OF TEMPERATURE MAP

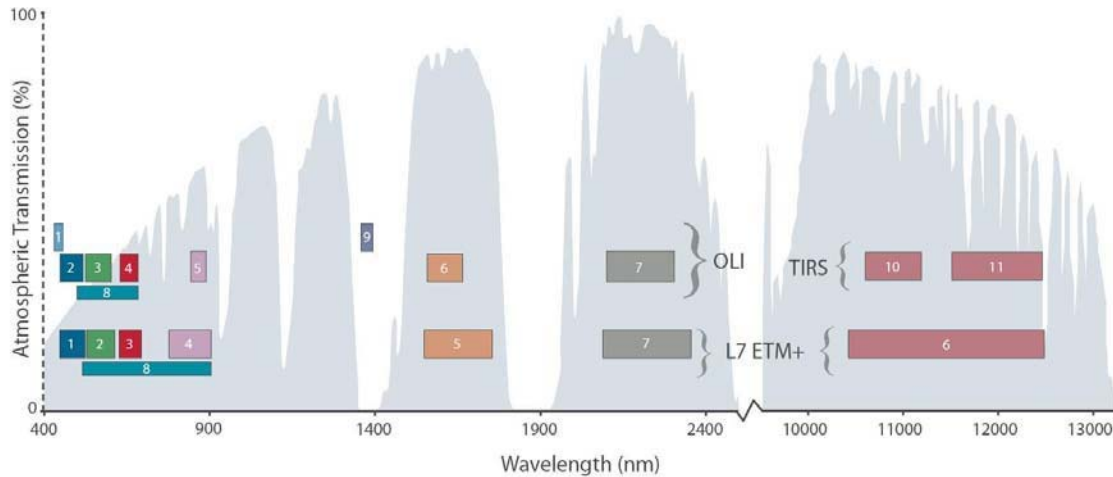
Using the remote sensing method, we created a temperature map for all four cities in four countries using Landsat 8 satellite images from 2025, employing the mono-window algorithm.

The calculation of land surface temperature was performed using the LST index in the ArcGIS Pro software package. The format of the output raster file was changed from ArcGIS Projected File to JPG File, which are presented in the paper.

First, the images were downloaded from the Earth Explorer website (<https://earthexplorer.usgs.gov/>).

Parameters for image search: Date of image acquisition: 21.06.–30.08.2025. Product type: L8 OLI/TIRS, max. cloud cover percentage: 20%.

Creation of the temperature map using thermal bands – B10 and B11.



Appendix 19: Landsat Thermal Bands

Source: <https://landsat.gsfc.nasa.gov/satellites/landsat-8/>

Landsat-8 OLI and TIRS Bands (μm)		
30 m Coastal/Aerosol	0.435 - 0.451	Band 1
30 m Blue	0.452 - 0.512	Band 2
30 m Green	0.533 - 0.590	Band 3
30 m Red	0.636 - 0.673	Band 4
30 m NIR	0.851 - 0.879	Band 5
30 m SWIR-1	1.566 - 1.651	Band 6
100 m TIR-1	10.60 - 11.19	Band 10
100 m TIR-2	11.50 - 12.51	Band 11
30 m SWIR-2	2.107 - 2.294	Band 7
15 m Pan	0.503 - 0.676	Band 8
30 m Cirrus	1.363 - 1.384	Band 9

Table 4. Thermal Bands of Landsat

Source: <https://landsat.gsfc.nasa.gov/satellites/landsat-8/>

Based on the downloaded raster images, further processing is performed computationally. The calculation is carried out in the ArcGIS Pro software package using the tool (Tools) - Raster calculator. Conversion of digital number to spectral radiance:

$$L\lambda = MLQcal + AL$$

ML – Special multiplicative scaling factor, AL – Special additive scaling factor, $Qcal$ – raw raster (cropped part) for which spectral radiance is calculated.

Band	RADIANCE_MULT_BAND (ML)	RADIANCE_ADD_BAND (AL)
1	1.2147E-02	-60.73491
2	1.2439E-02	-62.19329
3	1.1462E-02	-57.31058
4	9.6655E-03	-48.32751
5	5.9148E-03	-29.57403
6	1.4710E-03	-7.35479
7	4.9579E-04	-2.47896
8	1.0539E-02	-54.69344
9	2.3116E-03	-11.55820
10	3.3420E-04	0.10000
11	3.3420E-04	0.10000

Appendix 20. Values of constants ML and AL from Landsat metadata
Source: <https://earthexplorer.usgs.gov/>

Values of constants ML and AL are provided in the Landsat metadata:

- ML – RADIANCE_MULT_BAND_x, where x is the band number.
- AL – RADIANCE_ADD_BAND_x, where x is the band number.

Conversion of spectral radiation to brightness temperature at the sensor:

$$T = \frac{K_2}{\ln\left(\frac{K_1}{L_\lambda} + 1\right)} - 273.15$$

Values of constants K1 and K2 are provided in the metadata of Landsat images:

- K1 – K1_CONSTANT_BAND_x, where x is the band number.
- K2 – K2_CONSTANT_BAND_x, where x is the band number.

Band	K1_CONSTANT_BAND	K2_CONSTANT_BAND
10	774.8853	1321.0789
11	480.8883	1201.1442

Appendix 21. Values of constants ML and AL from the metadata of Landsat images
Source: <https://earthexplorer.usgs.gov/>

The same procedure needs to be repeated for the second thermal band (B11).

The final temperature map is obtained as the arithmetic mean of two rasters with surface temperatures.

Raster styling parameters:

- Primary symbology: Classify,
- Mode: Quantile,
- Color ramp: Condition Number,
- Classes: 5.

The layout was formed based on which the maps were created.

When changing the format, it is possible to change the projection and type of output data.

The same methods for downloading and processing recordings were used for all four cities.

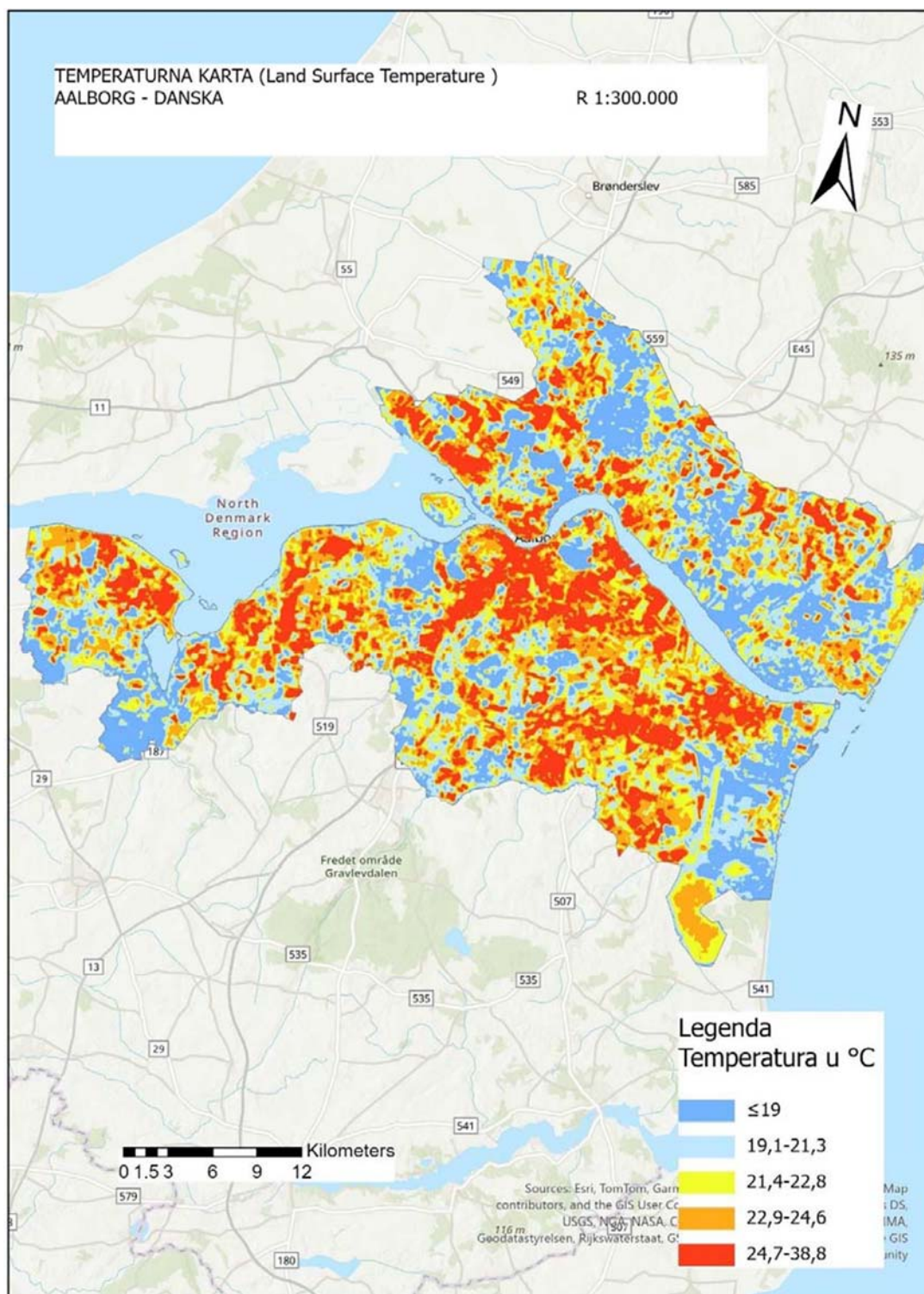
Method to obtain maps – temperature maps that can be compared.

The intermediate step for each of the four cities is the clipping of the obtained raster images within the boundaries of the urban areas we studied in this work using the tool (Tools) – Raster Clip.

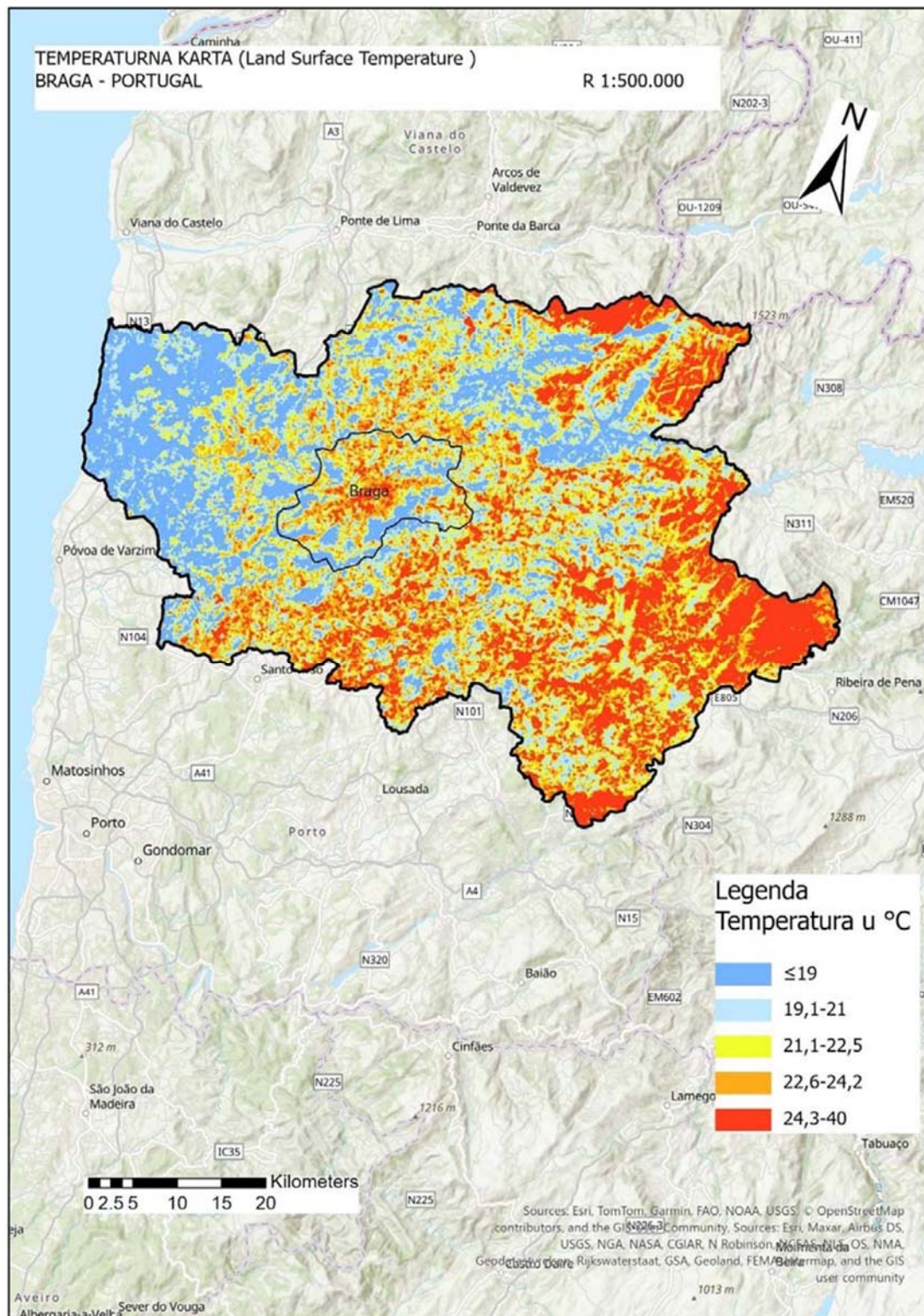
The reference boundaries were taken from the site geofabrik

<https://download.geofabrik.de/europe.html>), and for Serbia from the site geosrbija

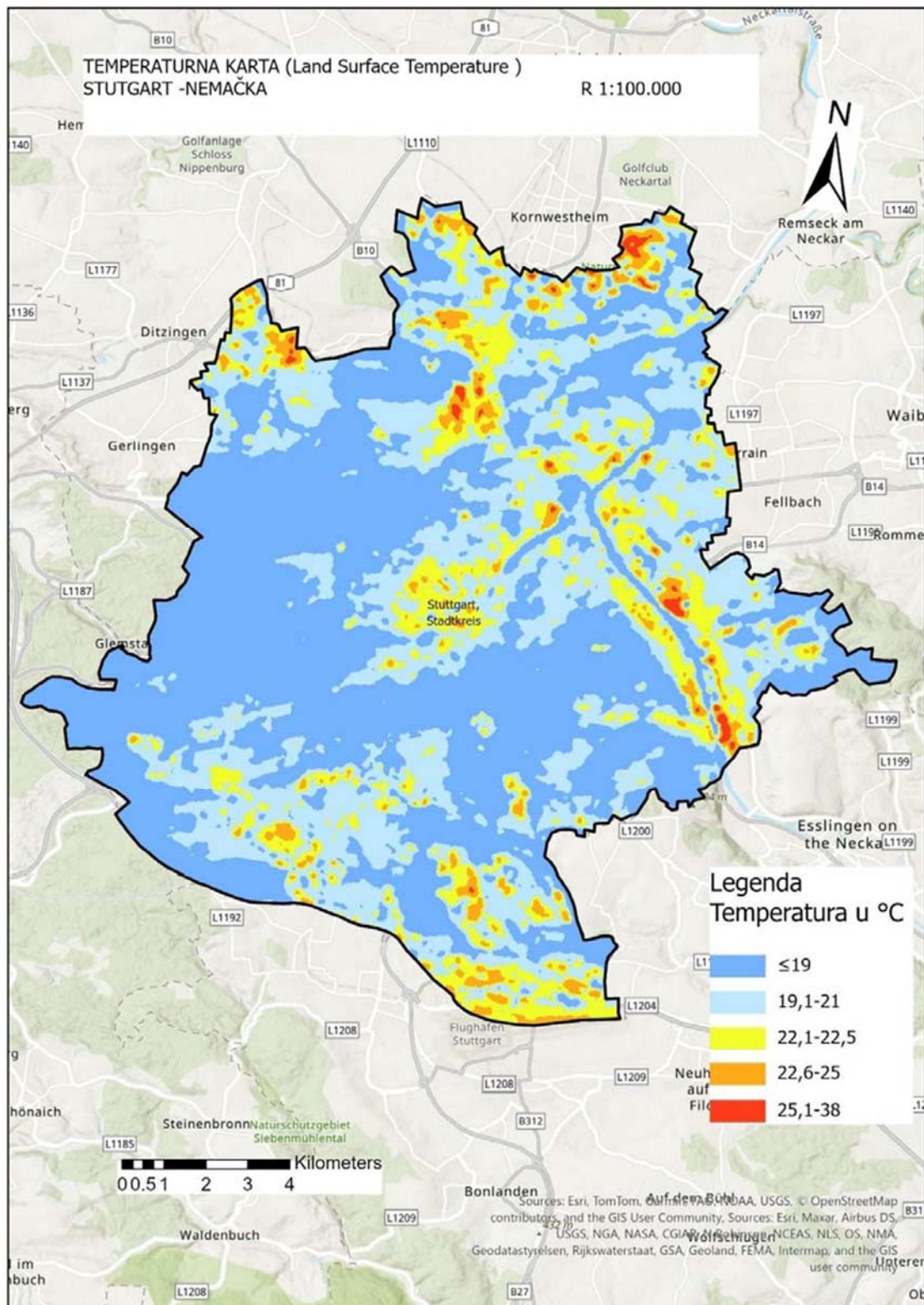
<https://a3.geosrbija.rs/>).



Map 8. Temperature map of Aalborg
Source: Ivana Momić satellite imagery processing in ArcGIS Pro

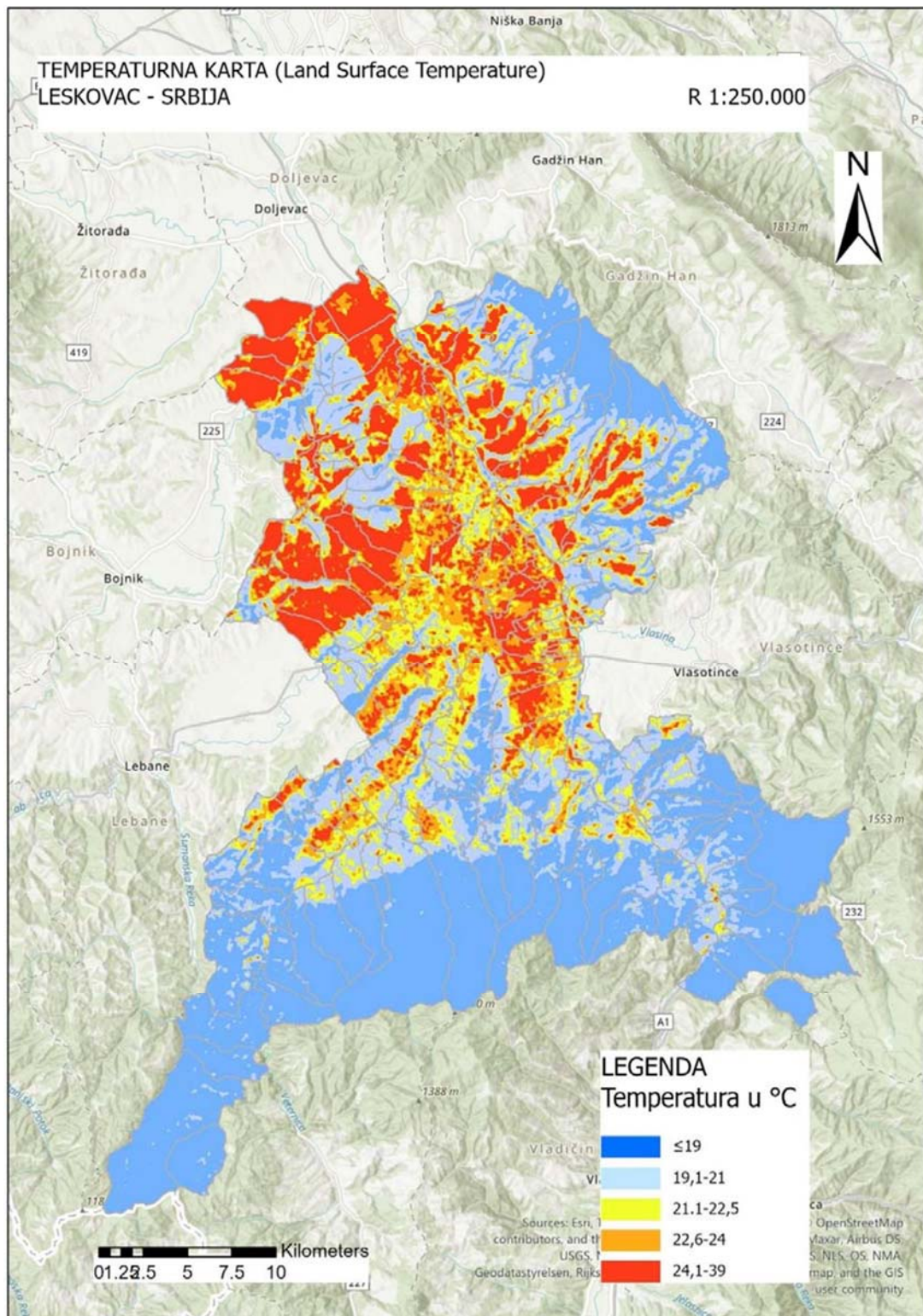


Temperature Map of Braga
Source: Ivana Momić satellite imagery processing in ArcGIS Pro

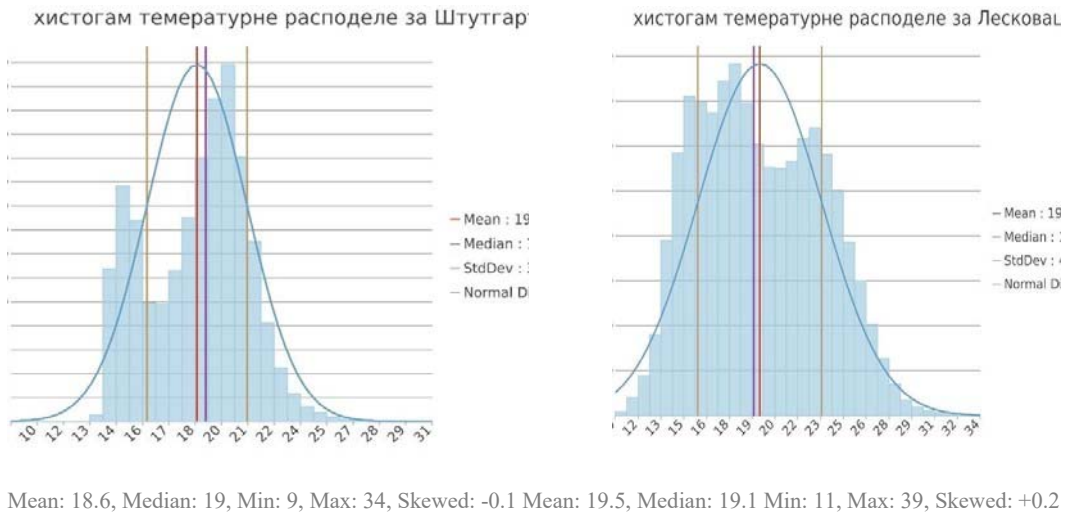
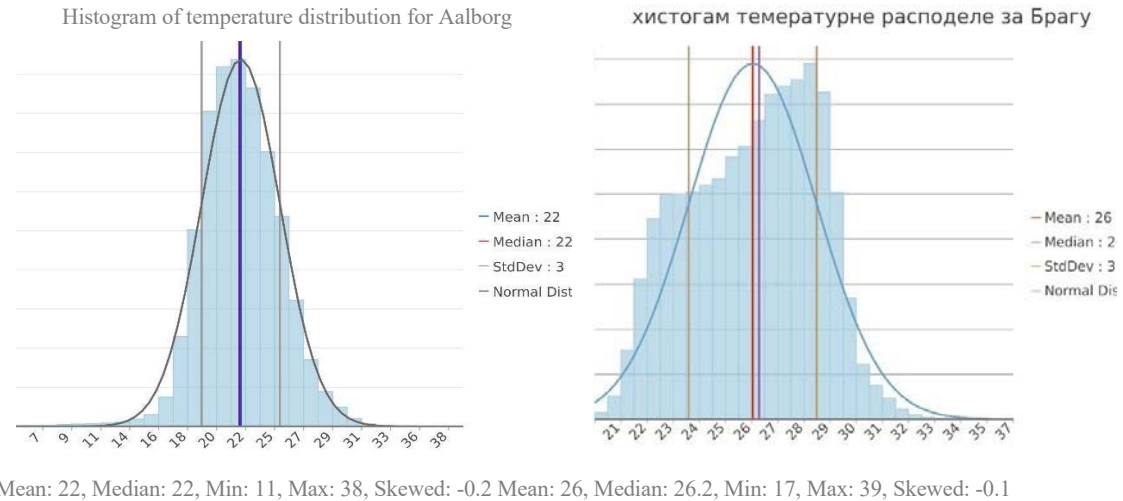


Map 10. Temperature map of Stuttgart

Source: Ivana Momić satellite imagery processing in ArcGIS Pro

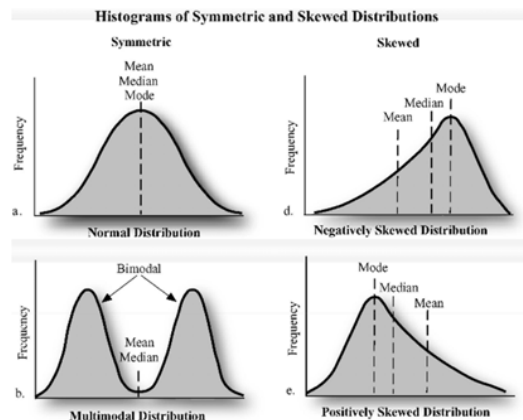


Map 11. Temperature map of Leskovac
Source: Ivana Momić satellite imagery processing in ArcGIS Pro



Appendix 21: Histogram with temperature maps

Source: <https://landsat.gsfc.nasa.gov/satellites/landsat-8/creation-of-satellite-images-in-ArcGIS-Pro>



Appendix 22: Histogram of symmetric and skewed distributions

Source: Dušan Jovanović and collaborators, 2020

Statistical analysis of temperature maps is achieved by creating histograms and univariate statistics, influenced by one factor. The histogram is viewed as a graphical representation of information about the content of a remote sensing image, in this case, temperature. There are two types of univariate descriptive statistics: central tendency (mode, median, mean) and dispersion (standard deviation). Central tendency provides the most common value from a set of values, as seen in Appendices 21 and 22. Dispersion tells us how much the values deviate from the central value. The mode is the value that occurs most frequently in the distribution and usually represents the highest point on the histogram curve. The median represents the middle in a distribution. The mean represents the arithmetic average defined as the sum of all values divided by the number of observations. For a symmetric distribution, the mean is usually close to values such as the median or mode (Jovanović, 2020).

Temperature maps are in perfect correlation with land use maps. The creation of temperature maps for the summer period of the current year, 2025, and histograms that carry statistical data tell us the following:

O Aalborg is a city in northern Denmark with an Atlantic climate; summers are pleasant, not too hot, with an average temperature of 22°C. The map shows areas in red indicating elevated temperatures above the average value of 24°C. These are distributed within the urban matrix and economic activities. Blue areas representing temperatures below 21°C are evenly distributed, especially near water bodies, but also throughout the entire area, indicating a perfect arrangement of green spaces in the city. Braga is a city at the far north of Portugal with a mild Atlantic climate, with an average temperature of 26°C. The map shows red areas indicating elevated temperatures above the average value, distributed within the urban matrix in the central part, but here the influence of a continental climate is noticeable towards the interior to the east. Blue areas representing temperatures below 19°C are along the Atlantic Ocean, as well as in the northern part, which is rich in forests and sporadically throughout the entire area. It is observed that almost the largest part of the area has temperatures below 26°C, indicating a large area covered with greenery. The city itself, regardless of the presence of green spaces. It indicates high temperatures, so greenery should be planned more optimally.

O Stuttgart is located in the south of Germany with a moderately continental climate; summers are not too hot, with an average temperature of 19°C. The map shows areas in red indicating elevated temperatures above the average value of 25°C. These are distributed within the urban matrix in the central part and developed industries to the east. Blue areas representing temperatures below 19°C are evenly distributed, particularly near water bodies, but also throughout the entire area. It is observed that almost the largest part of the area has temperatures below 21°C, especially towards the south and southwest, indicating a large area covered by greenery.

Leskovac is a city in the far south of Serbia with a moderately continental climate; summers are warm, with an average temperature of 19°C. Red areas indicate elevated temperatures above the average value of 24°C, distributed within the urban matrix in the central part. There are a large number of scattered settlements engaged in agriculture, particularly monocultures to the west and northwest. Blue areas representing temperatures below 19°C are unevenly distributed, exclusively towards the south and northeast, where forests dominate. The city itself has high temperature values above 26°C, so new types of green spaces must be considered to mitigate these differences.

5. CONCLUSION

Green infrastructure in all parts of Europe is important for environmental preservation, which is particularly crucial for the medium-sized cities observed in this study.

What is characteristic of all four cities is a developed spatial planning and urban system with a clear planning structure. Plans are vertically developed from the national level down to the local level. Each of the processed plans necessarily addresses green infrastructure – a system of green spaces with a special focus on maintaining existing parks, forests, recreational, and other natural areas, along with the arrangement and formation of new green spaces.

The climate is an important factor in the quality of the environment. Summer temperatures can be uncomfortably high, with all the consequences that entails. All four cities have different climates. Aalborg in Denmark has a temperate climate, Braga in Portugal has an Atlantic climate, Stuttgart in Germany has a continental climate, similar to Leskovac in Serbia, which has a moderately continental climate. Considering all four temperature maps, it can be observed that urban areas with little or no green spaces show the highest temperatures. Places on the outskirts of the city, rivers, seas, forests, parks, and green infrastructure, in short, reduce temperature extremes and make life in the city more pleasant.

Cities are characterized by air pollution and devastated living conditions with more concrete and buildings and fewer plants. All this causes a higher air temperature compared to the surroundings. A new study, on the European Commission's website (Internet source 4), published new data indicating that increased green cover in cities can help mitigate the effects of the greenhouse effect and warming. As summers, and even springs, become increasingly unbearable in cities year after year, the importance of vegetation in urban areas is emphasized. This is particularly important as heatwaves especially affect older individuals. The study analyzed data from 93 European cities to estimate the number of potentially saved lives through planting vegetation and trees. Previous studies have shown that trees can cool cities by an average of 1.1°C to 2.9°C, significantly reducing the heat island effect. Using temperature and age structure data, researchers calculated the burden of summer mortality due to the heat island effect. Current guidelines suggest a minimum of 10 percent tree canopy coverage in European cities, while aiming for 30 percent to ensure fresher and better air, as well as overall health. In these 93 cities that were monitored, nearly 58 million people over the age of 20 lived, and many reported that there were 128,000 deaths during the summer in the year the research was conducted. It was found that urban temperatures were on average 1.5°C higher, correlating with 6,700 premature deaths or 4.3 percent of all summer deaths, according to the research. Increasing tree cover to 30 percent could lower temperatures by an average of 0.4°C, preventing nearly 40 percent of deaths. The warming effect was most prevalent in cities in central and southern Europe such as Spain, Italy, Hungary, Croatia, and Romania, but increasing tree cover also showed significant potential in reducing mortality rates.

According to another study, researchers reviewed 27,486 papers based on 51 types of green infrastructure classified into ten broad categories according to their cooling benefits. They found that botanical gardens, wetlands, green walls, street trees, and vegetated balconies offer the most effective air cooling. A systematic review of hundreds of studies on green infrastructure shows that it regulates urban heating and reduces temperatures through shading, evapotranspiration, and thermal insulation. Cooling associated with green infrastructure is also linked to lower energy consumption in buildings. The most commonly reported measures in Europe were street trees (18.8%), green walls (15.9%), and green roofs (13.0%). According to the study, differences in types of vegetation

The studies conducted on different continents likely stem from various regional contexts, climatic conditions, and urban planning priorities, reflecting the distinct ecological needs and urban challenges specific to each continent, as well as the best interventions to address urban overheating in their respective regions. In addition to cooling, green infrastructure serves to manage rainfall, reduce flooding, and sequester CO₂. The study emphasizes the importance of considering a balanced approach to heat mitigation and adaptation during their implementation and provides an inventory of heat mitigation strategies that could assist policymakers and urban planners in selecting the best greening approach to reduce heat waves and lower temperatures in cities facing increasing risks from extreme and deadly heat waves (internet source 6).

The aim of the previous considerations is to contribute to the planning and management of green spaces in cities and urban regions. Since there is neither a universal methodology for every observed city nor a universal problem, the essence lies in seeking specific answers. The question posed at the beginning of the work, "can these examples be applied in the case of a city in Serbia, while avoiding mistakes and shortcomings," can be more easily addressed if we have certain positive experiences and guidelines at our disposal. For example, the examples from each city demonstrate how crucial spatial and urban planning is for the balanced development of areas. Green infrastructure plays a special role in plans and strategies, with recognized significance. This refers to proposing solutions that are sustainable and achievable under various conditions. A newer approach to planning green urban areas involves transdisciplinarity, meaning the integration of different disciplines, institutions, and human resources, as well as the ability for creative thinking. Geographic Information Systems in urbanism, planning, and landscape architecture are slowly taking their place. Through the exchange of knowledge, we can more quickly arrive at practical solutions – the development of green infrastructure that will meet multiple needs.

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