



LANDSCAPE FIRE MANAGEMENT REPORT FOR SERBIA



2025

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List of Acronyms

BAIS2	Burned Area Index for Sentinel-2
COST	European Cooperation in Science and Technology
CSO	Civil Society Organization
EUFD	EU Floods Directive
EFFIS	European Forest Fire Information System
FAO	Food and Agriculture Organization
FWI	Fire Weather Index
GFMC	Global Fire Monitoring Center
GHG	Greenhouse Gases
IPCC	Intergovernmental Panel on Climate Change
IPAFFP	IPA Floods and Fires Programme
LFM	Landscape Fire Management
LSG	Local Self-Government Unit
Mol	Ministry of Interior
MAFWM	Ministry of Agriculture, Forestry and Water Management
NFI	National Forest Inventory
PE	Public Enterprise
RFMC	Regional Fire Monitoring Center
RCP	Representative Concentration Pathways
RGA	Republic Geodetic Authority
RHMSS	Republic Hydrometeorological Service of Serbia
SEM Mol	Sector for Emergency Management, Ministry of Interior
SRES	Special Report on Emissions Scenarios
SWOT	Strengths, Weaknesses, Opportunities, and Threats
UN	United Nations
UNDP	United Nations Development Programme
USFS	United States Forest Service
VFA	Voluntary Firefighting Association

Introduction

The countries of the Western Balkan (WB) region have gone through a period of societal, economic, and social transformation in the last three decades. It is a significant period as almost all the countries and some of the processes of change and transformation are still being developed. In this period, population migration within the countries is particularly pronounced, but emigration outside of the region is also resolutely ongoing. In addition to these processes, unfortunately, the WB region has not been spared from the impacts of climate change either, causing numerous disasters and catastrophes, such as floods, landslides, periods of extremely high temperatures, etc. All this has had a negative impact on forest fire and landscape fire occurrence in the region resulting in large-scale forest fires, material damage, and, unfortunately, also cases of injuries and loss of human life in some instances.

Insufficiently defined forest fire protection systems (prevention, preparedness, suppression, and post-fire management) and inadequate coordination between the stakeholders on the landscape level within that system persist in all WB countries. This was influenced by the ever more frequent occurrence of fires that are not limited to forests but also burn on arable and agricultural areas, pastures, abandoned agricultural areas, and peri-urban landscapes. These types of fires (landscape-level fires) require both an appropriate approach and a concept for protection against them.

This was recognized by the Swiss Agency for Development and Cooperation (SDC) which supported the Landscape Fire Management in Western Balkan (LFMWB) Programme, coordinated by Farmahem – Skopje, North Macedonia, and Helvetas Swiss Intercooperation as a backstopper. This Programme, through its activities, aims to *increase the resilience of Western Balkans forests and landscapes against uncontrolled landscape fires to the benefit of the people who depend on these landscapes for their livelihoods and socioeconomic development.*

Following a landscape and participative approach, the LFMWB Programme contributes to establishing of the Landscape Fire Management (LFM) Network in Serbia as a science-practice-policy mechanism where different stakeholders have the opportunity to discuss the current situation and propose future guidelines regarding landscape fires. Acting as Serbia's sounding board, the LFM Network members were actively involved in a dynamic feedback process of preparation of the first Landscape Fire Management Report for Serbia representing a comprehensive, authentic, and well-rounded document that elaborates the current situation in the country regarding fires on a landscape level. The process for preparation of this report was coordinated by the Ministry of Agriculture, Forestry and Water Management of Serbia with the support of the Regional Fire Monitoring Centre (RFMC) for the Southeast Europe/Caucasus Region as partners of the LFMWB Programme.

In 2025, the LFM Network members in Serbia succeeded in developing a common understanding covering different areas of landscape fires through several workshops. All data elaborated in the report are provided and confirmed by official institutions of Serbia, giving more legitimacy to the conclusions derived from the result analysis. This report gives an overview of land use, demography and migration, climate characteristics, climate change and nationally determined contribution, analysis of the existing fire system on landscape level, recording fires, landscape fire risk assessment, and existing initiatives. Additionally, this report includes findings of the LFM Network members in Serbia who worked on developing a SWOT analysis elaborating the strengths, weaknesses, opportunities, and threats related to the LFM.

The last chapter of this report defines the LFM Guidelines developed by the LFM Network members, which will serve as a fundamental framework to steer future actions and strategies into landscape fire management governance in Serbia. These Guidelines offer essential recommendations, laying a solid foundation for implementing the landscape fire management approach in all of its phases, especially through stressing prevention and preparedness measures, all in one cohesive fire protection system.

The validation process of the Landscape Fire Management Report was ensured through continuous communication among the LFMWB Country Project Staff in Belgrade seconded by MAFWM as a drafting person of the report as well as the LFM Network members of Serbia with expert support provided by the RFMC. Through ensuring an inclusive and participatory approach, this report has become a valuable resource for promoting and advancing LFM guidelines and principles in making Serbia's forests and landscapes fire resilient.

This report will serve as a fundamental document for planning measures and activities that will lead to the establishment of a more efficient landscape fire management system that will be able to successfully respond to the challenges resulting from socioeconomic, demographic, natural, and climate change.

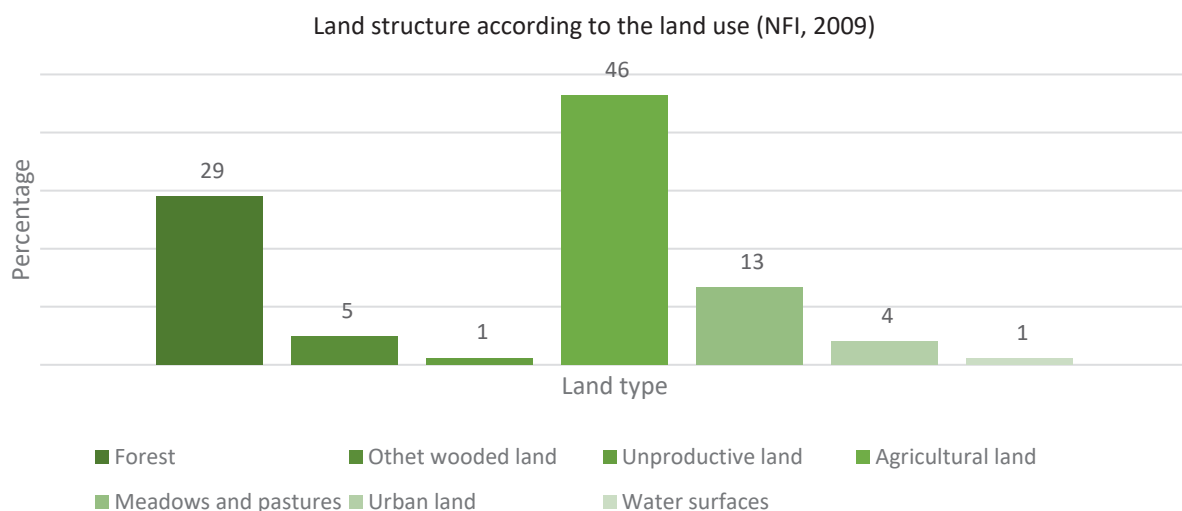
Land Use

Changes in land use across the past, present, and projected future provide valuable insights into broader societal trends. These shifts directly influence landscape fire dynamics, as land use determines both the amount and type of available fuel, as well as its spatial distribution. Beyond agricultural land and forests, changes also affect shrublands, grasslands, wetlands, and semi-natural areas, as well as the expansion of urban zones, transport corridors, and other artificial surfaces. Abandonment of farmland often leads to shrub encroachment and increased fuel loads, while changes in forest management reshape fuel structure and continuity. At the same time, urban growth intensifies the challenges at the wildland–urban interface, where human activity and wildland fuel and potentially flammable biomass overlap. Together, these evolving land use patterns play a decisive role in the likelihood, intensity, and spread of wildfires, highlighting the need to integrate land use dynamics into strategies for landscape fire management in Serbia.

The Republic of Serbia covers an area of 88,499 km² (<https://www.srbija.gov.rs/tekst/45625/osnovni-podaci.php>) and is located in Southeast Europe, in the central part of the Balkan Peninsula, while the smaller, northern part of the country belongs to the Central European region. The northern part is mostly flatland, while the central parts are hilly. Towards the south, the hilly areas gradually transition into mountains. The rivers belong to the basins of the Black, Adriatic, and Aegean Seas. Three rivers are navigable throughout their entire course in Serbia: the Danube, the Sava, and the Tisza. The longest river is the Danube, with 588 km of its total length of 2,783 km flowing through Serbia (February 2016).

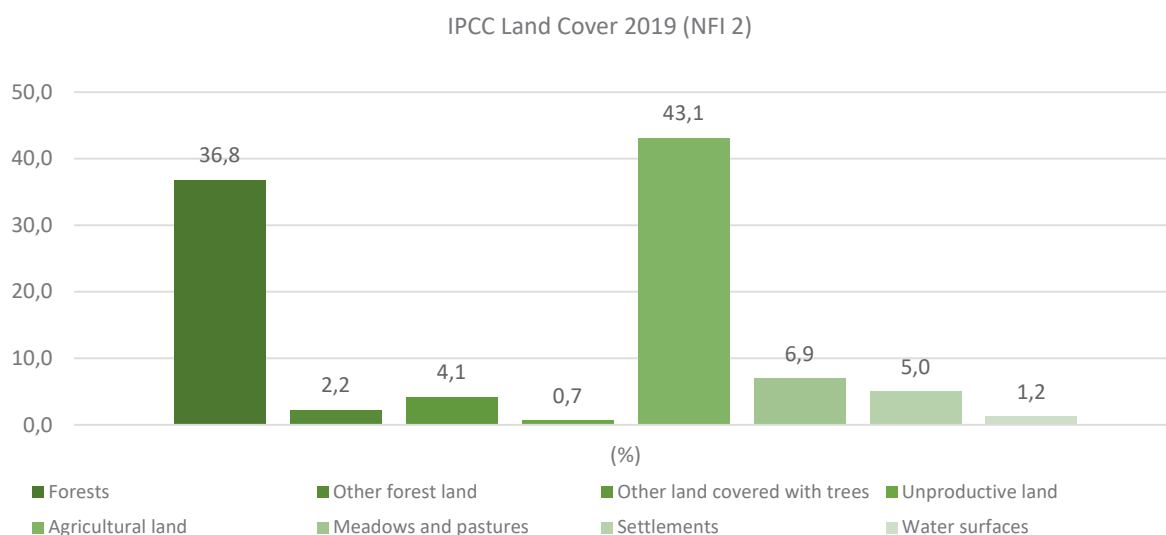
Serbia is a country of significant contrasts, both in terms of soil quality and in terms of land use, and a large portion of its territory is covered by forests and agricultural land. This chapter, through cartographic and graphical representations, presents details of land use in the Republic of Serbia.

Figure 1 presents data from the National Forest Inventory of the Republic of Serbia – NFI 1 (2009). According to these data, agricultural land together with forests and other forest land accounts for more than 80% of the country’s territory (excluding data for Kosovo and Metohija).



Graph 1. Land use structure (Medarević et al., 2009)

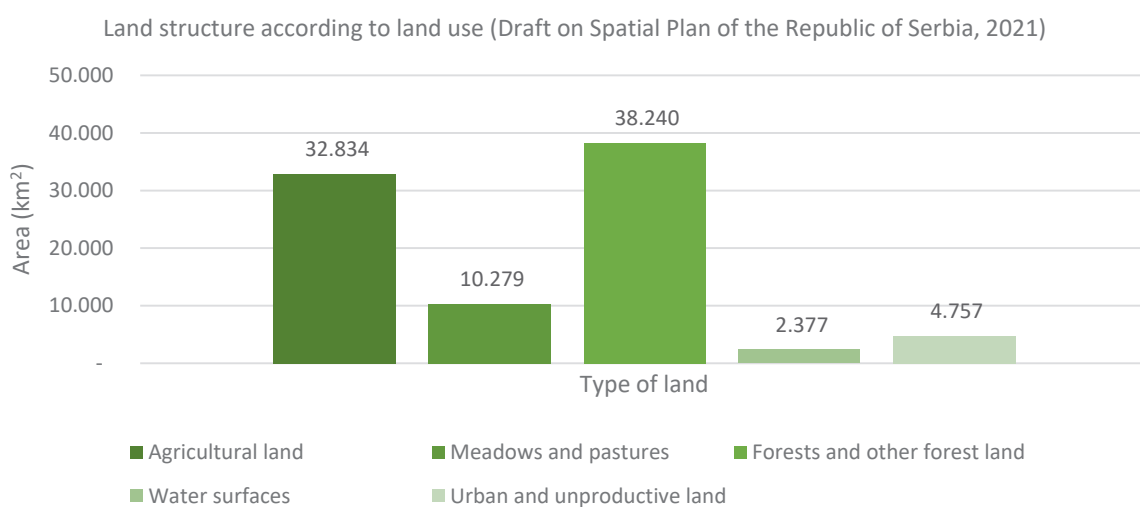
The results of the second National Forest Inventory from 2023 indicate an increase in forest cover from 29% to 36.8%. Simultaneously, a decrease in the areas covered by meadows and pastures has been recorded, largely as a result of the long-term abandonment of arable land and the decline in livestock production, and consequently the natural regeneration of vegetation. Such pronounced changes in land use have direct implications for planning and managing landscape fire risk.



Graph 2. IPCC land cover 2019 (Second National Forest Inventory – NFI 2)

When it comes to land use in Serbia, agriculture and forestry continue to dominate, with a significant increase in forest areas. According to the data from the Second National Forest Inventory (NFI 2), the total area of forests and other forest land in the Republic of Serbia covers 3,025,471.48 ha.

Spatial Plan of the Republic of Serbia has not yet been adopted; however, according to the draft of this document, the main categories of land cover are as follows: agricultural land – 43,113 km², forests and forest land – 38,240 km², wetlands and water surfaces – 2,377 km², and artificial and barren surfaces – 4,757 km². These figures are still unofficial.



Graph 3. Land use structure (Draft Spatial Plan of the Republic of Serbia, 2021)

The total area of protected natural assets amounts to 832,953 ha, which represents 9.41% of the territory of the Republic of Serbia. As of November 2015, 461 protected areas were under state protection, including: 5 national parks, 22 nature parks, 33 landscapes of outstanding features, 62 nature reserves, 7 protected habitats, 307 natural monuments, and 34 areas of cultural and historical significance (Institute for Nature Conservation of Serbia, Central Register of Protected Natural Assets, as of July 21, 2025).

Table 1. Protected natural assets in the Republic of Serbia (Institute for Nature Conservation of Serbia)

Category	Subcategory / Law	Republic of Serbia	Central Serbia	Vojvodina	Kosovo & Metohija	Area (ha) / % of territory
Protected Areas	National Parks	5	3	1	1	150,225 (1.70%)
Protected Areas	Nature Parks	22	7	14	1	345,074 (3.90%)
Protected Areas	Regional Nature Park – old law	1	0	1	0	-
Protected Areas	Nature Park – new law	21	7	13	1	-
Protected Areas	Landscapes	33	26	6	1	161,513 (1.82%)
Protected Areas	Landscape of Special Natural Beauty – old law	4	4	-	-	-
Protected Areas	Landscape of Outstanding Features – new law	29	22	6	1	-
Reserves	Special Nature Reserve – old law	1	0	0	1	160,657 (1.82%)
Reserves	Strict Nature Reserve – old law	15	3	8	4	-
Reserves	Scientific Research Reserve – old law	3	1	1	1	-
Reserves	Special Nature Reserve – new law	32	16	16	0	-
Reserves	Strict Nature Reserve – new law	8	8	0	0	-
Reserves	General Nature Reserve – new law	3	3	0	0	-
Reserves	Total Reserves	62	31	25	6	-
Protected Habitats	-	7	5	2	-	10
Natural Monuments	Botanical	230	129	80	21	-
Natural Monuments	Geological & Hydrological	77	59	4	14	11,659 (0.13%)
Natural Areas Around Cultural/Historical Sites	Memorial Natural Monument – old law	20	12	3	5	-
Natural Areas Around Cultural/Historical Sites	Natural Area Around Immovable Cultural Asset – old law	14	14	-	-	1,952 (0.02%)
TOTAL PROTECTED AREAS	-	470	286	135	49	832,953 (9.41%)
Protected Species	1,784 strictly protected; 865 protected wild species-					

An additional 96,879 ha are under consideration for protection, representing 1.10% of the national territory.

Agricultural land

According to the final data from the 2023 Agricultural Census, the number of agricultural holdings in the Republic of Serbia is 508,325. Of the total number of agricultural holdings, 2,002 are holdings of legal entities and entrepreneurs while the remaining holdings (99.6%) are family farms. The Zlatibor region has the largest share of the total number of agricultural holdings (8.5%).

The area of utilized agricultural land (UAL) is 3,239,373 ha, with arable land and gardens accounting for 77.7%. Livestock is raised on 61.7% of holdings, with the most common herd sizes being: 3–9 cattle, 1–2 pigs, and 3–9 sheep. Cattle and sheep are primarily raised in the Šumadija and Western Serbia region, while pigs and poultry are most common in the Vojvodina region.

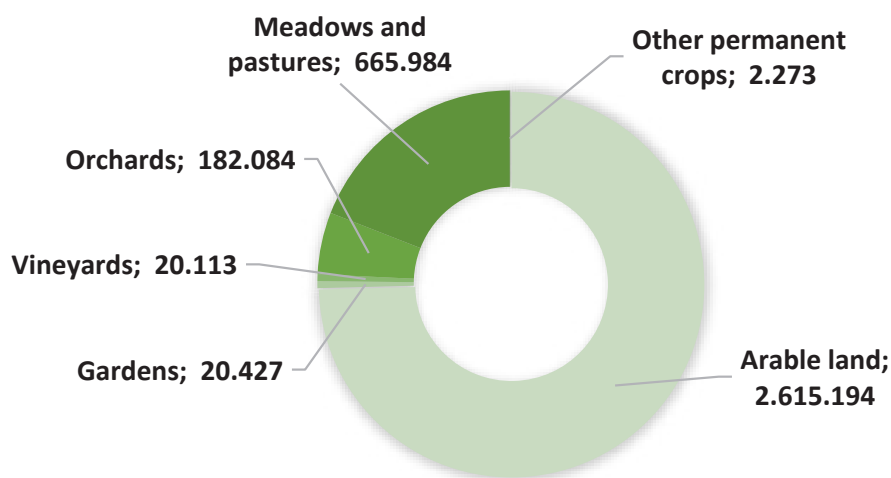
Most agricultural holdings (69%) have one or two persons engaged in agricultural production. Women account for 23% of the total number of managers. Regarding the age structure of family farm holders, 44.7% are over 65 years old, while only 0.9% are between 15 and 25 years old.

A map of land use structure is provided in Annex 1 (Draft spatial plan of the Republic of Serbia, 2021).

Due to its natural characteristics, climate, and water resources, the Republic of Serbia has potential in the agricultural sector that is not yet fully utilized. Based on its geographical position, Serbia has areas suitable for both extensive and intensive forms of agricultural development. With soil amelioration, it is estimated that only the Autonomous Province of Vojvodina possesses fertile plains capable of feeding half of Europe (Agricultural Strategy and Policy of the Republic of Serbia, 2022).

Agriculture is the oldest economic activity in Serbia, but today it occupies a relatively modest position in the national economy. During the monarchy, from 1882 to 1944, Serbia was one of the less developed agricultural countries. In the socialist period, from 1945 to 1990, through significant effort, it became a moderately developed industrial country with relatively strong agricultural production and food industry. However, in the years of economic transition, at the beginning of the 21st century, Serbian agriculture entered a period of stagnation and crisis. Its relatively unfavourable position in the economy is the result of systemic neglect by economic policymakers. Instead of investing in this strategically important sector with clear comparative advantages, Serbia experienced a retrogressive process of disinvestment (Agricultural Strategy and Policy of the Republic of Serbia, 2022).

Figure 4 shows the distribution of the total area of agricultural land by type of use in the Republic of Serbia.

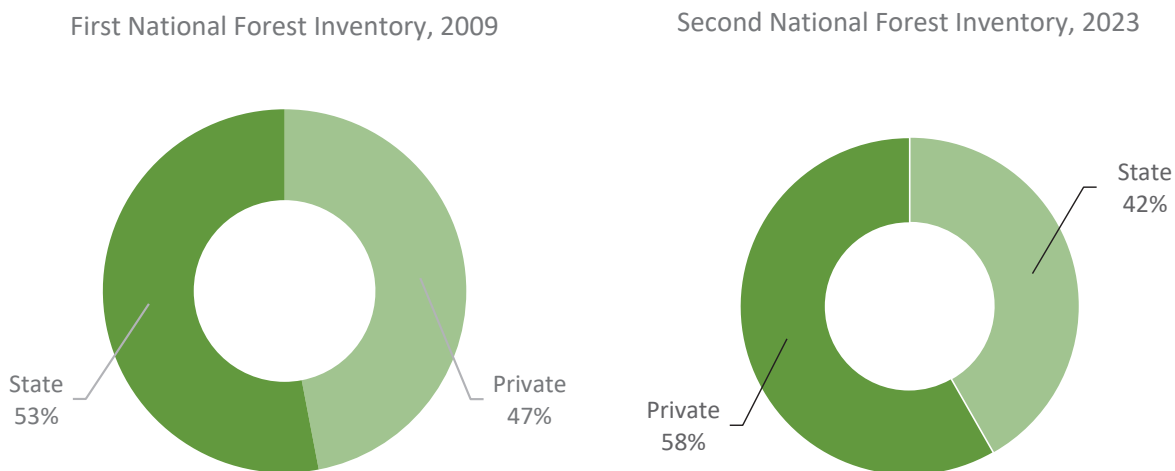


Graph 4. Utilized agricultural land in Serbia in 2021 (Statistical Yearbook of the Republic of Serbia, 2021)

Forests and forest land areas

In the context of land use assessment, understanding the national definitions of *forests* and *forest land* is essential, as these categories form the basis for spatial planning, ecosystem monitoring, and landscape fire risk analysis in Serbia. Under the **Law on Forests of the Republic of Serbia**, *forests* are defined as areas of at least 0.05 hectares (5 ares) covered by forest trees with a minimum canopy closure of 30%. This includes both natural and planted stands, as well as temporarily non-forested areas expected to regenerate naturally or artificially. *Forest land* comprises areas designated for forest production or those most suitable for growing forests due to their natural characteristics, including land and facilities used for forest and wildlife management or for providing the ecological and social functions of forests. These nationally defined forest categories are crucial for understanding how changes in land use influence vegetation structure, fuel availability, and the overall dynamics of landscape fires across Serbia.

According to the first National Forest Inventory, Serbia is moderately forested, with forests covering 29.1% of the country and other forest land accounting for 4.9%, for a total of 34%. Of this total 2,252,400 hectares of forest, 53% was state-owned and 47% privately owned. During the land restitution process, portions of forest land were returned to private individuals, churches, and similar entities, shifting ownership patterns. The Second National Forest Inventory reports that the total forest and forest land area has increased to 3,025,471 hectares, of which 41.7% is state-owned and 58.3% privately owned.

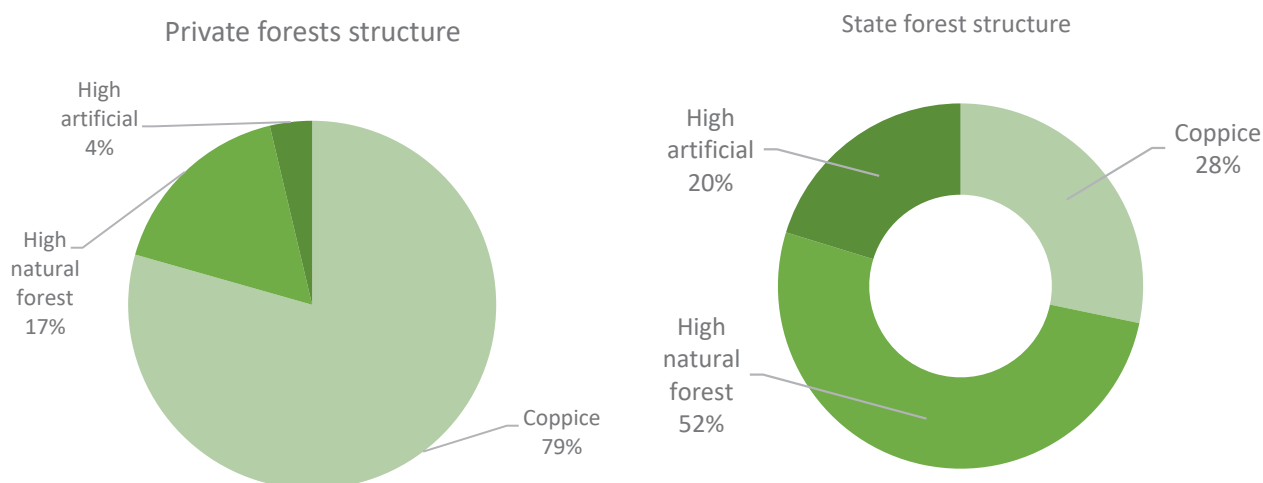


Graph 5. Forest status in the Republic of Serbia by ownership (NFI 1 – 2009 and NFI 2 – 2023)

Private forests in the Republic of Serbia, under the management of the public enterprise “Srbijašume,” cover an area of 1,222,624 ha, which includes approximately 3.4 million cadastral parcels and about 1,000,000 owners. The volume of these forests is around 140 million m³, with an annual increment of approximately 3.6 million m³.

Private forests are managed according to the Forest Area Development Plan and the Forest Management Programme, with professional and advisory support provided by **PE Srbijasume** (and **Vojvodinasume** in Vojvodina) under agreements with the Ministry of Agriculture, Forestry and Water Management. This support includes annual forest management planning, afforestation and improvement of existing forests, forest fire protection planning, marking trees for harvesting, monitoring biotic and abiotic impacts, stamping and documenting harvested timber, measuring and recording illegal logging, recording forest protection and utilization activities, notifying authorities about illegal activities, and other professional and advisory tasks.

A map from the first National Forest Inventory (Annex 2) shows the distribution of state and private forests across Serbia. Forests in Vojvodina are almost entirely state-owned, with only a small portion returned through restitution, whereas private forests dominate most areas of central Serbia. The composition of forests also differs between state and private ownership: state forests generally have a higher share of high natural forests while coppice forests are more common in private ownership.



Graph 6. Forest structure by origin in state and private forests (Statistical Yearbook, 2021)

From a broader land use perspective, the area of agricultural land has decreased, particularly pastures and meadows, while forest land has expanded. This change is partly due to the abandonment of agricultural production in rural areas and the restitution process, in which many owners retained land but did not continue farming. Abandoned agricultural land has undergone spontaneous forest regeneration, as natural vegetation gradually reclaims former farmland. In addition to natural regrowth, forestry policies have also contributed to the expansion of forested areas.

The increase in abandoned agricultural land and spontaneous forest regeneration in rural areas has implications for landscape fire dynamics, as it contributes to a higher continuity and availability of fuels in open spaces. Together, these patterns of forest distribution, ownership, management, and land use change play a decisive role in shaping the likelihood, intensity, and spread of landscape fires in Serbia.

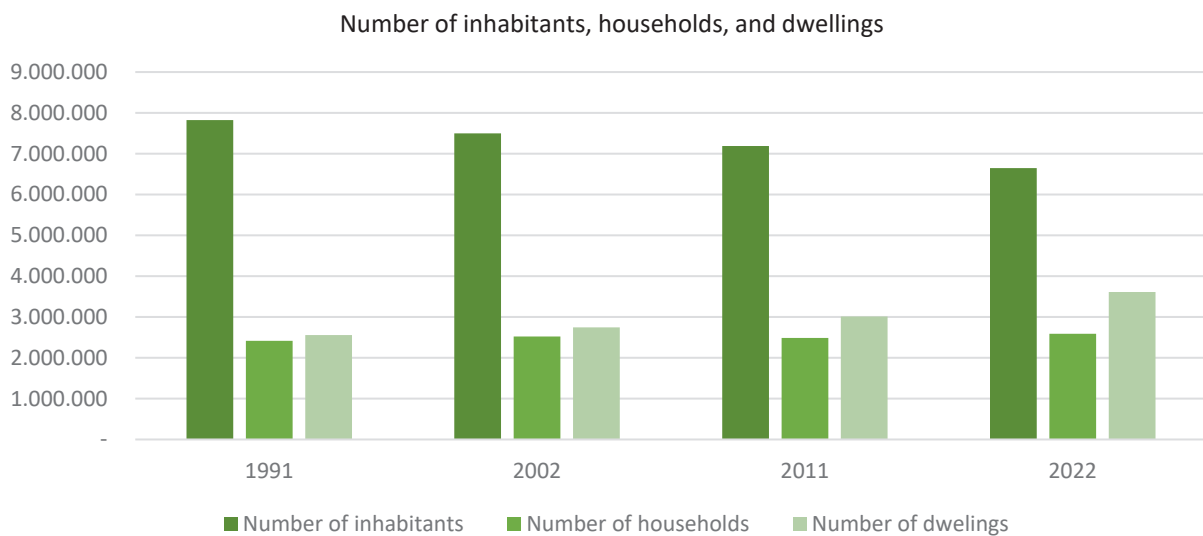
These trends further intertwine with demographic changes in rural areas, requiring their joint consideration in the subsequent analysis.

Demography

Demographic trends in the Republic of Serbia, particularly the decline in population in rural and border areas, have a direct impact on the increased risk of wildfires. With fewer inhabitants actively using, cultivating, and monitoring the land, large portions of agricultural and forested areas remain neglected and unmanaged. Abandoned properties, overgrown terrains, and accumulated dry vegetation become highly flammable, especially during the summer months when the fire risk is greatest. At the same time, the decreasing local population means fewer people are available to respond quickly or report fires, which further complicates effective protection and intervention.

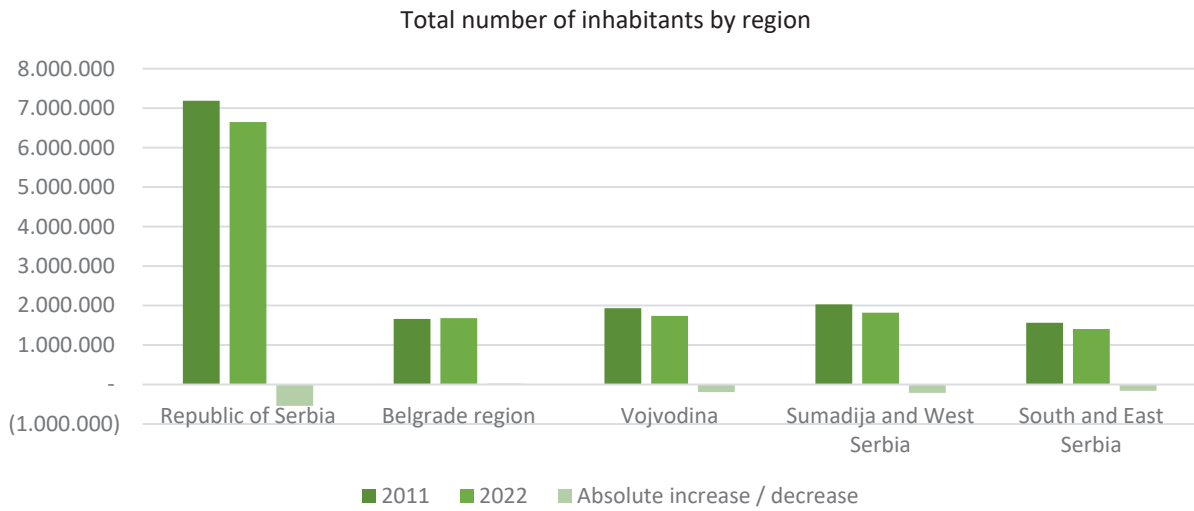
After World War II, nine population censuses were conducted in Serbia: 1948, 1953, 1961, 1971, 1981, 1991, 2002, 2011, and 2022. The population is estimated annually for the intercensal periods, including the census year. In 2021, the population of the Republic of Serbia was estimated at 6,834,326, with a negative growth rate of -9.4 per 1,000 inhabitants compared to the previous year.

The official results of the 2022 Population, Households, and Dwellings Census show that the Republic of Serbia has 6,647,003 inhabitants (3,231,978 men and 3,415,025 women). Compared to previous censuses, a trend of population decline is evident.



Graph 7. Number of inhabitants, households, and dwellings (<https://popis2022.stat.gov.rs/>)

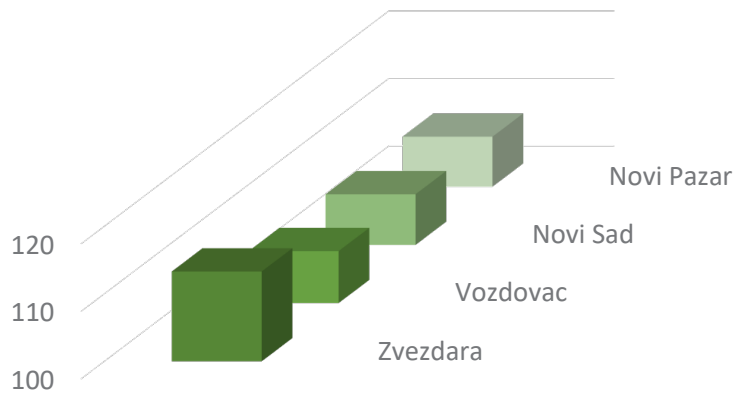
Compared to 2011, the total population decreased by 540,859, or 7.5%. The population decline was observed in all regions (around 10%), except in the Belgrade region, where the population increased by approximately 1.3%.



Graph 8. Total population by regions (<https://popis2022.stat.gov.rs/>)

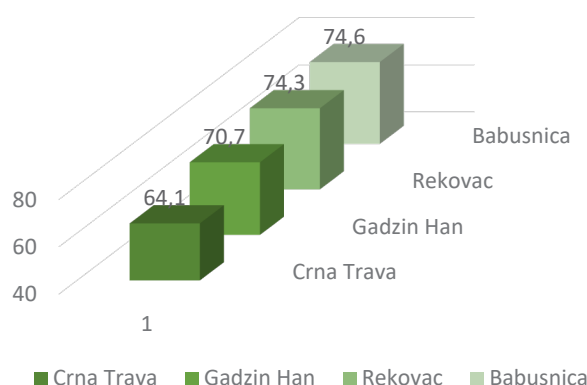
According to the 2022 Census, the cities and city municipalities with the highest population growth are Zvezdara, Voždovac, Novi Sad, and Novi Pazar, while the city municipalities with the largest population decline are Crna Trava, Gadžin Han, Rekovac, and Babušnica.

The municipality with the largest increase in the number of inhabitants (2011=100)



Graph 9. Cities and city municipalities with the highest population growth (<https://popis2022.stat.gov.rs/>)

The municipality with the largest decrease in the number of inhabitants (2011=100)



Graph 10. Cities and city municipalities with the largest population decline (<https://popis2022.stat.gov.rs/>)

The map in Annex 3 provides an overview of cities and city municipalities with the largest population decline (circled in red) and city municipalities with the highest population growth (circled in blue).

Since 1999, the Statistical Office of the Republic of Serbia has not had access to certain data for the Kosovo and Metohija region, so these are not included in the total data for the Republic of Serbia.

The average age of the population in the Republic of Serbia has increased from 42.1 years (2011) to 43.9 years (2022). This rising trend in the average age reflects ongoing population aging across the country and sets the context for the following figure illustrating demographic changes over the past decade.

Table 2. Average age of the population (by regions) according to the latest 2022 Census

Region	Number of inhabitants			Average age		
	Total	Men	Women	Total	Men	Women
Belgrade	1,681,405	794,413	886,992	42.73	41.03	44.25
Vojvodina	1,740,230	845,739	894,491	43.64	42.03	45.16
Sumadija & West Serbia	1,819,318	895,840	923,478	44.31	43.09	45.49
South & East Serbia	1,406,050	695,986	710,064	44.86	43.67	46.02
Kosovo & Metohija	...	...	...	...	...	...
Total	6,647,003	3,231,978	2,491,547	43.85	42.43	45.19

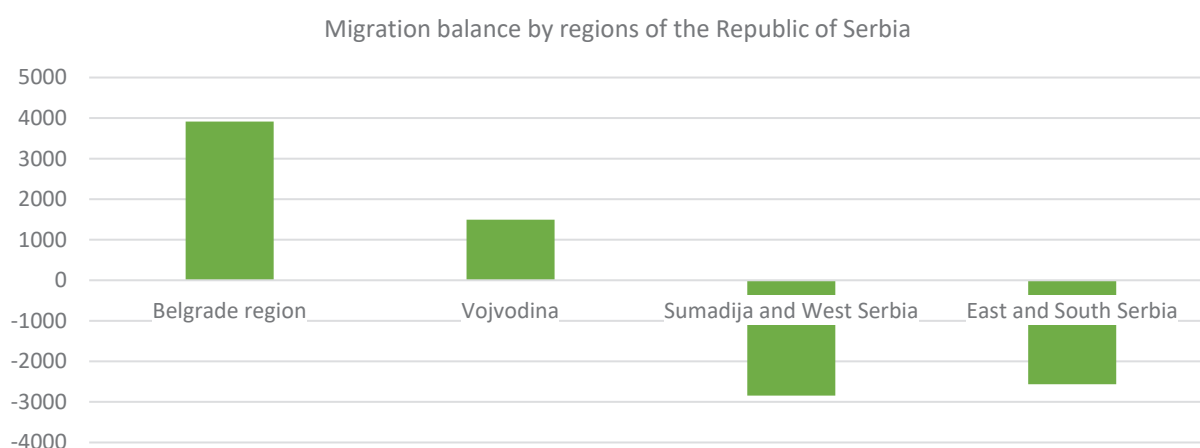
Demographic aging in Serbia is characterized by a persistently low proportion of young people and a steadily growing share of elderly in the total population. Between the 2011 and 2022 censuses, the share of individuals under 15 years of age remained largely unchanged, at 14.3% and 14.4% respectively. In contrast, the working-age population (15–64 years) declined from 68.3% to 63.5%, a drop of roughly 5 percentage points, while the proportion of those aged 65 and over rose from 17.4% to 22.1%. The Southern and Eastern Serbia region faces the most pronounced aging, with nearly one in four residents (23.7%) over the age of 64.

Table 3. Population by main age groups (by regions) according to the 2022 Census

Region	Number of inhabitants	Population by major age groups, by region					
		0–14	%	15–64	%	Over 64	%
Belgrade	1,681,405	254,270	15.12	1,086,113	64.60	341,022	20.28
Vojvodina	1,740,230	254,971	14.65	1,108,342	63.69	376,917	21.66
Sumadija & West Serbia	1,819,318	258,234	14.19	1,143,283	62.84	417,801	22.96
South & East Serbia	1,406,050	187,977	13.37	884,958	62.94	333,115	23.69
Kosovo & Metohija	...	...	...	...	...	...	...
Total	6,647,003	955,452	14.37	4,222,696	63.53	1,468,855	22.10

Depopulation, which is currently underway, is the main characteristic of the projected population trends in the Republic of Serbia for the period 2011–2041. According to each of the five projection variants, the population of Serbia in 2041 is expected to be smaller than in 2011, making Serbia a typical region with negative natural population growth. The population will continue to age demographically, so that over the next thirty years the share of those aged 65 and over is projected to increase from 17% to 24%. By the end of the projection period, nearly one in four inhabitants will be over 65 years old, and the elderly dependency ratio is expected to rise from 25% to 39% (Statistical Yearbook of the Republic of Serbia, 2022).

Regarding internal migration, in 2021, a total of 135,194 individuals changed their place of residence, permanently moving from one settlement to another within the Republic of Serbia. The average age of those who changed residence was 34.7 years (35 years for men and 34.5 years for women). By regions, the Belgrade Region and the Vojvodina Region recorded a positive migration balance in 2021. Within Serbia, the largest share of people moved from one municipality/city to another within the same area (36.3%), while the smallest share moved from one settlement to another within the same municipality/city (28.1%). Out of a total of 25 regions in Serbia, the highest number of migration movements occurred in the territory of the Belgrade area, with 51,206 (37.9%) in-migrants and 47,293 (35.0%) out-migrants. The Belgrade, South Bačka, North Bačka, Srem, Nišava, and South Banat regions recorded a positive migration balance, while 19 regions had a negative balance. At the level of municipalities/cities, only 49 municipalities/cities had a positive migration balance in 2021, one had a balance of zero, and the remaining 119 municipalities/cities recorded a negative migration balance (Internal Migrations 2021, 2022).



Graph 11. Migration balance by regions of the Republic of Serbia in 2021 (Internal Migrations 2021, 2022)

Between 2017 and 2021, internal migration patterns in Serbia reflected notable regional disparities and had important demographic and economic implications. Overall, 61.4% of migrants were dependents, 30.9% were economically active, and only 7.7% reported personal income. During this period, the Belgrade and Vojvodina regions attracted more people than they lost, recording a positive migration balance of approximately 6,000 and 800 people per year, respectively. In contrast, the Šumadija and Western Serbia region consistently experienced higher out-migration than in-migration, resulting in an average annual population loss of around 3,800 people, while the Southern and Eastern Serbia region saw a similar trend, losing roughly 3,000 residents per year. These internal migration dynamics contribute to population decline in certain regions while reinforcing the concentration of population and economic activity in Belgrade and Vojvodina, highlighting the ongoing spatial and socio-economic imbalances across the country (Internal Migrations 2021, 2022).

Table 4. Individuals who changed their place of residence by region, 2017–2021 (Internal Migrations 2021, 2022)

Year	2017	2018	2019	2020	2021
Belgrade region					
Immigrated	49,494	50,982	52,964	43,428	51,206
Emigrated	43,057	44,004	45,240	38,562	47,293
Difference	6,437	6,978	7,724	4,866	3,913
Vojvodina region					
Immigrated	27,362	27,772	28,729	26,270	32,588
Emigrated	26,692	27,464	28,210	25,333	31,095
Difference	670	308	519	937	1,493
Šumadija and West Serbia					
Immigrated	24,964	25,056	26,536	23,705	30,970
Emigrated	29,051	29,106	31,133	26,971	33,813
Difference	-4,087	-4,050	-4,597	-3,266	-2,843
South and East Serbia					
Immigrated	18,535	18,383	19,192	16,344	20,430
Emigrated	21,555	21,619	22,838	18,881	22,993
Difference	-3,020	-3,236	-3,646	-2,537	-2,563
Kosovo and Metohija					
Immigrated	...	...	...	...	...
Emigrated	...	...	...	...	...

Considering that rural areas of the Republic of Serbia occupy 85% of the territory, are home to 55% of the population, and contribute 41% of the country's GDP, the problem lies in the fact that these areas are characterized by pronounced poverty and significant development constraints. Given that the dominant part of Serbia's active rural population (45%) works in agriculture, there is low employment diversification among rural residents and a high dependence on agricultural employment. The high share of agricultural employment in rural areas also indicates low diversification of population activities and income in these

regions. Agriculture has been the main factor driving past development, but it also represents the primary limitation for further development of Serbia's rural areas. This is why it is necessary to identify certain regions in Serbia as areas where new rural policies will be implemented in accordance with requirements for ensuring efficient and sustainable development (Dimitrijević et al., 2019).

From Serbia's demographic situation, it can be concluded that there is a decrease in the total population from 7,186,862 in 2011 to 6,647,003 in 2022, which is a reduction of over half a million people who live in Serbia over a ten-year period. By gender, in 2022, women made up 51.4% of the population, and men 48.6%. The average age of the population in the Republic of Serbia increased from 42.1 years (2011) to 43.9 years (2022), indicating demographic aging. The share of people aged 65 and over is 22%, while those under 15 years account for 14.4%. In terms of internal migration, only Belgrade and the Vojvodina Region recorded a positive migration balance, whereas the rest of Serbia experienced a negative migration balance. Pronounced poverty and significant development constraints in rural areas, together with the declining rural population, substantially increase the risk of landscape fires.

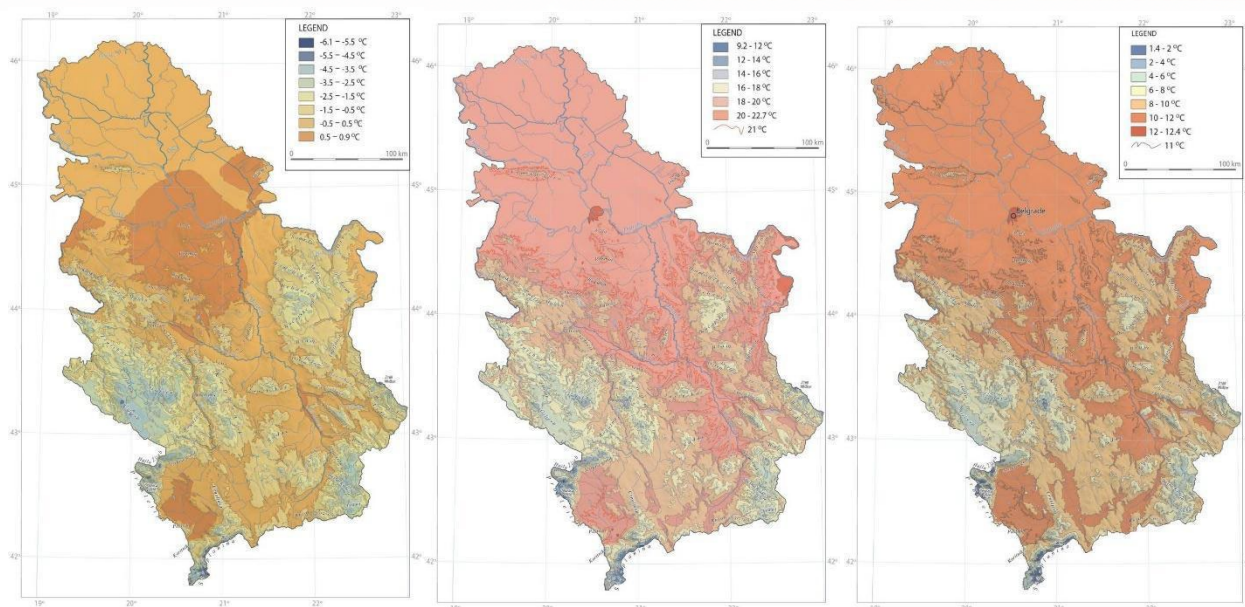
Overall, Serbia's demographic dynamics—marked by rural depopulation, an aging population, and migration toward urban areas—create significant challenges for landscape fire management. Declining local capacity for prevention, land stewardship, and monitoring, coupled with slower response times, increases the vulnerability of settlements situated in the wildland–urban interface, an issue further discussed in the Land Use chapter.

Climate Characteristics, Climate Change Scenarios, and Nationally Determined Contributions (NDCs)

Climate is one of the key factors influencing natural conditions, resource availability, and the daily lives of the population. Understanding the climate characteristics of Serbia as well as the increasingly pronounced impacts of climate change—from droughts and heatwaves to extreme precipitation—is essential for sustainable development planning and risk management. Recent analyses indicate increasingly significant changes in temperature and precipitation patterns, which, in addition to affecting agriculture, water resources, and human health, substantially increase the risk of landscape fires. Frequent dry periods, higher average temperatures, and longer-lasting heatwaves create favourable conditions for the ignition and spread of fires, particularly in rural and forested areas. In this context, climate change scenarios and adaptation measures through Nationally Determined Contributions (NDCs) represent the state's response to increasingly challenging climatic conditions in the coming decades.

a. Climate characteristics

The climate of the Republic of Serbia is predominantly temperate continental, with varying local characteristics and gradual seasonal changes. Continental climate prevails in mountainous areas at altitudes above 1,000 meters. The southwestern part of the country lies on the border between Mediterranean subtropical and continental climates. According to the Köppen climate classification, most of the country has a temperate warm rainy climate with hot summers, while mountainous areas have a snow-forest climate. Summer is the warmest season, with an average seasonal temperature ranging from 21 °C to 22 °C.



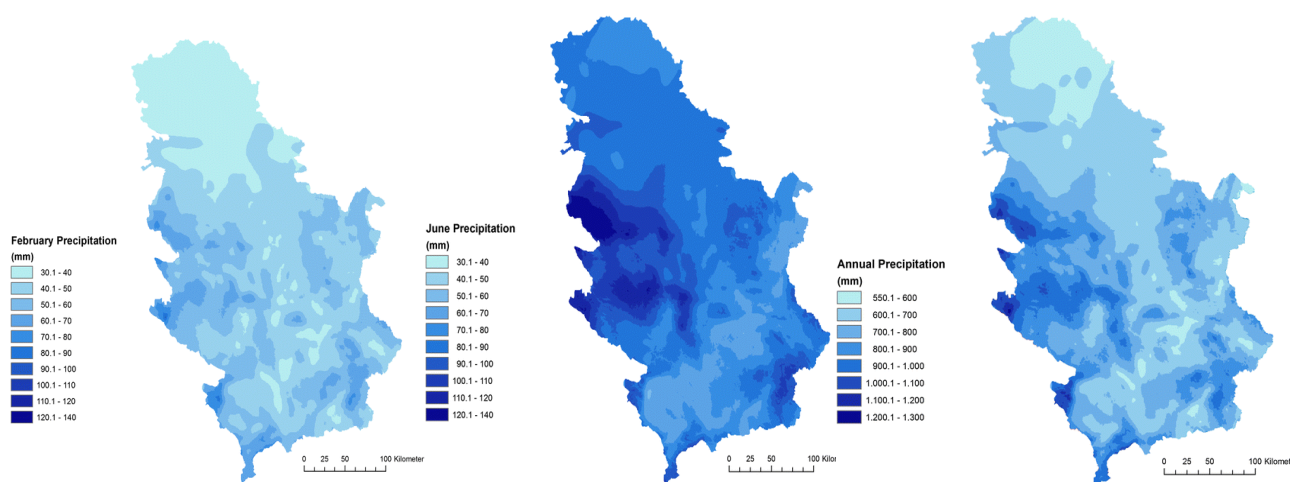
Map 1: Average January air temperatures in Serbia for the period 1961–2010 **Map 2:** Average July air temperatures in Serbia for the period 1961–2010 **Map 3:** Average annual air temperatures in Serbia for the period 1961–2010

The average annual air temperature for areas up to 300 meters above sea level is 10.9 °C, while for areas between 300 and 500 meters it is around 10.0 °C. In mountainous regions above 1,000 meters, the mean annual temperature is about 6 °C, and at altitudes above 1,500 meters, it is around 3 °C. Autumn is generally warmer than spring. The coldest month is January, with average monthly temperatures ranging from -6 °C in mountainous areas to around 0 °C in lowland regions. Belgrade has the highest average January temperature of 0.4 °C due to a pronounced urban heat effect, whereas areas up to 300 meters above sea level have an average January temperature between -1 and 0 °C, with the Timok region and prominent valleys reaching as low as -3 °C. For areas between 300 and 500 meters, average January temperatures range from -3 to -1 °C, and for locations above 1,000 meters from -6 to -3 °C. The warmest month is July, with average monthly temperatures ranging from 11 to 22 °C. Areas up to 300 meters above sea level have an average July temperature between 20 and 22 °C, as do some locations in southern Serbia at altitudes of 400–500 meters. Above 1,000 meters, average July temperatures range from 11 to 16 °C. The lowest recorded temperatures for the 1961–1990 period occurred in January, ranging from -35.6 °C (Sjenica) to -21.0 °C (Belgrade). Absolute maximum temperatures were recorded in July, ranging from 37.1 to 42.3 °C (Temperature Regime in Serbia 1961–1990, RHMS).

Precipitation is one of the most important climatic elements. Due to atmospheric processes and relief characteristics, precipitation in Serbia is unevenly distributed in time and space. The normal annual precipitation for the whole country is 896 mm. Annual precipitation generally increases with altitude. Drier areas, with less than 600 mm of precipitation, are located in the northeast of the country, as well as in the valley of the South Morava and parts of Kosovo and Metohija. The region including the Danube area, the Great Morava valley, and its continuation towards Vranje and Dimitrovgrad receives up to 650 mm of precipitation annually. Moving eastward, in the Homolje Mountains, annual precipitation reaches approximately 800 mm. Similar conditions are found in mountainous areas in southeastern Serbia. Larger and more compact areas in the west and southwest constitute the wettest regions of Serbia. In the Pešter plateau and Kopaonik, annual precipitation reaches up to 1,000 mm, and some mountain peaks in southwestern Serbia exceed 1,000 mm.

Most of Serbia experiences a continental precipitation regime, with higher amounts during the warmer half of the year. The largest rainfall occurs in May and June, with June alone accounting for 12–13% of the annual total. The months with the least precipitation are February or October, averaging 5–6% of the yearly total. In southwestern Serbia, due to relief, the slopes of high mountain ranges, and the influence of the Mediterranean climate, the region experiences a Mediterranean precipitation regime, with a maximum in November, December, and January, and a minimum in August (Precipitation Regime in Serbia 1961–1990, RHMS).

The occurrence of snow cover is typical from November to March, with the possibility of it appearing in April and October, except in mountains above 1,000 meters. The highest number of days with snow cover occurs in January, which accounts on average for 30–40% of the total annual days with snow cover (2017, August).



Map 4: Spatial distribution of February precipitation in Serbia for the period 1961–2010

Map 5: Spatial distribution of June precipitation in Serbia for the period 1961–2010

Map 6: Average annual precipitation in Serbia for the period 1961–2010

During the warmer part of the year, northwestern and western winds prevail, while in the colder part of the year, eastern and southeastern winds (Košava) are characteristic. In mountainous areas of southwestern Serbia, southwest winds dominate.

The total annual sunshine duration ranges between 1,800 and 2,100 hours (only Požega has about 1,550 hours per year). Appendix 4 and Appendix 5 provide maps of Serbia's relief and the locations of stations from which data were used, including precipitation stations (2017, August).

According to official data covering the period 1950–2017, nine out of the ten warmest years were recorded after 2000. On average, the warmest years were 2014 and 2015. In general, the number of dry days and dry years is steadily increasing (Božanić et al., 2019).

During the period 1998–2017, the average annual temperature across Serbia was 0.5–1.5 °C higher than the 1961–1990 period. Between 2008 and 2017, the average annual temperature was 1.5 °C higher than the 1961–1990 reference period over most of Serbia. The trend of rising average temperatures in Serbia is three times higher than the trend of average global temperature increase over land, indicating that Serbia is more affected by climate change in terms of temperature increase than most places on Earth (Božanić et al., 2019).

During 1998–2017, 2014 was the wettest year in Serbia, with deviations of about +40% relative to the 1961–1990 reference period, while 2000 was the driest year, with about -40% deviation compared to the same reference period (Božanić et al., 2019).

This period also saw a redistribution of precipitation throughout the year, with a marked decrease in total precipitation during the summer season (June–August). Temperature changes have become increasingly pronounced, causing more frequent and intense heatwaves and extreme events. Lowland areas, especially in central and southern Serbia, are the most affected by extreme temperatures (Božanić et al., 2019).

The number of extreme heatwaves during 1961–1990 was one per decade, whereas under current climatic conditions, they occur every year or even more than once a year. Precipitation deficits, accompanied by an increased number of intense rainfall events, are observed during the summer season. Dry periods and extreme temperatures usually coincide with summer, which amplifies their impact. The number of days with heavy precipitation is steadily increasing. During 2008–2017, on average, the number of days with precipitation over 40 mm was twice as high across most of Serbia, with southern regions experiencing a fivefold increase (Božanić et al., 2019).

Additionally, climate indices indicate a significant increase over the years, amplifying negative consequences for society and the country’s economy (Božanić et al., 2019).

Table 5. Changes in climate indices during 2008–2017 compared to 1961–1990 (Božanić et al., 2019)

Change of climate indicators in the period 2008-2017 as compared to 1961-1990	
Climate indices	Change
Number of frost days	-20-30 days
Number of ice days	-3 to 9 days
Number of summer days	+20-30 days
Number of tropical days	+20-30 days
Number of days with heat waves	+30 days
Number of days with extreme heat waves	+2-4/per year

The risk of fires increases due to the higher frequency of warmer and drier conditions, i.e., the increased occurrence of favourable conditions for fire ignition, as well as the potential for fire spread and/or longer duration in locations with characteristics conducive to fire, such as forests, landfills, and waste disposal sites. It is important to note that the fire occurrence analysed here does not refer exclusively to forest fires, but to weather conditions that can influence processes in various environments, potentially leading to spontaneous ignition or easier ignition caused by human activity.

Based on assessments using the Fire Weather Index from the Copernicus Climate Change Service database (C3S, Giannakopoulos et al., 2022), the Republic of Serbia is classified, on average, as a region with moderate fire risk under the climatic conditions of the late 20th century (1981–2005). This classification is based on average conditions determined by the index during the so-called fire season (June–September). This level of risk also applies to parts of the Mediterranean region that have experienced a shift toward drier climatic conditions, such as parts of Spain, Italy, and southern France. Some more vulnerable areas include southern Italy, southern Spain, Greece, and others.

The average number of days under high fire risk in Serbia per year during the late 20th-century climate was 30–40 days in most of the territory, while the number of days under very high risk ranged from 10 to 15. An increase in the number of days with moderate risk, and particularly days with high fire risk, is expected (National Programme for Adaptation to Changing Climatic Conditions).

Given the significant impact of these variable climatic conditions, the fire risk in Serbia is increasing. Warmer and drier weather, combined with prolonged periods of conditions favourable for fire occurrence,

has raised the overall fire risk, not limited to forest fires. The country is expected to experience more days with high fire risk, particularly during the fire season (June–September).

Climate change has significant implications for Serbia, affecting various aspects of society and the economy. Adapting to these variable conditions and implementing strategies to mitigate climate-related risks will be essential for ensuring resilient ecosystems and national sustainability.

b. Climate scenarios

In the Republic of Serbia, climate change monitoring has been conducted for more than ten years, covering observed changes and future projections up to the end of the 21st century under different greenhouse gas (GHG) emission scenarios. Reporting under the United Nations Framework Convention on Climate Change (UNFCCC), relevant for adaptation to changing climatic conditions, has been carried out through national reports, known as National Communications. Serbia has adopted two such reports (First National Communication, MoENRS, 2010; Second National Communication, MoENRS, 2017).

The Second National Communication presents an analysis of observed climate changes up to 2012 and considers future climate changes using the IPCC SRES (Special Report on Emissions Scenarios) greenhouse gas emission scenarios, in accordance with the IPCC Fourth Assessment Report (Working Group I; IPCC, 2007). The selected scenarios for these analyses were SRES A1B and A2, referred to as the “medium” and “extreme” scenarios, assuming that projections under these scenarios encompass the most likely climate change outcomes for adaptation planning purposes (National Programme for Adaptation to Changing Climatic Conditions).

As the adoption of the Second National Communication occurred relatively late compared to the period of analysis and after the publication of the IPCC Fifth Assessment Report, which includes new future greenhouse gas emission scenarios (RCP – Representative Concentration Pathways; IPCC, 2013), and as observed climate changes and their impacts became more pronounced in Serbia, new analyses were immediately initiated for the preparation of the Third National Communication. The new analyses of observed climate changes cover data up to 2017, while future climate projections were performed using the RCP4.5 and RCP8.5 scenarios for selected future periods in accordance with the IPCC Fifth Assessment Report (near-future 2016–2035, mid-century 2046–2065, and end-of-century 2081–2100), compared to the reference period 1986–2005.

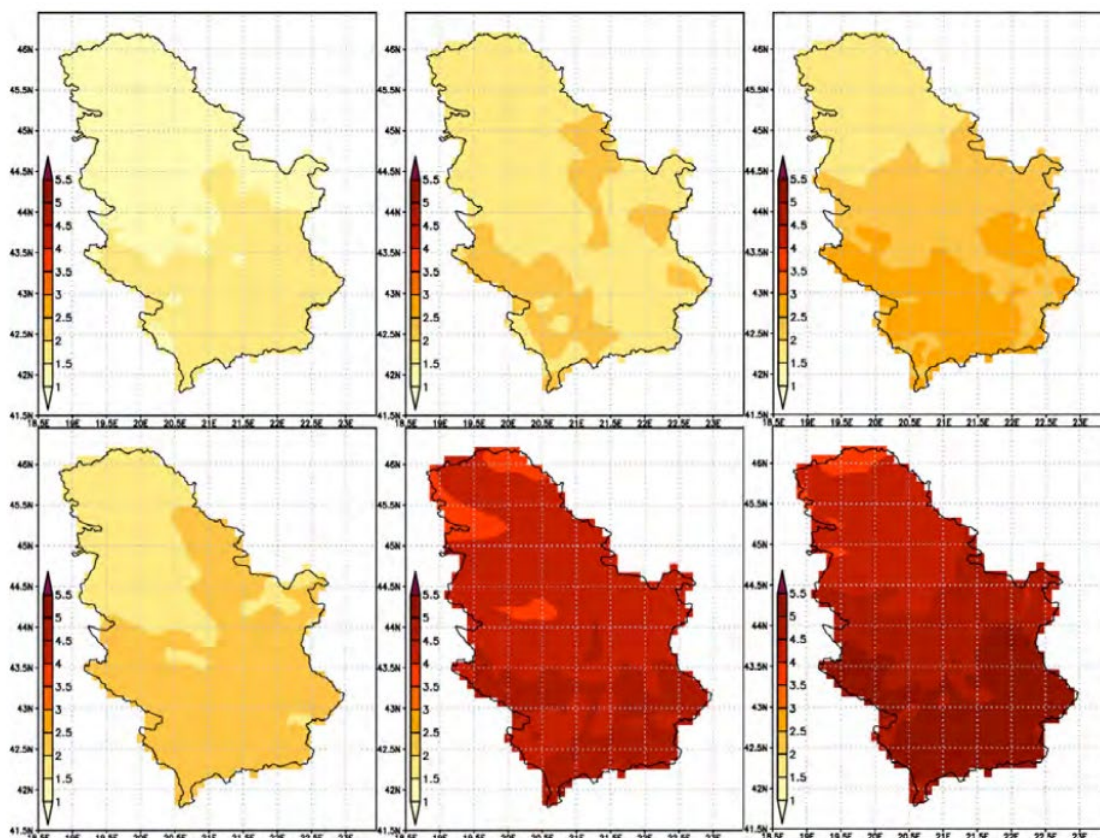
These scenarios were adopted to provide projections encompassing the most likely range of future climate conditions, forming the basis for sectoral climate risk assessments. The RCP4.5 scenario assumes stabilization of GHG emissions after 2040, limiting the increase in average global air temperature to between 2 °C and 3 °C relative to pre-industrial levels. This scenario is considered a “middle-of-the-road” pathway toward fulfilling the Paris Agreement, implying partial implementation of mitigation measures. The RCP8.5 scenario assumes continued GHG emission growth, with no mitigation measures, and projects an expected rise in average global air temperature of about 4.5 °C by the end of the century relative to pre-industrial levels (National Programme for Adaptation to Changing Climatic Conditions).

Under the stabilization scenario RCP4.5, the increase in mean annual temperature is about 0.5 °C lower than under RCP8.5 during the first two analysed periods. However, under RCP4.5, GHG emissions stabilize, balancing the climate system’s energy budget and ultimately stabilizing temperatures. By the end of the 21st century, Serbia’s mean annual temperature increase under RCP4.5 is projected to be significantly lower than under RCP8.5, reaching approximately 2 °C above the reference period (October 2018).

Seasonal analyses and assessments of changes in mean maximum and minimum temperatures indicate that future warming during the colder part of the year will initially be slightly lower than during the warmer part of the year. However, during the second half of the century under RCP8.5, winter warming becomes more intense and eventually matches or exceeds summer warming (October 2018).

The increase in maximum temperatures is slightly higher than that of minimum temperatures. The largest rise is projected under RCP8.5 for mean maximum temperatures during June–August at the end-of-century period, with values up to 4.7 °C higher than the reference period 1986–2005 (October 2018).

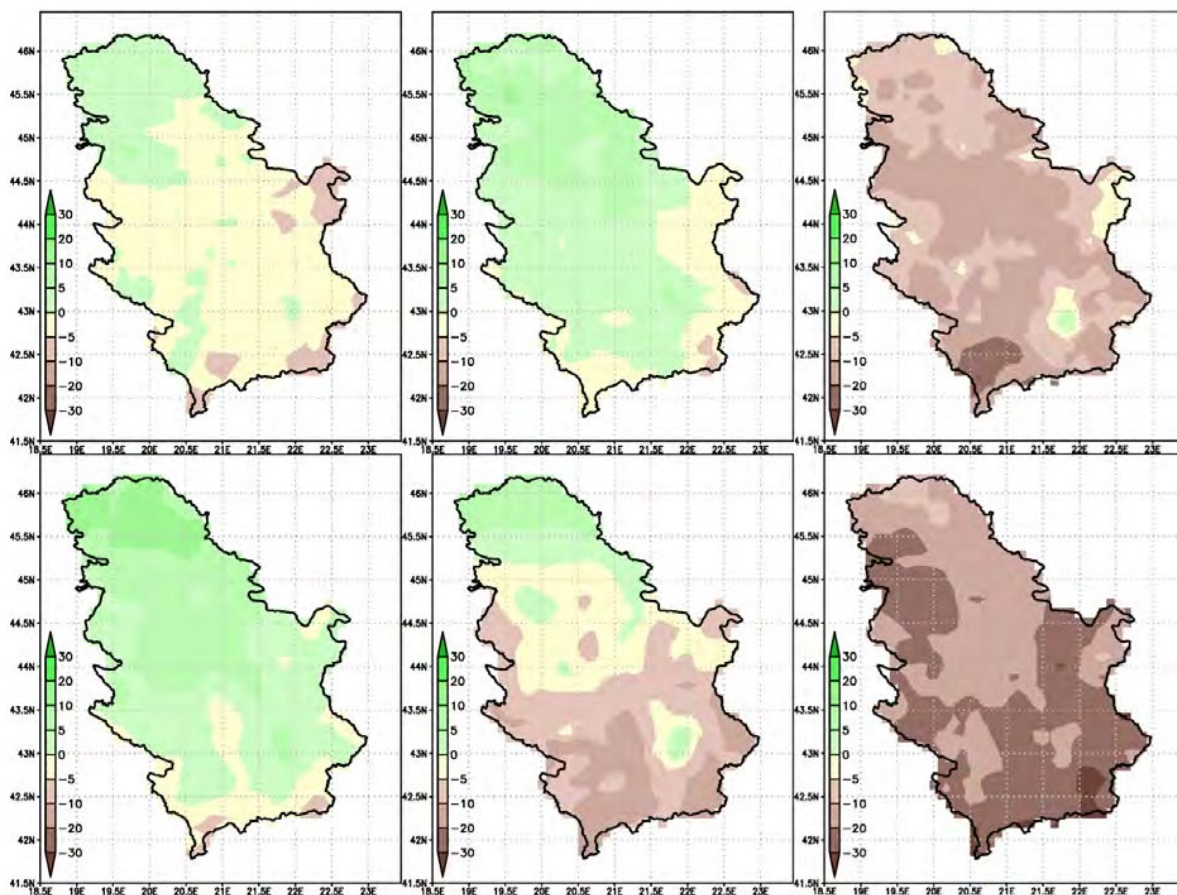
Spatial analysis of temperature changes in future periods indicates a north-to-south gradient of increasing warming. Selected results from the analysis of future temperature changes are shown in Map 7.



Map7: Deviations of mean annual temperature (°C) for the period 2046–2065 (left panel) and 2081–2100 (middle panel) relative to the reference period 1986–2005; deviations of mean maximum temperature (°C) for June–August 2081–2100 relative to the mean maximum temperature of the same period in 1986–2005 (right panel). Results obtained under the RCP4.5 scenario are shown in the upper panels, while results under the RCP8.5 scenario are shown in the lower panels.

Future changes in mean annual accumulated precipitation across Serbia are not expected to exhibit a pronounced trend as is the case with temperature. However, in the second half of the 21st century under the RCP8.5 scenario, average annual precipitation is projected to decrease, with central and especially southern Serbia experiencing the largest reductions—exceeding 10% compared to the reference period 1986–2005. The spatial trend of percentage change in precipitation shows positive values in northern regions of the country, decreasing toward the south and even turning negative in southern areas.

The reduction in precipitation during June–August has already been observed and is expected to continue under both scenarios in future climate periods. By the end-of-century period under RCP8.5, the average decrease in precipitation across Serbia is projected to reach 20.5%, with much larger reductions in southern regions, approaching 40%. Selected results from the analysis of future precipitation changes are shown in Map 8 (October 2018).



Map8: Deviations of mean annual precipitation (%) for the period 2046–2065 (left panel) and 2081–2100 (middle panel) relative to the reference period 1986–2005; deviations of mean precipitation (%) for the June–August season 2081–2100 relative to the mean seasonal values of 1986–2005 (right panel). Results under the RCP4.5 scenario are shown in the upper panels, while results under the RCP8.5 scenario are shown in the lower panels.

Due to climate change, shifts in the intensity distribution of precipitation have been observed, with a decrease in the number of days with light and moderate precipitation and an increase in the number of days with heavy precipitation. This results in a reduction of precipitation amounts from light and moderate events and an increase in amounts from more intense events (National Programme for Adaptation to Changed Climate Conditions).

Unlike changes in mean annual accumulated precipitation, which show variable trends, changes in precipitation intensity distribution exhibit a clear trend toward stronger precipitation throughout the observed period. For example, the proportion of total precipitation across Serbia occurring on days with very heavy rainfall (daily precipitation 20–30 mm) increased by about 40% (from 6.1% in 1961–1990 to 8.5% in the recent past 2001–2020), while the share of precipitation from extreme rainfall events (daily precipitation over 30 mm) more than doubled during the recent past, with an even more pronounced increase in the second decade of this period (2011–2020). The proportion of precipitation from extreme rainfall events relative to total precipitation was 2.4% in 1961–1990, 4.9% in 2001–2020, and 5.6% in 2011–2020 (National Programme for Adaptation to Changed Climate Conditions).

Ongoing monitoring of climate change in Serbia clearly indicates the main characteristics of climate change in the country:

- (a) an increase in mean temperature, with a larger rise in mean maximum temperatures than in mean minimum temperatures, and the greatest increase occurring during the summer season;

- (b) changes in mean annual precipitation totals are not significant; however, the distribution of precipitation by intensity shows fewer days with low and moderate precipitation and more days with high and extreme precipitation; the annual distribution of precipitation shifts toward a longer dry season characteristic of summer, with the average monthly peak precipitation moving from late spring/early summer to earlier in spring;
- (c) increased frequency and intensity/duration of heatwaves;
- (d) increased frequency and intensity/duration of droughts (National Programme for Adaptation to Changed Climate Conditions).

By mid-21st century (2041–2060), under projected climate conditions, the average increase in the number of days with high fire risk is expected to be 10–15 days per year, or 30–50%, and the number of days with very high fire risk is expected to increase by about 50%, depending on the region. By the end of the 21st century under RCP8.5, the expected increase is over 20–25 days per year for high-risk days and 15–20 days for very high-risk days, depending on the region. These projections relate to weather conditions favourable for fires and indicate an increased likelihood of fire occurrence, spread, intensification, and prolonged duration, as well as other events involving the combustion of flammable materials in open areas (National Programme for Adaptation to Changed Climate Conditions).

From the perspective of landscape fire management, there is a noticeable increase in the number of high fire-risk days, along with an increased risk of fire spread and intensification. This poses a significant threat to the environment and public safety.

Climate in Serbia is changing, and the country is expected to experience further warming, shifts in precipitation patterns, and an increased risk of extreme events. These findings provide a basis for climate adaptation strategies and highlight the need for climate action to mitigate the impacts of these changes on the environment, society, and the economy.

Targeted analyses of 21st-century climate scenarios indicate that climate change will significantly increase the risk of landscape fires in Serbia. Compared to the climate of the late 20th century, the number of days with high and very high fire risk is expected to increase by 30–50% by mid-century, and even more by the end of the century—over 20 additional days per year. These changes in weather conditions create a more favourable environment not only for fire ignition but also for faster fire spread, greater intensity, and prolonged duration. The consequences of these phenomena pose serious threats to the environment, human safety and property, and the functioning of public services. Therefore, climate projections must serve as a foundation for further improvement of fire prevention and management systems, as well as for formulating adaptation strategies to mitigate the adverse effects of climate change at national and local levels.

c. Nationally determined contributions (NDCs)

The Republic of Serbia has been a Party to the United Nations Framework Convention on Climate Change (UNFCCC) since 2001 and a signatory to the Paris Agreement since 2017. In 2015, the Government of the Republic of Serbia submitted its Intended Nationally Determined Contributions (INDC), defining a target to reduce greenhouse gas (GHG) emissions by 9.8% by 2030 compared to 1990 levels. The first NDC also addressed losses and damages caused by extreme weather events and emphasized the need for adaptation to changing climate conditions.

By submitting the updated Nationally Determined Contribution (NDC) in accordance with Articles 3 and 4 of the Paris Agreement and paragraphs 22 and 24 of Decision 1/CP.21, Serbia increased its ambition to reduce GHG emissions by 13.2% relative to 2010 levels (equivalent to 33.3% relative to 1990 levels) by 2030. The update also takes into account that material damages caused by climate change and extreme

weather events in Serbia were estimated at at least €1.8 billion for the period 2015–2020, while material damages in the period 2000–2015 were estimated at at least €5 billion (September 2022).

Key mitigation measures include afforestation using terrain and tree-species mapping adapted to climate change, reforestation, implementation of enhanced nature-based forest management, and introduction of climate-smart forestry practices. Management of landscape fires and integrated control of pests and diseases provide co-benefits in terms of substituting fossil fuels and construction materials with biomass. The mitigation potential from afforestation is estimated at 25.9 Mt CO₂ eq./year. The effect of sustainable forest management and nature-based forestry is projected at 1.008 Mt CO₂ eq. by 2030, encompassing all three aspects (nature-based forest management, conversion of seedling forests into high forests, and restoration of overmature stands, mostly beech).

In the context of landscape fire management, Serbia's commitment to international climate agreements, such as the UNFCCC and the Paris Agreement, reflects the recognition of the interconnection between climate change and fire risk. Serbia's efforts in landscape fire management and sustainable forest practices play a vital role in the broader climate change mitigation strategy and align with the global agenda for emission reduction and adaptation to changing climatic conditions. These actions are not only environmentally responsible but also contribute to the long-term economic sustainability and resilience of Serbia in facing climate challenges.

Projected increases in temperature, prolonged dry periods, and more frequent extreme climatic events under both moderate (RCP4.5) and high-emission (RCP8.5) scenarios indicate a growing landscape fire risk across Serbia. These climatic changes, when combined with demographic trends such as rural depopulation, population aging, and uneven settlement patterns, heighten societal vulnerability by reducing local capacities for prevention, monitoring, and response. Serbia's commitments under the UNFCCC and the Paris Agreement, including mitigation and adaptation measures outlined in NDCs, reflect the recognition of this interconnection. Integrated actions—such as sustainable forest management, afforestation, and climate-smart fire prevention—simultaneously contribute to reducing greenhouse gas emissions, protecting communities, and enhancing resilience to the increasing risk of landscape fires, demonstrating the essential link between climate policy, demographic realities, and effective fire management.

IV Existing Landscape Fire Management System

The landscape fire management system refers to a comprehensive framework of policies, strategies, institutions, and practices aimed at the effective management of fires. This includes coordination among various stakeholders, including governmental agencies, non-governmental organizations, local communities, and other relevant entities, in order to prevent fires, prepare for them, respond to them, and recover from landscape fires. The system integrates principles of fire ecology, land management, risk assessment, community engagement, and emergency response to promote landscape resilience to fire and ecosystem stability. Its objectives typically include reducing the risk of catastrophic landscape fires, protecting lives and property, preserving biodiversity, maintaining ecosystem functions, and promoting sustainable land-use practices.

a. Key actors within the existing system

Key actors within the existing landscape fire management system typically include governmental agencies, non-governmental organizations (NGOs), fire management professionals, forest owners and farmers, local communities and individuals, research institutions and the academic community, the industry, and other relevant stakeholders. Effective collaboration and communication among these diverse stakeholders are essential for developing and implementing comprehensive landscape fire management strategies that prioritize safety, ecosystem stability, and overall community resilience.

Within the existing system in the Republic of Serbia, the following key actors have been identified:

1	Ministry of Interior
2	Ministry of Agriculture, Forestry and Water Management
3	Ministry of Environmental Protection
4	Environmental Protection Agency
5	Institute for Nature Conservation
6	Provincial Institute for Nature Conservation
7	Ministry of Defence
8	Ministry of Public Administration and Local Self-Government
9	Public Forest Management Enterprises
10	National Park Public Enterprises
11	Serbian-Russian Humanitarian Centre
12	Firefighting Association of Serbia
13	Republic Geodetic Authority
14	Republic Hydrometeorological Service

15	Associations of Private Forest Owners
16	Mountain Rescue Service
17	Institute of Forestry
18	Institute of Lowland Forestry
19	Faculty of Forestry
20	Faculty of Agriculture
21	University of Defence
22	Standing Conference of Towns and Municipalities
23	Chamber of Forestry Engineers of Serbia
24	Statistical Office of the Republic of Serbia (SORS)
25	Public Enterprise Roads of Serbia
26	Civil society organizations addressing environmental protection, with particular focus on nature conservation

1. Ministry of Interior (<http://www.mup.gov.rs/wps/portal/sr/>)

Within its scope, the Ministry of Interior carries out important tasks related to fire protection (Fire Protection Law). The Ministry is responsible for:

- Planning, organizing, and implementing fire protection measures
- Preventive measures to prevent the outbreak of fires and mitigate their consequences
- Supervising the implementation of the provisions of this law, regulations adopted based on it, fire protection plans, and other acts related to fire protection
- Professional training of members of fire-rescue units
- Education and training of personnel performing fire protection duties
- Development of a Fire Protection Strategy
- Cooperation with other fire protection services
- Other tasks in the field of fire protection as determined by law

Sector for Emergency Management (<http://prezentacije.mup.gov.rs/svs/HTML/delatnost.html>) aims to build, maintain, and enhance the nation's capacity to both proactively address risks and respond to and mitigate the effects of various disasters that may affect the region. It consolidates all existing resources in protection, rescue, and emergency response.

Since 2006, a modern service has been organized, which, in addition to firefighters-rescuers, includes directorates dealing with preventive protection, risk management, and civil protection. Significant effort is devoted to improving organization, strengthening human capacities, and providing equipment to enhance safety and reduce casualties and material damage.

The Sector for Emergency Management performs the following tasks:

- Drafting and proposing laws, regulations, and recommendations that meet European Union requirements in the field of protection and rescue in emergencies to ensure comprehensive legal regulation for performing its duties.
- Establishing institutional, organizational, and personnel conditions for carrying out protection and rescue in emergencies.
- Taking preventive measures to prevent fires and mitigate the effects of natural disasters, technical-technological accidents, etc., as well as preventing threats to citizens' health from hazardous substances and other dangerous conditions.

- Providing professional training for members of organizational units in tasks within the Sector's remit (directorates and departments), among others.

The headquarters of the **Sector for Emergency Management** consists of: Department for General Legal Affairs and International Humanitarian Assistance, Department for Economic and Material-Technical Support and Equipment, Directorate for Preventive Fire and Explosion Protection, Directorate for Fire-Rescue Units and Directorate for Civil Protection and Risk Management.

At the local level, the Sector has 27 organizational units: four Directorates for Emergency Situations in Belgrade, Kragujevac, Niš, and Novi Sad, and 23 Departments for Emergency Situations in Bor, Valjevo, Bran, Jagodina, Kikinda, Pančevo, Sremska Mitrovica, Užice, Šabac, Kraljevo, Leskovac, Novi Pazar, Pirot, Požarevac, Prokuplje, Čačak, Prijepolje, Smederevo, Subotica, Sombor, Zaječar, and Zrenjanin.

The Ministry of Interior, particularly through its Sector for Emergency Management, is the central authority responsible for fire protection and emergency response. Its role in wildfire management includes fire prevention, training, response coordination, and risk assessment. The Ministry plays a key role in ensuring citizens' safety and protecting the landscape from fires.

2. Ministry of Agriculture, Forestry, and Water Management (<http://www.minpolj.gov.rs/?script=lat>)

Forestry Directorate (<https://upravazasume.gov.rs>), as an administrative body within the Ministry, performs state administration and expert tasks related to forestry policy, forest conservation, improvement and utilization of forests and wildlife, implementing measures for forest and wildlife protection, controlling seeds and planting material in forestry, and inspection supervision in forestry and hunting.

The Forestry Directorate is one of the key institutions in wildfire management in Serbia. Its responsibilities in forest management, conservation, and protection contribute to the prevention, mitigation, and management of forest fires, which is critical for preserving forests and the environment from fire hazards.

Agricultural Land Directorate (<https://upz.minpolj.gov.rs/sadrzaj/>), as an administrative body within the Ministry, manages state-owned agricultural land, establishes and maintains an information system on agricultural land in Serbia, allocates funds for implementation of works, monitors annual programmes for protection, arrangement, and use of agricultural land, facilitates international cooperation in protection, management, and use of agricultural land, monitors the preparation and implementation of the Agricultural Base, and performs other tasks in planning, protection, management, and use of agricultural land.

The Agricultural Land Directorate indirectly contributes to wildfire management by promoting responsible land use, collecting and analysing data, and cooperating with relevant agencies. While it is not a primary agency for fire management, its activities help reduce the risk of fires on agricultural lands, which may spread to surrounding areas.

3. Ministry of Environmental Protection (<https://www.ekologija.gov.rs/>)

Performs state administration tasks related to: environmental protection basics; environmental protection and improvement systems; national parks; environmental inspection; applying scientific and technological research results; implementing the Convention on public participation, access to information, and the right to legal protection in environmental matters; nature protection; air protection; ozone layer protection; climate change; transboundary air and water pollution; water protection from pollution to prevent deterioration of surface and groundwater quality; establishing environmental protection conditions in spatial planning and construction; protection from major chemical accidents and participation in chemical accident response; protection from noise, vibrations, and non-ionizing radiation; ionizing radiation protection; management of chemicals and biocidal products; implementing the Chemical Weapons Convention; waste management (excluding radioactive waste); authorizing transboundary waste movement and protected plant and animal species; and other tasks determined by law.

In short, the Ministry of Environmental Protection plays an indirect but crucial role in landscape-level wild-fire management by addressing environmental protection, safety, and natural resource management. Its activities help reduce forest fire risks and mitigate impacts on the environment and public health.

4. Serbian Environmental Protection Agency (<http://www.sepa.gov.rs/>), as an agency under the Ministry of Environmental Protection with legal entity status, performs expert tasks related to developing, harmonizing, and maintaining an environmental information system (monitoring environmental factors through indicators, pollutant registries, etc.) and implementing state monitoring of air and water quality, including prescribed and agreed control programmes for air, surface and groundwater, and precipitation quality.

The Serbian Environmental Protection Agency plays a key role in assessing and monitoring the impacts of forest fires on the environment, especially regarding air and water quality. Its data and expertise are valuable for understanding fire effects on the environment and supporting emergency response efforts and environmental policy development.

5. Institute for Nature Conservation of Serbia (<https://zzps.rs/>)

A professional institution performing tasks in the protection and enhancement of Serbia's natural heritage. Nature protection is regulated by the Nature Protection Law and other legal and sub-legal acts directly or indirectly related to nature and natural resources. In addition to laws, many sub-legal acts are significant for regulating this field. By aligning environmental and nature protection regulations with EU legislation, European and global standards are being considered and applied.

The Institute also contributes to improving and harmonizing nature protection through the implementation of provisions and principles of international conventions to which Serbia is a signatory.

The Institute plays a key role in landscape fire management, focusing on the protection and preservation of natural areas and biodiversity. Its work contributes to reducing fire risks, preparedness, and recovery of unique and ecologically important landscapes after fires.

6. Provincial Institute for Nature Conservation of Vojvodina (<https://pzzp.rs/>)

Operates as an institution in accordance with public service regulations and performs tasks related to the protection of nature and natural resources as established by the Nature Protection Law ("Official Gazette of the Republic of Serbia" No. 36/2009, 88/2010, 91/2010), the Provincial Assembly's decision establishing the Institute (Official Gazette of AP Vojvodina, No. 2/2010), and the Statute of the Provincial Institute for Nature Conservation (Official Gazette of the Autonomous Province of Vojvodina, No. 9/2010).

7. Ministry of Defence (<https://mod.gov.rs/eng>)

Within its remit, the Ministry of Defence proposes and implements defence policy, executes laws and international treaties, and enforces general acts of the National Assembly, the Government, and the President of the Republic in the field of defence. Within its competencies, it also performs tasks related to organizing, planning, implementing, and controlling occupational safety and health, environmental protection, and protection against fires and explosions, in accordance with laws regulating these activities.

8. Ministry of Public Administration and Local Self-Government (<https://mduls.gov.rs/en/about-ministry/>)

Established on 26 April 2014 by the Law on Ministries, one of its core responsibilities is coordination with public administration reform. Administrative reform, one of the three pillars of European Union enlargement policy, is also an essential condition for successfully implementing reform principles and objectives across all areas of society.

This Ministry plays multiple roles in landscape fire management. Its responsibilities include policy development, coordination, support, legislation, public awareness raising, financing, emergency response, monitoring, and international cooperation. By fulfilling these roles, the Ministry contributes to reducing risks associated with wildfires and strengthening the country's preparedness and resilience in facing this natural hazard.

9. Public Enterprises for Forest Management

Public Enterprise Srbijašume (<https://srbijasume.rs/en/>) manages state forests and forest lands on a surface area of 892,029 ha and carries out professional-advisory service activities in private forests (forests owned by natural/legal persons) on an area of 1,221,265 ha. The Enterprise carries out both its public and business mission through 20 Enterprise parts - 18 Forest Estates (FE), Bureau for Planning and Design in Forestry, and Other Forestry Products and Services, Belgrade. It is composed of 69 Forest Administrations (FA) and 21 Work Units (WU).

Public Enterprise Vojvodinašume (<https://www.vojvodinasume.rs/en/>) manages state forests and forest land covering 129,951.88 ha. Its organizational structure mirrors that of "Srbijašume" and consists of four FMUs: "Sremska Mitrovica" (Sremska Mitrovica), "Banat" (Pančevo), "Sombor" (Sombor), and "Novi Sad" (part of "Vojvodinašume-Lovoturs" in Petrovaradin). FMUs comprise forestry administrations and other operational units, similar to "Srbijašume."

Public forest management enterprises develop forest fire protection plans for forests of all ownership types in their areas. These plans include operational action maps for fire incidents and both passive and active surveillance for timely detection and reporting of forest fires, with approval from the Ministry of Interior and the Ministry of Agriculture, Forestry, and Water Management. Fire risk in forests is defined in forest management planning documents, which specify appropriate management measures.

These enterprises maintain organized ranger services and teams trained to extinguish forest fires, conduct regular monitoring, reporting, and alerting, and, during critical fire periods, operate 24-hour duty shifts. Forest users are obliged to quickly detect fires, arrive at the site, and begin suppression in the initial phase. They must immediately notify the fire-rescue unit and the relevant ministry or provincial authority (Fire Protection Strategy 2012–2017).

10. Public Enterprises – National Parks

Public Enterprise National Park Kopaonik (<https://npkopaonik.rs/>) is located in central Serbia. Due to its natural resources, it was declared a national park in 1981, covering an area of 11,810 ha. With a high number of endemic plant species, it is one of Serbia's most important biodiversity centres.

Public Enterprise National Park Đerdap (<https://npdjerdap.rs/en/>) was established in 1974. The Đerdap Gorge and natural riverbanks, covering over 637.99 km², are areas of exceptional cultural-historical value, significant ecosystems with rare wildlife, native flora and fauna, and well-preserved natural forests of outstanding beauty.

Public Enterprise National Park Fruška Gora (<https://www.npfruskagora.co.rs/lat/o-parku/>) was established in 1960 to ensure permanent protection and enhance its natural wealth and beauty. The actively protected area covers 25,525 ha.

Public Enterprise National Park Tara (<https://nptara.levelap.rs/>) was founded in 1981, located in western Serbia, covering 19,175 ha. Along with surrounding areas (Zaovine and Mokra Gora), it has been nominated by the National Committee for Man and the Biosphere (MAB) as a potential biosphere reserve.

Public enterprises managing forests and national parks in Serbia play a key role in protecting these natural areas from fires. Their responsibilities include prevention, detection, response, and recovery, ensuring the conservation of biodiversity in these unique ecosystems. They work in coordination with government agencies, local communities, and forest owners to effectively manage fire risks in these valuable areas.

11. Serbian-Russian Humanitarian Centre (<https://www.ihc.rs/about-us/>)

The Serbian-Russian Humanitarian Centre (SRHC) is an intergovernmental humanitarian non-profit organization with legal entity status. The Centre is registered in the Republic of Serbia in accordance with national legislation. SRHC was established based on the Agreement between the Government of the Russian Federation and the Government of the Republic of Serbia on 25 April 2012, signed in the city of Niš (Serbia) by the Russian Minister for Emergency Situations and the Serbian Minister of Interior.

The legal basis for the Centre's establishment was the Agreement between the Governments of the Russian Federation and the Republic of Serbia on Cooperation in Humanitarian Response, Disaster Prevention, and Man-Made Accident Mitigation, dated 20 October 2009.

12. Volunteer Fire Brigades, under the Firefighting Association of Serbia (<https://vss.org.rs/>), are voluntary and non-profit organizations founded on freedom of association. They exist to organize voluntary citizen participation in fire protection, rescue of people and property, and implementation of projects and programmes in this area of public interest. They comply with legal requirements and are registered in the Association Register.

13. Republic Geodetic Authority – RGA (<https://www.rgz.gov.rs/>)

The RGA is a specialized organization performing professional and state administration tasks related to state surveying, real estate cadastre, water cadastre, basic geodetic work, address registration, topographic and cartographic activities, property valuation, geodetic-cadastral information systems, the National Spatial Data Infrastructure, and engineering-geodetic works.

RGA plays a vital role in landscape fire management by providing geospatial information, mapping, and analysis to support fire risk assessment, response coordination, and recovery efforts. These geospatial data are essential for understanding spatial aspects of fires and ensuring community safety and well-being in Serbia.

14. Republic Hydrometeorological Service of Serbia (https://hidmet.gov.rs/index_eng.php)

RHMSS is the reference institution fully responsible for preparing and presenting weather and water level forecasts, issuing warnings, and notifying authorities of extreme and hazardous meteorological and hydrological events.

Since spring 2008, RHMSS has contributed to organized landscape fire protection in Serbia by calculating fire danger indices using the Canadian Forest Fire Weather Index (FWI) system. This method assesses forest fuel flammability based on past and current weather conditions, indicating potential fire hazards. Real-time and forecast data are regularly sent to relevant state authorities and published on www.meteoalarm.rs in tabular and graphical form (National Strategy for Protection and Rescue in Emergencies).

RHMSS plays a key role in providing essential weather and water level information to support landscape fire management. Their forecasts, warnings, and data contribute to early detection, preparedness, and response to fire risks in Serbia.

15. Associations of Private Forest Owners

These associations primarily represent the interests of their members. In Serbia, they act as a counterbalance to fragmented private forest holdings and low owner engagement. The oldest association, “Šumska zajednica Beočin,” was founded in 1903 and still exists. By 2023, 34 active associations of private forest owners (UPŠ) were registered, with two (“Tilva” and “Žagubica”) managing their own forests.

Private forest owners’ associations are key actors in landscape fire management, facilitating cooperation, education, and resources for forest owners, supporting coordinated and effective responses to forest fires, and advocating policies that reduce fire risk and promote sustainable forest management.

16. Mountain Rescue Service (GSS) (<https://www.gss.rs/>)

The Mountain Rescue Service is a non-profit volunteer organization focused on assistance and rescue in inaccessible conditions, both rural and urban. Founded in 1952 by mountaineers and alpinists, the service aims to help people in need in mountainous areas. Today, it has about 1,000 volunteers, including 250 active rescuers experienced as mountaineers, alpinists, climbers, speleologists, divers, skiers, and paragliders.

While the primary focus is mountain and wilderness rescue, their skills and dedication can be valuable during landscape fire incidents in challenging terrains, supporting official firefighting agencies and emergency services.

17. Forestry Institute (<http://www.forest.org.rs/?sLang=en>)

The Forestry Institute conducts fundamental, applied, and developmental research in forestry, environmental protection, and improvement. Its researchers lead and participate in nationally and internationally recognized research projects. The Institute plays a key role in landscape fire management by conducting research, providing recommendations, collaborating with government agencies, and engaging with the community. Their work contributes to risk reduction and mitigation of landscape fire impacts, protecting the environment and communities in Serbia.

18. Institute of Lowland Forestry and Environment (<https://www.uns.ac.rs>)

This research institute focuses on applied and developmental studies to meet the needs of end-users of research outcomes as well as fundamental research that underpins applied and developmental work.

While its primary focus is research, the Institute indirectly supports landscape fire management by providing knowledge, data, and tools necessary for understanding, preventing, and responding to fires in lowland forest ecosystems. This research is essential for sustainable management and reducing fire impacts on ecosystems and communities.

19. Faculty of Forestry, University of Belgrade (<https://www.sfb.bg.ac.rs/?lang=en>)

The Faculty of Forestry is the oldest and most prominent higher education institution in Serbia for forestry, wood processing, landscape architecture, and environmental engineering for soil and water protection. It plays multiple roles in landscape fire management through education, research, policy advice, and community engagement, contributing to prevention, mitigation, and management of forest and landscape fires in Serbia.

20. Faculty of Agriculture, University of Belgrade (<https://www.agrif.bg.ac.rs/en/faculty>)

The Faculty of Agriculture provides education and research in crop production, horticulture and viticulture, livestock, land management, crop protection and food products, agricultural machinery, food technology

and biochemistry, and agricultural economics. While its primary focus is agriculture and food-related disciplines, its expertise in land management, sustainable practices, and crop protection can contribute to mitigating landscape fire risks in agricultural and rural areas. These efforts reduce fire vulnerability and increase the resilience of the agricultural sector in facing fire hazards.

21. University of Defence (<https://www.uo.mod.gov.rs/eng>)

The University of Defence is an independent higher education institution responsible for advanced military education through first-, second-, and third-cycle studies across multiple scientific fields, within the framework of educational and scientific programmes and specialized training, in accordance with its license, founding act, the Higher Education Act, and the Military Education Act.

In addition to higher education, the University conducts research through basic, applied, and developmental studies aimed at improving, upgrading, and modernizing education within the defence system. The University of Defence is a member of the Conference of Universities of Serbia.

22. Standing Conference of Towns and Municipalities (SCTM)

SCTM is a local government association. Its mission is to represent interests, provide services, and support the development and improvement of local self-government through collective action of its members, in line with European standards.

23. Chamber of Forestry Engineers (<https://sumarskakomora.rs/>)

As a legal entity based in Belgrade, established by the Law on Forests, the Chamber promotes professional work in forestry, protects general and individual interests in professional practice, and organizes provision of forestry services. Members are forestry engineers.

The Chamber plays a vital role in landscape fire management by providing expertise, technical support, and guidance to reduce fire risk, enhance preparedness, and enable effective response to landscape fires in forests and natural environments.

24. Statistical Office of the Republic of Serbia (SORS) (<https://www.stat.gov.rs/>)

SORS is the official state authority responsible for collecting, processing, and presenting statistical data in Serbia. It operates as an independent and professional institution, providing accurate, reliable, and up-to-date statistical information to support government policies, economic research, and public decision-making.

Although SORS indirectly supports landscape fire management through data provision, primary responsibility for managing and responding to landscape fires lies with relevant government agencies, such as the Ministry of Interior, the Ministry of Agriculture, Forestry and Water Management, local authorities, and specialized firefighting and emergency units. These agencies use data from SORS and other sources to inform strategies and actions for addressing landscape fires.

25. Public Enterprise “Roads of Serbia” (<https://www.putevi-srbije.rs/index.php/en/>)

This public enterprise performs professional tasks related to the permanent, continuous, and quality maintenance and preservation, operation, construction, reconstruction, toll management, and administration of state roads of categories I and II in Serbia.

While the primary focus of “Roads of Serbia” is road infrastructure, its activities intersect with landscape fire management due to potential fire risks along road corridors. Awareness and collaboration with rele-

vant authorities responsible for fire prevention, response, and management are important to ensure the safety of road networks and surrounding areas.

26. Civil society organizations (CSOs) focusing on environmental and nature protection

CSOs operate locally and combine activism and expertise to implement prevention programmes, raise public awareness, educate communities, participate in local governance, influence public policies, and enhance the legal framework. They also engage in concrete volunteer actions contributing to fire protection.

This comprehensive list of stakeholders highlights the complex nature of landscape fire management, which is crucial for the protection of forests, natural areas, and public safety. Each stakeholder in this extensive network plays a unique and essential role, contributing expertise, resources, and efforts to prevent, prepare for, and respond to landscape fires.

The diverse group includes government agencies, research institutions, educational institutions, and organizations involved in forest management. Participation of bodies such as the Ministry of Agriculture, Forestry and Water Management, public forestry enterprises, and the Chamber of Forestry Engineers emphasizes the key role of the forestry sector in landscape fire management, advocating risk reduction and sustainable forest management.

Furthermore, environmental protection agencies, hydrometeorological institutes, and nature conservation institutions highlight the importance of considering environmental impacts of landscape fires and coordinating efforts to protect biodiversity and natural resources.

The list also includes emergency response organizations such as the Ministry of Interior, volunteer fire brigades, and the Mountain Rescue Service, reflecting the preparedness and response component of landscape fire management.

In summary, the collaborative network of stakeholders involved in landscape fire management in the Republic of Serbia demonstrates a shared commitment to preserving landscapes and natural areas, maintaining environmental quality, and safeguarding life and property. Effective coordination among these stakeholders is essential to address the challenges posed by landscape fires and to move towards a more resilient and sustainable landscape.

b. Organizational setup of the system

The landscape fire management system in the Republic of Serbia is institutionally established and involves a range of actors operating across all phases of management: prevention, preparedness, response, and recovery. These activities engage state institutions, ministries, public enterprises, local governments, research institutions, as well as civil society organizations. The system relies on the existing legislative and institutional framework, but in practice, its functioning is often hindered by overlapping responsibilities, unclear lines of command, and limited resources and capacities, especially under increasingly intense fire seasons.

Below is an organizational chart (Figure 1) illustrating the key actors and the main coordination flows within the fire management system. While unofficial, it provides a useful representation of the current setup, though it does not encompass all relevant stakeholders, including those with indirect or potential roles. This highlights the need for further formalization and institutional improvement, particularly in the areas of preventive measures, systemic education, and operational coordination.

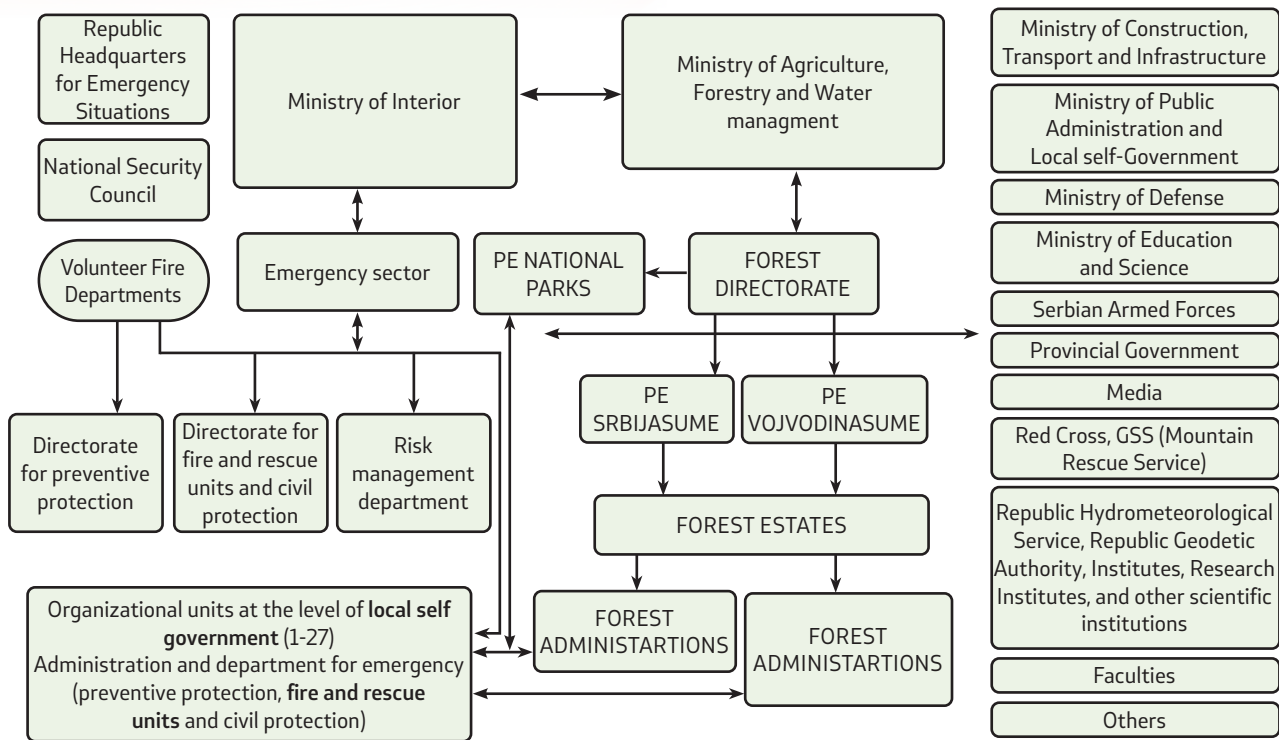


Figure 1. Organizational setup of the forest fire management system (informal representation)

In the prevention and preparedness phase, key roles are played by forestry enterprises, local government units designated as fire protection entities under the Fire Protection Act, the Ministry of Agriculture, Forestry and Water Management, and specialized services responsible for implementing measures such as constructing firebreak roads and belts, preparing fire protection plans, maintaining high-risk areas, and conducting fire hazard assessments.

Additionally, educational institutions play an important role in long-term capacity building—through formal and informal education on environmental protection, responsible behaviour in nature, and the importance of fire prevention. Integrating fire-related topics into curricula, providing training for students in forestry, ecology, and related fields, and cooperating with research institutions contribute to a knowledge-based approach within Landscape Fire Management (LFM).

The media, including social networks, play a crucial role in informing the public and raising awareness of fire risks, especially during critical periods of the year. Campaigns focused on prevention, timely risk notifications, and promoting responsible behaviour in nature can significantly reduce the number of human-caused fires.

When a fire occurs, particularly in forested areas, the initial response is typically carried out by the forestry enterprise managing the affected site. Their teams mobilize available resources and begin firefighting. If the fire surpasses their capacity, the local fire-rescue unit is activated, providing additional personnel and equipment, with operations coordinated by the unit's commander. When multiple units from the same battalion or brigade are involved, coordination is handled by the shift chief or the battalion/brigade commander.

If it is necessary to deploy fire-rescue units from other organizational units of the Fire and Rescue Service (units outside the territory/zone of responsibility of the battalion/brigade where the fire occurs), coordination is managed by the senior officers of the Fire and Rescue Administration. The Ministry of Interior intervenes in the case of fire escalation and the need for broader mobilization; the Sector for Emergency

Management then assumes operational management. In extreme situations, the National Emergency Headquarters is activated, which may include international resources (e.g., firefighting aircraft), and coordinates all activities. Emergency Headquarters may operate at municipal, city, provincial, or national levels depending on the situation and scale.

It is important to note that voluntary fire brigades, operating within the Firefighting Association of Serbia, also play a significant role in response efforts, particularly in rural and less accessible areas.

After firefighting operations are completed, damage assessment and restoration take place. Local government units, public enterprises, as well as environmental and forestry services participate in this phase, aiming to rehabilitate the area, assess ecological and economic losses, and implement measures to prevent erosion, landslides, or additional damage.

Although the basic system structure exists and provides a framework for action across all aspects of landscape fire management, greater attention must be given to prevention, specifically strengthening human resource capacities, developing information systems, and formalizing the roles of individual institutions and specialists within the overall landscape fire management process.

c. Legislation regulating this area

The landscape fire management system in Serbia relies on a broad regulatory framework that includes laws, strategies, subordinate legislation, and planning documents. While some provisions directly address fire protection, many legal acts play an indicative or indirect role, influencing prevention, preparedness, firefighting, and post-fire recovery.

A significant challenge lies in improving the alignment and implementation of existing regulations as well as developing missing strategies and action plans, especially in light of increasingly frequent and intense fires caused by climate change.

The key legislation and regulatory documents underpinning landscape fire management in Serbia cover a range of areas, from fire protection to land use, forestry, and emergency response.

Laws

1. Law on Fire Protection
2. Law on Climate Change
3. Law on Disaster Risk Reduction and Emergency Management
4. Law on Forests
5. Law on Agricultural Land
6. Law on Environmental Protection
7. Law on Nature Protection
8. Law on Voluntary Firefighting
9. Law on Local Self-Government
10. Law on National Parks
11. Law on Climate Change, "Official Gazette of RS", No. 26 of 23 March 2021

Strategies

1. Fire Protection Strategy – in preparation
2. National Strategy for Protection and Rescue in Emergency Situations – in preparation
3. Defence Strategy of the Republic of Serbia
4. Forest Development Strategy
5. National Security Strategy of the Republic of Serbia
6. Agriculture and Rural Development Strategy 2014–2024

Other Sub-Legal Acts

1. Rulebook on Forest Order
2. Methodology for Disaster Risk Assessment and Development of Protection and Rescue Plans
3. Regulation on Mandatory Means and Equipment for Personal, Mutual, and Collective Protection Against Natural Disasters and Other Accidents
4. Regulation on the Composition and Operation of Emergency Headquarters
5. Rulebook on the Organization and Use of Specialized Civil Protection Units
6. Rulebook on the Method of Drafting and Content of Fire Protection Plans for Autonomous Provinces, Local Self-Government Units, and Classified Entities of the First and Second Category
7. Regulation on the Implementation of Evacuation
8. Rulebook on the Organization of Fire Protection According to Fire Hazard Categories
9. Rulebook on Special Conditions that Legal Entities Must Meet to Organize Fire Protection in Entities of the First, Second, and Third Fire Risk Category
10. Nature Protection Programme of the Republic of Serbia for the Period 2021–2023
11. Draft Spatial Plan of the Republic of Serbia 2021–2035
12. Nationally Determined Contribution (NDC) of the Republic of Serbia for the Period 2021–2030
13. Climate Change Adaptation Programme with Action Plan
14. Environmental Protection Programme of the Republic of Serbia
15. National Forestry Programme and Action Plan for the Period 2024–2026 – in preparation
16. Spatial Plan of the Republic of Serbia

Laws

1. Law on Fire Protection

The Law on Fire Protection regulates the fire protection system, the rights and obligations of state authorities, autonomous province authorities, and local self-government units, business entities, other legal and natural persons, firefighting organizations, supervision over the implementation of this law, and other issues of significance for the fire protection system. The fire protection system defines a set of measures for planning, organizing, and controlling these measures, measures for preventing the outbreak and spread of fires, detecting and suppressing fires, as well as mitigating the consequences of fires on forests and forest ecosystems.

2. Law on Disaster Risk Reduction and Emergency Management

This comprehensive law establishes rules and regulations for general disaster resilience and preparedness. It contains provisions regulating the rights and obligations of citizens, state institutions, and private legal entities. The law also includes provisions related to disaster risk reduction, emergency management, early warning, and climate change adaptation.

In 2011, the National Assembly of the Republic of Serbia adopted the **National Strategy for Protection and Rescue in Emergency Situations**. This sub-legal act was derived from the previous Emergency Situations Act, but a new strategy is currently being developed based on the new Law on Disaster Risk Reduction and Emergency Management. The purpose of the strategy is to protect the lives, health, and property of citizens, the environment, and the cultural heritage of the Republic of Serbia. It defines national coordination mechanisms and programme guidelines for reducing disasters caused by natural phenomena and accident risks, as well as for protection, response, and recovery. The National Strategy ensures compliance with European Union recommendations for developing a national protection system: establishing institutional, organizational, and personnel conditions for emergency protection; providing well-trained personnel; forming and training existing firefighting and rescue units for new tasks; developing the capacity to respond effectively in case of disaster, including terrorist attacks; providing material support for implementing the strategy; training firefighting and rescue units of the Ministry of Interior, firefighting units in business entities, voluntary firefighting units, and civil protection units (specialized and general); and educating citizens on emergency response.

3. Law on Forests

The Law on Forests regulates the preservation, protection, planning, cultivation, use, and management of forests and forest land, supervision over its implementation, and other matters of significance for forests and forest land. According to current legislation, entities managing forests (public enterprises) must prepare fire protection plans for all categories of forest property within their territory. Such plans are mandatory for forests in the first and second fire risk categories and must include:

- an overview of the current state of fire protection
- fire risk assessment
- organization of fire protection
- prescribed technical and organizational measures to address weaknesses and strengthen fire protection capacity
- calculation of the necessary financial resources for these purposes.

These plans must be approved by the Ministry of Interior and the Ministry of Agriculture, Forestry, and Water Management. Fire risks and forest vulnerability are defined in forest management plans. To reduce these risks, decrease forest vulnerability, and protect forests from fires, the management team must define appropriate forest management activities. The law also specifically obliges forest users to restore areas affected by forest fires and other natural disasters (wind, snow, ice, etc.). It prohibits lighting fires in forests and on land within 200 meters from the forest edge, except in special cases designated for this purpose. Violations carry penalties for legal and natural persons.

4. Law on Agricultural Land

This law regulates the planning, protection, organization, and use of agricultural land, supervision of its implementation, and other matters important for the protection, management, and use of agricultural land as a public good. Local self-government units prescribe measures to protect agricultural land from frost, hail, fire, and other natural disasters.

5. Law on Environmental Protection

This law establishes a comprehensive system for environmental protection, ensuring the human right to live in a healthy environment and a balanced relationship between economic development and the environment. Although it does not specifically address forest or landscape fires, fire prevention is incorporated within the broader environmental protection framework.

6. Law on Nature Protection

The law regulates the protection and preservation of biological, geological, and landscape diversity as part of the environment. One of the legally prescribed measures includes mitigating harmful consequences of human activities in nature, including forest fires.

7. Law on Voluntary Firefighting

This law regulates the organization of voluntary firefighting, the establishment, operation, and governing bodies of voluntary fire brigades, the rights and obligations of voluntary firefighting societies, the federation of voluntary firefighting societies, and other matters relevant to the operation and organization of voluntary firefighting in Serbia.

8. Law on Local Self-Government

This law regulates local self-government units, criteria for their establishment, responsibilities, powers, supervision over their acts and operations, protection of local self-government, and other matters of importance for exercising the rights and duties of local self-government units. Municipalities, through their organs, perform, in accordance with the Constitution and law, tasks of protection and rescue, fire protection, and other tasks of direct interest to citizens.

9. Law on National Parks

The law regulates the objectives, values, areas, boundaries, and protection regimes, management, and sustainable use of the following national parks: Fruška Gora, Đerdap, Tara, Kopaonik, and Šar Planina.

Strategies

1. Fire Protection Strategy

Adopted for a period of at least five years (duration of the current strategy), it includes: 1) a description and assessment of the fire protection status; 2) main objectives and criteria for implementing fire protection at all levels, including priority measures; 3) conditions for applying optimal economic, technical, and technological fire protection measures; 4) long- and short-term measures to prevent fires, mitigate their consequences, and control implementation; 5) means of securing funding for fire protection.

2. Disaster Risk Reduction and Emergency Management Strategy

This is the primary strategic document defining policy and guiding state authorities and other actors in managing disaster risks. It establishes guidelines for deploying human and material resources and for developing legal and institutional frameworks to reduce risks and respond effectively. The strategy is adopted at the national level, with the government approving the strategy and its action plan.

3. Defence Strategy of the Republic of Serbia

This strategy guides the deployment of defence resources and the development of regulatory, doctrinal, and organizational solutions for the Serbian defence system. It analyses the security environment, identifies challenges, risks, and threats, and pays special attention to natural disasters and chemical, biological, nuclear, technical, and technological accidents that may pose long-term security threats. Negative impacts may also affect neighbouring states.

4. Forest Development Strategy of the Republic of Serbia

Its objective is to coordinate general development goals for the forestry sector and define measures to achieve these goals.

5. National Security Strategy of the Republic of Serbia

This strategy serves as the leading document outlining national security principles, threats, and priorities. It is subject to revision and updates over time.

6. Agriculture and Rural Development Strategy (2014–2024)

This strategy outlines Serbia's approach to agricultural sector development and rural sustainability, defining objectives, priorities, and institutional frameworks. It includes a budgetary framework for support and will be succeeded by the 2025–2034 strategy with an action plan for 2025–2028.

Other Sub-Legal Acts

To ensure consistent application of laws and strategies, additional sub-legal acts have been adopted:

1. **Decisions on the formation of local emergency headquarters**, based on the Regulation on the composition, manner, and organization of emergency headquarters (Official Gazette of RS, No. 27/2020), regulating headquarters operations, coordination of actors, risk assessment, and restoration measures.
2. **Local self-government fire protection plans** pursuant to Article 22 of the Law on Fire Protection (Official Gazette of RS, Nos. 111/09, 20/15, 87/2018) and the relevant Rulebook on preparation and content (Official Gazette of RS, No. 73/10), approved by the Ministry of Interior.
3. **Fire protection plans for protected areas** managed by local self-government, pursuant to Article 27 of the Law on Fire Protection, also approved by the Ministry of Interior.
4. **Rulebook on Forest Order** – regulates forest maintenance, particularly in high-risk forests (e.g., conifers), firebreaks, observation towers, water points, and access restrictions during extreme heat.
5. **Methodology for Disaster Risk Assessment and Development of Protection and Rescue Plans (2019)**
6. **Regulation on Mandatory Means and Equipment for Personal, Mutual, and Collective Protection Against Natural Disasters and Accidents** (Official Gazette of RS, No. 3/11)
7. **Regulation on Composition and Operation of Emergency Headquarters** (Official Gazette of RS, No. 98/10)
8. **Rulebook on Organization and Use of Specialized Civil Protection Units** (Official Gazette of RS, No. 26/2011)
9. **Rulebook on the Preparation and Content of Fire Protection Plans for Autonomous Provinces, Local Self-Government Units, and Entities of the First and Second Category** (Official Gazette of RS, No. 73/2010)
10. **Regulation on Evacuation Implementation** (Official Gazette of RS, No. 22/2011)
11. **Rulebook on Fire Protection Organization According to Fire Hazard Category** (Official Gazette of RS, No. 6/21)
12. **Rulebook on Special Conditions for Legal Entities Organizing Fire Protection in Entities of First, Second, and Third Fire Risk Categories** (Official Gazette of RS, No. 6/21)
13. **Nature Protection Programme of the Republic of Serbia 2021–2023**

14. Draft Spatial Plan of the Republic of Serbia 2021–2035 – Local self-government units adopt spatial plans to regulate land use and sustainable development, in line with the Law on Planning and Construction.

15. Nationally Determined Contribution (NDC) of Serbia 2021–2030

16. Climate Change Adaptation Programme with Action Plan

17. Environmental Protection Programme of the Republic of Serbia – developed to improve environmental quality and the population’s quality of life.

Serbia has a well-structured and comprehensive legal and strategic framework for managing landscape fires, integrating multiple sectors and emphasizing risk reduction, environmental protection, and local community engagement. While challenges remain in fully aligning and implementing existing regulations and in developing the missing strategies and action plans, the framework provides a solid basis for addressing these gaps. Continuous refinement and coordination among the various actors will be essential to ensure effective landscape fire management in the face of increasingly frequent and intense fires caused by climate change.

The legal and strategic framework is designed to account for key contextual factors, including land use patterns, demographic trends, and climate characteristics. By integrating these considerations, the framework supports targeted prevention, preparedness, and response measures that reflect the spatial, social, and environmental realities influencing landscape fire risk. The forthcoming Fire Protection Strategy and National Strategy for Protection and Rescue are expected to further enhance national preparedness and response capabilities. Although the term “landscape fire management” is not explicitly used in the regulatory framework, the principles and measures are incorporated into broader disaster risk reduction, environmental protection, and emergency management frameworks, recognizing the importance of addressing wildfire risks and mitigating their environmental and societal impacts.

V History of Landscape Fires

Understanding the historical occurrence and development of landscape fires in Serbia is crucial for shaping effective management policies. It provides context for current challenges and helps identify patterns and lessons that inform future prevention, preparedness, and response efforts.

Landscape fires can have significant and far-reaching consequences for ecosystems, natural resources, human health, and the economic stability of communities. Beyond the direct damage they cause to forest resources, biodiversity, and infrastructure, landscape fires often result in long-term ecological and social impacts – from soil erosion and habitat loss to air pollution and an increased risk of floods.

Like many other countries, Serbia is increasingly facing challenges posed by more frequent, intense, and complex forest fires, driven by climate change, demographic dynamics, and land-use practices. Strengthening the landscape fire management system is therefore essential for safeguarding natural resources, protecting people and property, and enhancing overall societal resilience.

The beginnings of organized fire protection in Serbia date back to the rule of Prince Miloš Obrenović, specifically with the enactment of the Fire Prevention Decree in 1834. Since then, fire protection has evolved in line with various forms of state governance and has continued uninterrupted to the present day.

There are numerous sources of data regarding the number of fires and burned areas in the Republic of Serbia. It is important to emphasize that data can vary significantly depending on the source. Some data-sets cover exclusively forest fires, while others also include other categories of landscape fires.

According to the annual reports of the Joint Research Centre (JRC), the scientific and technical body of the European Commission on forest fires in Europe, the Middle East, and North Africa, the distribution of burned areas in Serbia by land cover type is presented in Table 6.

Table 6. Distribution of burned areas in Serbia by land cover type (Forest Fires in Europe, the Middle East, and North Africa)

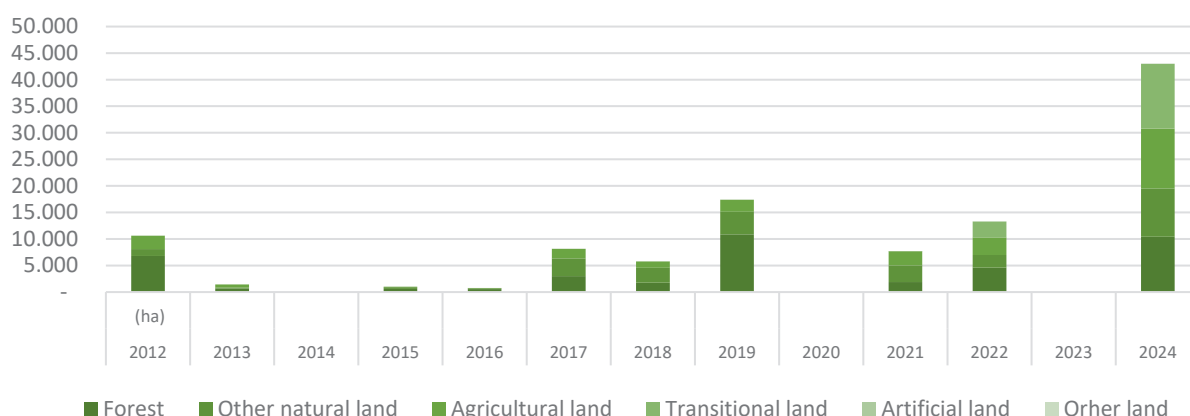
Land cover / year	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
	(ha)												
Forest	6,800	691		596	549	3,005	1,771	10,882		1,886	4,608		10,413
Other natural	1,307	146		330	168	3,340	2,800	4,223		3,136	2,368		9,112
Agricultural l.	2,492	588		86	55	1,795	1,200	2,262		2,681	3,311		11,284
Transitional l.											2,988		12,167
Artificial land	54					8		0		4	18		2
Other land						22	29	19		2			27
Total	10,653	1,424	599	1,011	772	8,170	5,800	17,386	1,417	7,709	13,293	358	43,005

Fires mapped in the European Forest Fire Information System (EFFIS) include all individual fires recorded on areas larger than 30 ha. The data from the table indicate that the total burned area varies significantly from year to year. According to the reports, years with large total burned areas were 2022, when 235 fires

affected 13,293 hectares, with the greatest damage recorded in March, including one fire exceeding 1,000 hectares, and 2019, with a total of 17,386 hectares.

However, 2024 was the worst year ever recorded for Serbia since the beginning of EFFIS monitoring. The country was hit by fires that affected 43,004 hectares, well above the multi-year average of 5,847 hectares. Most fires occurred between February and April and in August. The largest fire of that year (5,274 hectares), which took place in the Pirot region in August, represents the second-largest forest fire in Serbia recorded in the EFFIS database (Advance report on Forest Fires in Europe, Middle East and North Africa 2024).

Distribution of burned areas (ha) in Serbia by land cover type



Graph 12. Distribution of burned areas (ha) in Serbia by land cover type (EFFIS Annual Statistics for Serbia)

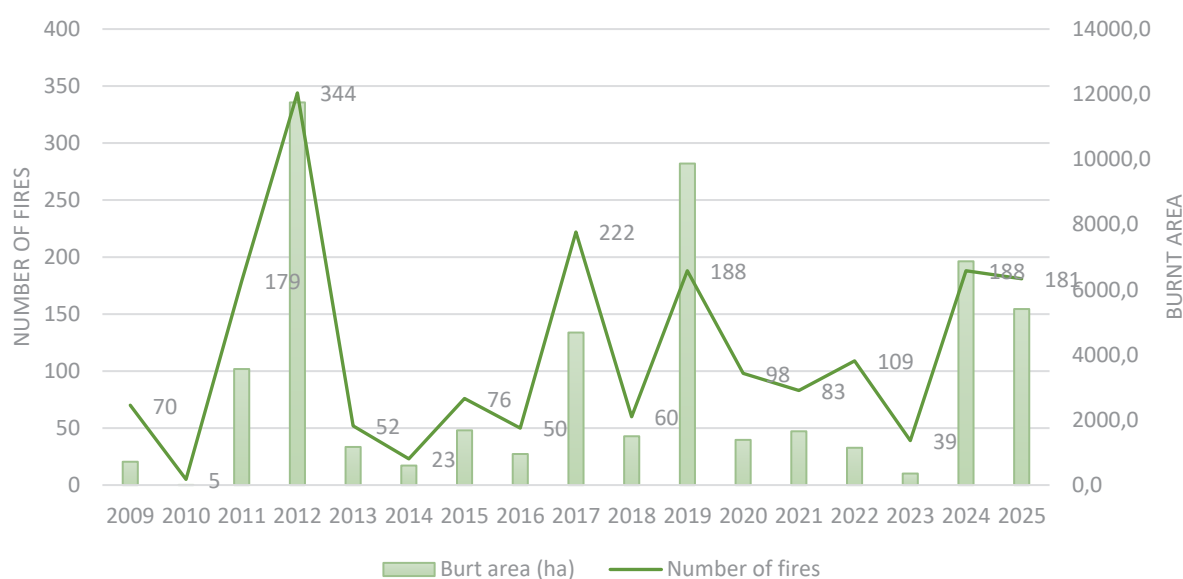
Based on the data from the Study on Forest Fires – for the Republic of Serbia, prepared by the Regional Fire Monitoring Centre in 2015, the number of wildfires is presented in the table below, and these data cover the period from 2001 to 2012.

Table 7. Number of fires (Study on Forest Fires – for the Republic of Serbia, Regional Fire Monitoring Centre, 2015)

Number of	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Forest fires	385	643	595	264	259	837	1,627	17,720	408	254	734	1,321
Fires in crops	189	221	175	213	62	62	147	552	286	98	721	416
Fires in meadows	1,877	2,919	3,820	2,311	1,936	2,831	10,273	200	4,159	2,789	9,814	11,665
Fires in orchards	51	91	90	55	32	92	299	6,339	129	70	332	349
Waste dumps	811	1,273	2,031	1,797	2,215	3,073	4,060	140	1,212	755	1,671	1,663
Other fires	2,837	3,756	4,034	3,486	3,810	4,721	6,178	4,554	5,947	4,349	8,659	10,041
Total	5,961	8,903	10,745	8,126	8,314	7,749	22,584	5,935	12,141	8,315	21,931	25,455

Although the observation periods in previous reports differ and this report includes only the number of recorded fires, data show that the highest number of landscape fires occurred in 2012, followed by 2007 and 2011, across all land categories. Most fires were registered on meadows and grasslands. While these figures should not be regarded as fully reliable indicators, they nevertheless highlight the years with notably higher fire activity.

Since 2009, all public enterprises managing state-owned forests have been required to monitor forest fires and report each incident to the Forest Administration, with all data consolidated within a unified geographic information system. According to the Ministry of Agriculture, Forestry and Water Management – Forest Directorate, the chart below illustrates the number of forest fires and the extent of burnt areas for the period 2009–2025 noting that the data refer exclusively to state-managed forest lands.

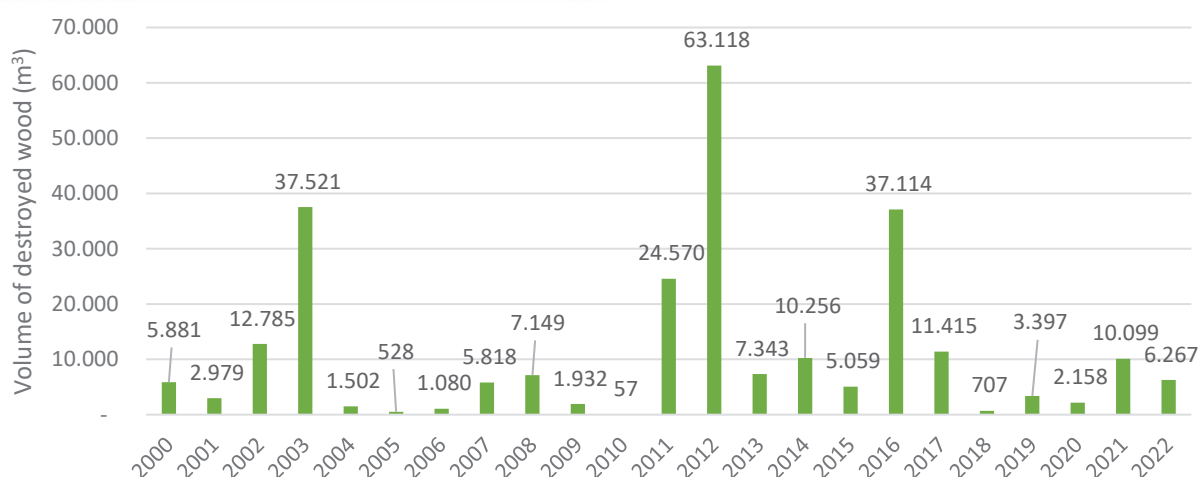


Graph 13. Cumulative overview of the number of forest fires and burnt areas in Serbia for the period 2009–2025 (Forest Directorate)

According to the original data, a total of 1,967 fires occurred in Serbia during this period, affecting around 53,000 hectares of forest land. The number of fires and the burned area varied significantly from year to year. The record year in this period was certainly 2012, both in terms of the number of fires and the burned area, with 344 registered forest fires and around 12,000 hectares burned. It should be emphasized that the data refer only to forests and forest land under state ownership, managed by public forest enterprises as well as public enterprises managing national parks.

The spatial distribution of forest fires recorded in national parks and other public enterprises in the period 2009–2025 indicates that the largest number of fires, as well as the largest burned area, occurred in the forest estates of southern Serbia.

Another important indicator of forest fires in Serbia is the assessment of damages. Chart 14 shows the damages caused by forest fires in terms of burned wood volume for the period 2000–2022. The analysis shows that the volume of burned wood varied greatly from year to year, ranging from very low in 2005 and 2010 to as high as 63,118 m³ in 2012.



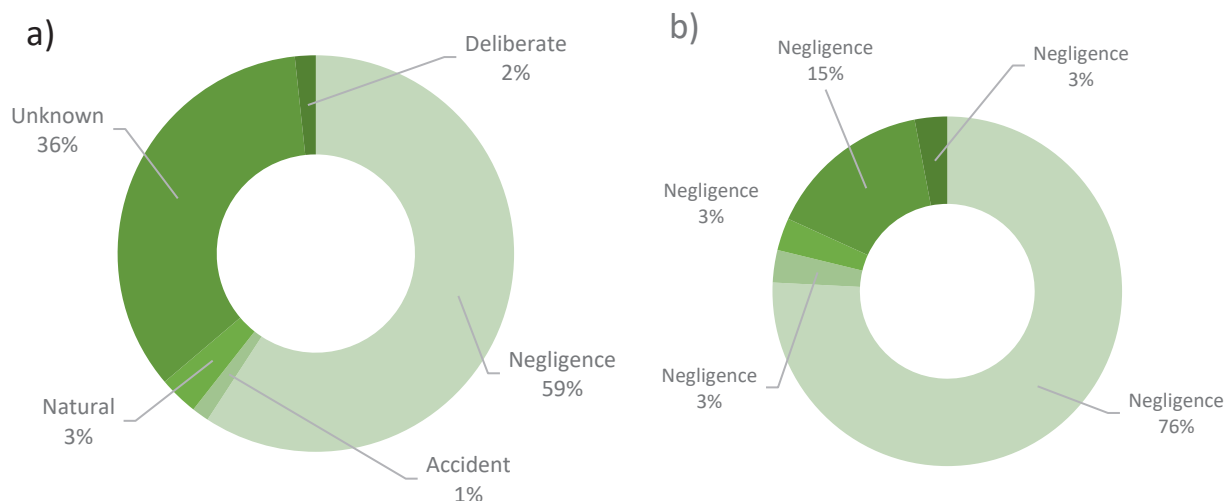
Graph 14. Damages from forest fires in state-owned forests for the period 2000–2022 (Based on data from the Statistical Office of the Republic of Serbia)

Since 2009, the Forest Directorate has been monitoring, collecting data, and keeping records on the costs of suppression, rehabilitation, as well as the direct costs caused by each individual fire. According to the original data, fires in 2012 caused the greatest direct and indirect damages in the forests of Serbia. Direct damages amounted to as much as €2,844,964, rehabilitation costs to €361,197, and suppression costs to €223,778.

Table 8. Direct damages and costs of rehabilitation and suppression (Forest Directorate, MAFWM)

Year	Number of fires	Area (ha)	Direct damage (EUR)	Extinguishing costs (EUR)	Rehabilitation costs (EUR)
2009	70	716	15,641	7,665	8,150
2010	5	5	-	415	-
2011	179	3,563	305,547	51,464	451,551
2012	344	11,748	2,844,964	223,778	361,197
2013	52	1,170	36,459	12,418	3,183
2014	23	599	1,156	1,215	-
2015	76	1,681	191,324	32,073	5,124
2016	50	954	4,114	5,832	992
2017	222	4,683	65,104	42,615	28,752
2018	60	1,499	19,187	11,766	4,549
2019	188	9,872	88,885	25,585	10,564
2020	98	1,388	7,562	3,663	-
2021	83	1,652	27,202	7,762	14,379
2022	109	1,145	1,148	5,308	2,146
2023	39	354	-	623	-
2024	188	6,870	217,407	58,449	-
2025	181	5,405	203,039	87,049	15,794
Total	1,967	53,304	4,028,738	577,681	906,380

During the previous decade, human negligence was identified as the main cause of forest fires in Serbia (59.2%), while in the 2021 fire season the main reported cause was unknown origin (50.7%), followed by natural occurrences (16%).



Graph 15. Causes of forest fires: [a] Years 2013–2023; [b] Fire Season 2021 (Forest Fires in Europe, the Middle East and North Africa 2021)

Human activity is a significant cause of forest fires worldwide. More than 95% of fires in Europe are caused by human activities, according to EFFIS. Among the most common triggers of human-induced forest fires are land use change, urbanization, industrial activities, and recreation (Forest Fires in Europe, Middle East and North Africa (2021)).

It appears that the data on the number of fires and burned areas in Serbia vary significantly depending on the source. This discrepancy may be the result of differences in data collection methods or reporting standards.

The historical record of landscape fires in Serbia reveals clear temporal and spatial patterns that are closely linked to land use dynamics, demographic trends, and climatic conditions. Periods of extreme fire activity, particularly in 2012, 2017, 2019, 2022, 2024 and 2025 coincide with prolonged droughts, high temperatures, and increased human activity in rural and peri-urban areas. The predominance of fires on meadows, grasslands, and agricultural lands underscores the strong connection between land management practices and fire occurrence.

Demographic shifts—particularly depopulation and land abandonment in rural regions—have contributed to vegetation overgrowth and the accumulation of combustible materials, further increasing fire risk. At the same time, changing land-use patterns, such as agricultural decline and forest expansion in unmanaged areas, have created new fire-prone landscapes.

These dynamics highlight the need to view fire not merely as an environmental or technical issue, but as a complex socio-ecological process that reflects broader changes in the landscape. In this context, strengthening the landscape fire management system is essential. Serbia’s existing institutional and legal frameworks provide a solid foundation, but improved coordination, data integration, and proactive prevention measures—especially those linked to sustainable land management and community engagement—are critical to enhancing national resilience.

Ultimately, understanding the history of landscape fires provides more than a record of past events—it offers valuable insight for anticipating future risks and designing adaptive, cross-sectoral policies that integrate environmental protection, disaster risk reduction, and rural development objectives.

VI Assessment of the Risk of Landscape Fires

The assessment of landscape fire risk represents a key element of an effective risk management system, planning of protective measures, as well as timely and coordinated response. In the context of increasingly pronounced climate change and rising frequency and intensity of landscape fires, the importance of this process is growing. Like many other countries, Serbia increasingly faces the need for a systematic approach to identifying, analysing, and mapping areas at risk. Risk assessment allows decision-makers, institutions, and local communities to understand where, when, and to what extent there is a danger of fire, forming the basis for planning preventive measures, allocating resources, and building societal resilience to this type of disaster. Without reliable and regularly updated risk assessments, effective LFM systems is impossible, which may lead to greater material losses, ecological damage, and threats to human life.

The Ministry of Interior in the field of disaster risk reduction and emergency management coordinates the preparation of the Republic of Serbia's Disaster Risk Assessment and the Protection and Rescue Plan, which includes landscape fires as one of the disaster types. State authorities in the field of disaster risk reduction and emergency management participate in the preparation of the Disaster Risk Assessment within their respective jurisdictions and submit it to the Ministry of Interior, while the Ministry of Agriculture, Forestry, and Water Management contributes with the assessment of forest fire hazards, along with other administrative bodies within their competences. The Ministry of Interior also establishes and maintains the Disaster Risk Register.

Representatives of the Sector for Emergency Management of the Serbian MUP and the Republic Geodetic Authority (RGA) held a conference in October 2022 within a United Nations programme, in partnership with the MUP Civil Protection Service and the Faculty of Security, titled "Disaster Risk Reduction – Models and Practices at the International and National Level", where the Disaster Risk Register was presented (<https://drr.geosrbija.rs/drr/>). This interactive digital database, established within the RGA Geoportal, provides all Serbian citizens with information on risks at specific locations, allowing them to make better-informed decisions regarding living locations or financial investments, and to take timely preventive measures. Decision-makers also gain access to real-time data through the Disaster Risk Register, improving urban planning processes, as well as the speed and quality of response in crisis situations (October 22, 2022).

The risk of forest fires has increased globally over the past decades. The Mediterranean region is traditionally the most vulnerable in Europe, but continental countries such as Serbia have also experienced significant economic and ecological losses due to forest fires. To prevent damage to forests and infrastructure, as well as other societal losses, it is necessary to establish an effective fire protection system that minimizes harmful effects. Mapping the probability of forest fire occurrence, as one of the primary tools in risk management, enables the allocation of firefighting resources within the fire season, from lower-risk zones to areas of higher vulnerability (Milanović et al., 2020).

For the needs of the Ministry of Interior – Sector for Emergency Management, the Institute of Forestry prepared a Forest Fire Risk Map for the territory of Serbia (Ratknić M., 2015), implemented within the project "GIS in Forest Fire Prevention in Serbia and Monitoring System". Based on a detailed analysis of climatic, edaphic, compositional, ecological, and anthropogenic factors, along with high-resolution satellite and aerial imagery, areas were categorized by the degree of vulnerability in Serbia as follows: extreme

– 19.9%, high – 56.9%, medium – 22.4%, and low – 0.8%. The Forest Fire Risk Map for Serbia is presented in Annex 6.

A specific methodology was developed to determine the degree of fire vulnerability, considered a key element in preparing forest protection plans using GIS technology (Ratknić T., 2018). Forest fire risk maps were created for the municipalities of Knjaževac (Ratknić T., 2018), Boljevac (Dimitrijević T. et al., 2023), Žagubica, as well as for the municipality of Belogradchik in Bulgaria. Forest fire risk maps for Knjaževac and Žagubica are provided in Annex 7.

The risk maps are based on homogeneous units derived from high-resolution satellite imagery. For Knjaževac, 30,411 units were identified; for Boljevac, 26,476 units; and for Žagubica, 54,750 units. These spatial data in the Geodata database contain information for each homogeneous unit across the following thematic categories:

- Orographic characteristics: digital terrain model, elevation map, exposure map, slope map, spiral index map, heat degree map, thermal coordinate map of exposure and slope.
- Climatic data: map of average annual air temperature, map of average annual precipitation, map of average annual relative humidity, drought periods, hydrological map with springs.
- Geological and pedological maps: geological characteristics map, soil characteristics map.
- Vegetation: forest type map, composition degradation map, age class map, stand condition map.
- Fuel material: deadwood map, forest edge map (forest/non-forest boundary), isokeraunic map.
- Anthropogenic impacts: human impact map, fire history map, land openness map, natural heritage map, tourist facilities map, land management level map, degree of management for tourist and recreational activities.

These databases and maps also include elements that support firefighting, such as equipment location maps, water source maps, road infrastructure, and more, enabling the preparation of forest fire protection plans.

As part of the Institute of Forestry's studies, a mandatory component was the development and application of detailed fire prevention plans based on preventive action programmes. This enabled the formation and equipping of organizational units at all levels, interconnectivity, and coordinated action. Activities were intensified to monitor potentially hazardous elements contributing to forest fires. Fire danger is forecasted, and measures are taken to protect the most vulnerable areas. Fire modelling is conducted for all forested areas at risk. At this stage, the entire system is prepared to operate under actual fire conditions (Ratknić et al.).

The potential use of the Canadian Forest Fire Weather Index (FWI) and the Modified Angström Index (Mod Ang) for forest fire risk assessment was analysed (Ratknić et al., 2019). Daily values of these indices for the period 2005–2015 were linked with the forest fire database. It was determined that there was a relatively weak to moderate correlation between forest fires and FWI values. To improve the assessment of landscape fire risk (including forest fires), a modified index was developed with a significantly higher correlation with actual fire events, making it applicable for southern Serbia. The Modified Angström Index is recommended for creating climate change scenarios when data on fuel loads and microclimatic conditions are unavailable, which is the case in most developing countries, including Serbia (Ratknić T., et al., 2019; Ratknić T., et al., 2021).

In the risk management segment for firefighting response, a defined organizational structure has been established to ensure normal and effective functioning. This structure defines: observation and detection methods for incidents, rapid and timely notification procedures, the exact organization and units involved in the response, the type and quantity of equipment used, the type and quantity of extinguishing agents and logistical support, and the use of data relevant to the incident and reporting (Ratknić T. et al., 2021).

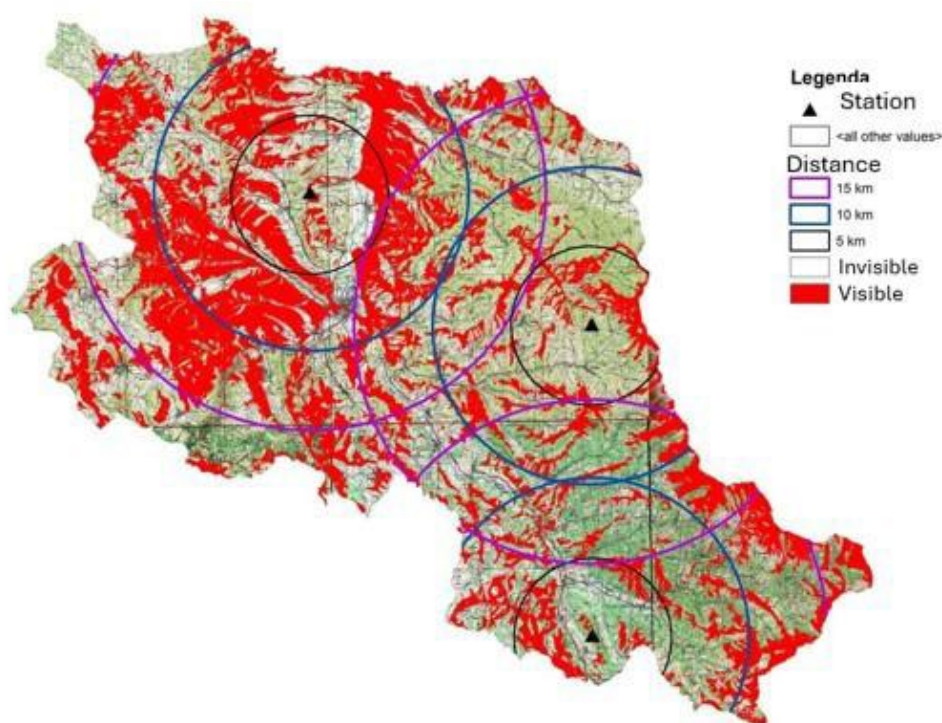
Studies by the Institute of Forestry have identified that reducing damage caused by landscape fires requires three prerequisites, implemented through automated observation and data collection systems:

1. Early detection of fires at the ignition stage.
2. Timely and rapid firefighting actions, supported by objective and relevant information.
3. Detection and sanctioning of deliberately caused fires.

A more technically advanced method of landscape monitoring is remote control via video cameras, where an operator monitors multiple cameras from a control centre. The automatic observation system aims to support preventive fire activities and firefighting operations in two segments:

- Preventive activities: 24-hour observation in the visible and near-infrared spectrum, integrated with an expert alarm system for early fire detection, based on smoke and fire recognition, with the ability to rapidly transmit and store footage at a central unit.
- Firefighting activities: remote video monitoring and camera control adapted to users, supporting fire tracking and management of firefighting operations.

The map shows the distribution of camera locations and visibility zones at different distances for the municipality of Knjaževac.



Map9: Camera locations and visibility zones for the municipality of Knjaževac

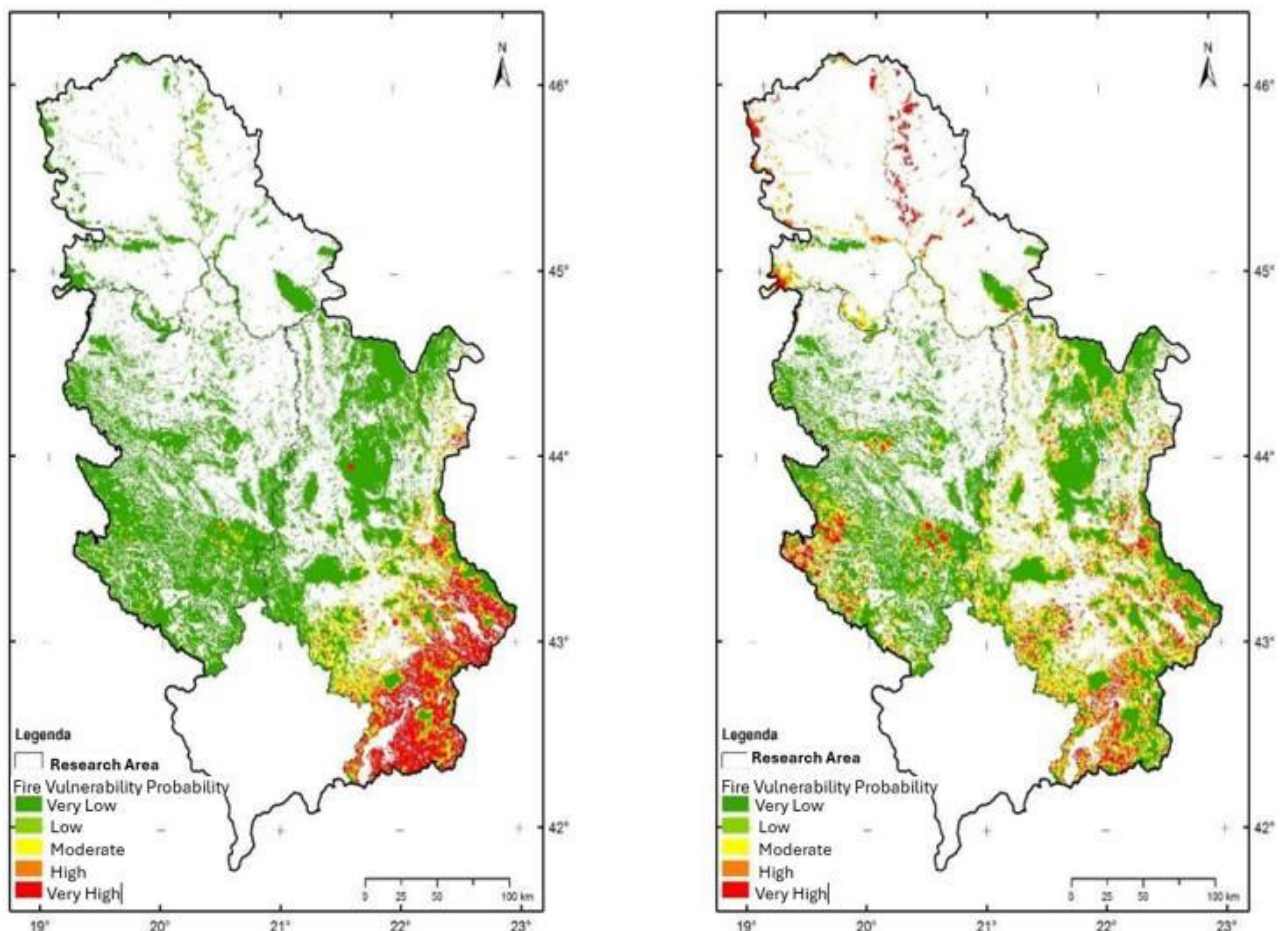
This phase affects the extent of material damage and losses, and the efficiency of the entire risk management system depends on it (Đorđević G., et al., 2023; Đorđević G., et al., 2022; Đorđević G., et al., 2021).

The fourth element in risk management for forest fire protection, studied by the Institute of Forestry, concerns post-fire site rehabilitation (the dynamics of vegetation revitalization in burned areas), i.e., the actions and measures undertaken after extinguishing a forest fire. This element corresponds to the post-risk phase, during which the damaged system must be restored to functionality. The duration of these activities depends on the degree of system damage and the feasibility of rehabilitation (Ratknić T., et al., 2017; Ratknić T., et al., 2018; Hadrović S., et al., 2017; Ratknić M., et al., 2015; Ratknić M., et al., 2013; Ratknić T., et al., 2017; Ratknić T., et al., 2021; Rakonjac Lj., et al., 2020).

One outcome of a project conducted by a professional team led by Professor Milanović from the Faculty of Forestry was the development of a fire hazard assessment model, forming the basis for a “dynamic” fire hazard map for the territory of Serbia. Research conducted during 2017 and in the period from October 2018 to March 2019 provides a solid foundation for constructing fire risk assessment models. Using logistic regression, all significant factors influencing fire occurrence in forested areas of the Toplica District were ranked. An identical analysis was applied to several forested areas in eastern and southern Serbia, identifying the most significant factors for fire occurrence, which may differ from those in the Toplica District due to regional specificities and differences in fire behaviour.

This model enabled the integration of static elements, such as vegetation type, orographic factors, and anthropogenic impacts, with the Fire Weather Index (FWI), which varies in time and space across the remaining territory of Serbia. Eastern (Southern and Eastern Serbia), Western (Šumadija, Western Serbia, and the Belgrade region), and Vojvodina regions were delineated. Based on differences in factors affecting fire occurrence in the static model, “dynamic models” were created for each research area separately (Milanović et al., 2020).

The following section presents the dynamic fire hazard map for August 10, 2017, on the left side, and for August 16, 2017, on the right side of the map.



Map10: Dynamic fire hazard map for August 10, 2017, on the left and August 16, 2017, on the right side of the map

The architecture of the forest fire monitoring system is available at the temporary address <https://pozari.procss.org/#/> (Milanović et al., 2020).

In 2019, a methodology for disaster risk assessment and the development of protection and rescue plans was adopted to establish unified criteria for preparing the Disaster Risk Assessment, improve the quality and comparability of data, and enhance databases on risks from natural hazards and other emergencies in the territory of the Republic of Serbia.

As part of the Draft Spatial Plan of the Republic of Serbia for the period 2020–2035, a hazard map for natural disasters was prepared, which also provides a spatial overview of areas potentially at risk from forest fires. The map is presented in Annex 8.

Understanding the historical occurrence and development of landscape fires in Serbia provides a valuable foundation for assessing current and future fire risks. The analysis of past fire patterns, causes, and impacts helps identify the most vulnerable areas and supports the continuous refinement of risk assessment methodologies.

The assessment of landscape fire risk in Serbia has evolved considerably over the past decade, integrating geospatial technologies, climatic and ecological data, and advanced analytical models. Institutions such as the Ministry of Interior, the Republic Geodetic Authority, and the Institute of Forestry have established important frameworks and tools that support decision-making, planning, and response. However, to further strengthen the effectiveness and accuracy of risk assessments, continuous improvement is needed — particularly in the development and updating of **risk maps**.

In this regard, **further advancements in fuel mapping** are essential to ensure a more realistic and dynamic understanding of fire potential across different landscapes. It is also necessary to **update and harmonize cadastral data**, since many agricultural and grassland areas have undergone natural succession and are now covered by shrubs or forest vegetation. These land use changes significantly affect fuel availability and fire behaviour and therefore must be properly reflected in spatial and risk assessment databases. Furthermore, **enhancing cooperation in data gathering, updates, and exchange between sectors** will be critical for maintaining accurate, up-to-date, and harmonized information systems.

Comprehensive and regularly updated risk assessments — supported by reliable data, improved methodologies, and intersectoral collaboration — represent the cornerstone of an effective landscape fire management system, linking historical insights with forward-looking preventive and adaptive strategies.

VII Projects

This chapter provides an overview of ongoing and completed projects dedicated to landscape fire management and climate change mitigation. The presented initiatives illustrate how Serbia and its partners are addressing the escalating risks of forest fires in the context of climate change. Reviewing these efforts offers valuable perspectives on emerging methodologies and innovative solutions for the protection of ecosystems, human settlements, and natural resources.

The table below provides a comprehensive overview of each project, including objectives, scope, donors, implementers, budget, and duration. The featured projects encompass a variety of activities, such as fire prevention and preparedness, community engagement, sustainable land management, and initiatives aimed at climate change adaptation and mitigation.

Table 9. Current and recent projects from the past decade

Project Title	Project Duration	Budget	Website / Link
Strengthening the Resilience of Serbian Forests to Ensure Energy Security of the Most Vulnerable While Contributing to Their Livelihoods and Carbon Sequestration (FOREST Invest)	2025–2032	84,000,000 USD	https://www.greenclimate.fund/project/fp260
Improving Forest Management in Serbia as a Contribution to Climate Change Adaptation and Mitigation	2021–2023	1,000,000 EUR	https://eu-for-forests-in-serbia.euzatebe.rs/en/about-project
Contribution to Sustainable Forest Management for Low-Emission and Resilient Development	2017–2023	3,585,750 USD	https://www.thegef.org/projects-operations/projects/9089
EU for the Green Agenda in Serbia	2021–2024	16,500,000 EUR	https://open.undp.org/projects/00136377
Reducing Community Carbon Footprint Through the Application of Circular Economy Approaches in the Republic of Serbia	2022–2027	400,000 USD	https://open.undp.org/projects/00129537
European Union for Strengthening Civil Protection and Disaster Resilience in the Republic of Serbia	2020–2024	12,940,000 EUR	https://open.undp.org/projects/00126724
Advancing Adaptation Planning for the Medium and Long Term in the Republic of Serbia (GCF Readiness Program)	2018–2023	1,740,000 USD	https://open.undp.org/projects/00105424
Creating an Enabling Environment at the Policy, Field, and Market Levels for Forest Landscape Restoration (FLR) to Achieve Land Degradation Neutrality (LDN) in Serbia	2021–2024	3,929,121 USD	https://www.thegef.org/projects-operations/projects/10814
Systemic Solutions for Accelerating Emergency Ecosystem Restoration for Forest-Related Biodiversity and Ecosystem Services	2021–2025	20,248,122 EUR	https://cordis.europa.eu/project/id/101036849
IPA Floods and Fires Programme	2021–2024	5,000,000 EUR	https://www.ipaff.eu/
Prevention and Suppression of Forest Fires in the Municipalities of Knjaževac and Belogradchik	2014	–	https://ipacbc-bgrs-fire-prevention.eu/

Joint Training Programme for Forest Fire Prevention and Management	2016–2019	581,000 EUR	IPA Serbia – Bulgaria
Firefighting Service in Cross-Border Cooperation	2019–2021	1,700,000 USD	https://keep.eu/projects/22376/Firefighting-service-in-cro-EN/
Together Against Forest Fires: Empowering Local Communities	2024	–	https://nptara.rs/vesti/881-zajedno-protiv-sumskih-pozara-osnazivanje-lokalne-zajednice.html
Forests Without Fires	2024	–	https://ekosistem.mis.org.rs/podrzani-projekti-2024/

The objectives of these initiatives focus on promoting the sustainable management of natural resources in Serbia, particularly in the areas of forests, land, and energy efficiency, in line with European Union standards and requirements. Core goals include enhancing climate resilience, reducing greenhouse gas emissions, conserving and restoring biodiversity and ecosystem services, and fostering a circular economy and low-carbon innovations. At the same time, efforts are directed toward strengthening legislative and strategic frameworks, building institutional capacities, and securing long-term financing mechanisms. Particular emphasis is placed on an inclusive approach that engages public, private, and civil sectors in planning, developing, and implementing measures contributing to a comprehensive ecological and climate transformation of the country.

Within this broader framework, several international projects stand out for their direct relevance to landscape fire management, addressing prevention, preparedness, and response to fire risks in the context of climate change.

IPA Floods and Fires 2021–2024

The three-year **IPA Floods and Fires Programme**, funded by the European Union, aimed to strengthen capacities for flood and forest fire risk management in Albania, Bosnia and Herzegovina, Kosovo*, Montenegro, North Macedonia, Serbia, and Turkey. By fostering regional cooperation and the exchange of good practices, the **IPAFF Implementation Consortium** worked closely with national civil protection authorities and other relevant institutions to improve the legal and institutional framework related to the **EU Floods Directive (EUFD)**, enhance coordination among all stakeholders involved in its implementation, and build prevention, preparedness, and response capacities for forest fires at national, regional, and EU levels.

Programme activities included workshops, training sessions, field exercises, expert exchanges, procurement of firefighting equipment, and public awareness campaigns. The IPA Floods and Fires Programme stood as a strong example of **regional solidarity and joint efforts** to advance disaster risk management. By combining institutional and legislative improvements with practical preparedness measures, the programme contributed significantly to the **safety, resilience, and well-being** of communities across the region.

European Union for Civil Protection and Disaster Risk Resilience in the Republic of Serbia (2020–2024)

The main objective of the project was to reduce disaster vulnerability and increase the country's resilience to climate change. Recognizing that a critical issue in Serbia's disaster risk reduction and emergency man-

* This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence

agement system is the fragmentation of the institutional framework, procedures, and insufficient capacities at national and local levels for adequate prevention, preparedness, and response to community and population emergencies, the project focused on:

- Enhancing national and local capacities for preparedness and response to accidents and disasters through improved infrastructure and human resources.
- Strengthening institutional coordination at horizontal and vertical levels, as well as technical and operational capacities.
- Contributing to improved inter-sectoral cooperation and enabling faster, better coordinated, and more efficient responses to natural and man-made disasters.

In addition to international projects, several national-level projects should be highlighted.

“Improvement of the Forest Fire Protection System in the Republic of Serbia”

This eight-month project was implemented in 2017 by the Faculty of Forestry, Department of Forest Protection, and funded by the Forest Administration under the Ministry of Agriculture, Forestry, and Water Management. Key results included:

- Selection and testing of an optimal forest fire hazard forecasting system.
- Ranking of factors affecting fire ignition and behaviour.
- Selection of an optimal early fire detection system.

“Forest Fire Hazard Forecasting and Early Detection in Eastern Serbia – Supporting Forest Management Planning”

As a continuation of the previous project, this six-month project was implemented in 2019 by the Faculty of Forestry and also funded by the Forest Administration. Key results included:

- Development of a “static” fire hazard map for Eastern Serbia.
- Design of a network of early fire detection cameras for Eastern Serbia.
- Development of a fire risk assessment model as the basis for a “dynamic” fire hazard map.
- Definition of guidelines to support forest management planning according to varying fire risk levels.

“Forest Fire Hazard Forecasting and Early Detection in Serbia”

Unlike the previous project focused on Eastern Serbia, this six-month project in 2020 produced results for the entire country. It was implemented by the Faculty of Forestry, Department of Forest Protection, and funded by the Forest Administration. Key results included:

- Development of a “static” fire hazard map for Serbia.
- Development of a fire risk assessment model as the basis for a “dynamic” fire hazard map.
- Design of a national early fire detection camera network.
- Creation of a comprehensive database containing all relevant data collected since the beginning of the research.

Based on research conducted between 2017 and 2019, an analysis of existing fire hazard forecasting systems worldwide was performed. Domestic resources necessary for implementation were analysed, leading to the selection of the Canadian FWI system as the basis for fire hazard forecasting. Data from forest fires between 2012 and 2018 were collected to test and calibrate the selected system.

These results enabled the next phase of the project, aiming to develop and implement a national forest fire hazard forecasting system to permanently address this gap in the forestry sector. The impact of these projects is reflected in reduced damage and costs during fire suppression and post-fire recovery. Fire risk forecasting allows human resources and technical means to be deployed from lower-risk areas to higher-risk zones, enabling rapid response and reducing burned areas.

Several local-level projects funded under United Nations programmes were also implemented:

“Together Towards Fire Reduction in Areas of Exceptional Importance – Pilot Action ‘Stolovi’” (Association “Novi Put,” Kraljevo);

Implementation of Early Fire Detection Measures in a High-Risk Area of Exceptional Biological Value – Natural Monument “Lalinac Slatina” (Association “Biological Society Dr. Sava Petrović,” Niš).

The projects presented in this chapter demonstrate Serbia’s ongoing efforts to strengthen landscape fire management and climate change mitigation across multiple levels — from local pilot initiatives to large-scale international programmes. Building on the insights gained from historical fire occurrence and risk assessment, these projects have contributed to improving preparedness, early detection, and response capacities, as well as enhancing the legal, institutional, and technological frameworks needed for effective fire management.

VIII Analysis of Strengths and Weaknesses of the Landscape Fire Management System

This chapter provides a detailed analysis of the strengths and weaknesses of the landscape fire management system in the Republic of Serbia. A SWOT analysis was conducted during a national workshop with the participation of key national stakeholders, who jointly identified internal and external factors affecting the system. The SWOT analysis—as a strategic planning tool—was used to assess the current state of the system and to determine opportunities for its improvement.

Landscape-level fire management is a crucial element in reducing the risk of uncontrolled fires, preserving healthy ecosystems, and protecting local communities. By analysing the key challenges and potentials of the existing system, the aim is to provide a balanced understanding of its current state and highlight possibilities for enhancement. A better understanding of this complex system allows decision-makers and practitioners to more effectively direct activities toward creating fire-resilient landscapes.

Prevention

Preventive measures in landscape fire management, such as fuel reduction, vegetation management, regulations, education, community partnerships and collaboration, and other actions, aim to reduce the likelihood of fire occurrence in each area and minimize their potential impact. Fire prevention is a cornerstone of a comprehensive approach to fire risk management in Serbia. National legislation on fire protection places significant emphasis on proactive measures to prevent the outbreak of fires. Serbia employs a multifaceted approach to preventing and mitigating the destructive effects of fires in the region.

In relation to landscape fires as a significant hazard, responsibilities are distributed among several governmental bodies. The Sector for Emergency Management of the Ministry of Interior plays a key role, while in the case of forest fires, the Directorate of Forests within the Ministry of Agriculture, Forestry and Water Management also holds important responsibilities. However, the system includes other institutions whose mandates are essential—from the Ministry of Environmental Protection and the Republic Hydrometeorological Service, to local self-government bodies, public enterprises managing forests and protected areas, as well as other sectors whose work directly or indirectly affects landscape fire risk management.

In accordance with national legislation, primarily the Law on Forests and the Law on Fire Protection, forest users are obliged to monitor the condition of forests and implement protective measures, taking into account their vulnerability to natural disasters, including fires. Preventive fire protection measures are planned within Forest Management Plans—ten-year strategic documents for forest management. These plans are approved by the Ministry of Agriculture, Forestry and Water Management, ensuring the alignment of planned activities and the effectiveness of the forest protection system.

Prohibiting open fires in the immediate vicinity of forests, as defined by the Law on Forests and the Law on Fire Protection, serves as a basic preventive measure. The obligation to establish forest order is also a preventive measure and relates to potential disturbances in forest ecosystems arising from various forestry activities.

The Republic Forestry and Hunting Inspection plays a key role in implementing preventive measures, using its legal authority to intervene and temporarily prohibit actions that may cause harm in emergency situations.

Additionally, the Republic Hydrometeorological Service contributes significantly to assessing forest fire risks using the Canadian Fire Weather Index (FWI), providing timely information to relevant authorities.

The Law on Agricultural Land also prescribes clear preventive measures, emphasizing cooperation with agricultural entities, inspection of machinery, worker training, and the establishment of harvest task forces. Despite ongoing efforts, challenges remain, making continuous attention to preventive measures essential, including inspections of facilities for drying and storing cereals. Entrepreneurs and farmers engaged in harvesting are obliged to implement specific measures to protect crops from fire hazards. Prohibitions include burning crop residues, disposing of waste in the open, and burning plant residues (Law on Fire Protection).

In accordance with the current legal framework, the preparation of the Fire Protection Plan and the Disaster Risk Assessment, in the part relating to fires, may be carried out exclusively by legal entities holding an appropriate licence, while the final approval of these documents is issued by the Sector for Emergency Management of the Ministry of Interior. However, the conditions for obtaining a licence are defined in such a way that it can only be acquired by experts in civil engineering, mechanical engineering, or electrical engineering, which has oriented the system primarily toward fires in enclosed spaces. Such an arrangement excludes forestry engineers, meteorologists, and other relevant professions who possess essential knowledge for risk assessment and management of landscape fires. Forestry experts hold data on vegetation, fuel structure, and terrain characteristics, while meteorologists provide critical information on climatic parameters, humidity, temperature, winds, and fire danger indices. The absence of their formal involvement in the process results in risk assessments and planning documents being incomplete, insufficiently functional, and often limited to technical aspects, without a comprehensive understanding of the factors influencing the occurrence and spread of fires in natural and rural areas.

Electrical infrastructure, particularly low-voltage power lines, represents an increasingly significant source of initial fires in rural areas. Fires occur due to sparking, short circuits, and the impact of wind on worn-out lines, as well as the presence of dry and poorly maintained vegetation in their immediate vicinity. Although legislation places the responsibility for clearing vegetation on parcel owners, in practice these owners are often elderly individuals, heirs who do not live in the area, or numerous co-owners without clearly defined responsibility, which leads to a complete absence of preventive maintenance. As a result, large areas beneath power lines remain overgrown and dry, representing direct fuel and a constant fire risk.

Furthermore, in the planning and construction of high-voltage transmission lines, environmental impact assessments mainly focus on biodiversity, while the assessment of fire ignition and spread risk along the corridors is most often missing. Consequently, energy infrastructure is frequently placed in high-risk areas without adequate technical protection measures or management plans in case of malfunction. These systemic shortcomings contribute to an increasing number of fires caused by electrical infrastructure, unclear lines of responsibility, the inability to implement preventive measures, material damage, risks to public safety, and losses of electricity and frequent network failures during extreme weather conditions.

In Serbia, there is no integrated national database that would consolidate information from relevant institutions—Mol (interventions), the Directorate of Forests, public enterprises, local governments, and satellite-based fire detection systems (MODIS, EFFIS, OroraTech, etc.). Each institution maintains its own records, often in different formats, without a spatial component and without the possibility of mutual comparison. Such fragmentation of data leads to numerous limitations in planning and prevention:

- inconsistent statistics on the number and area of fires (e.g., Mol and public enterprises report different figures);
- inability to monitor repeated fires at the same locations;
- absence of comprehensive analyses of trends, fuel types, seasonality, and dominant fire spread directions.

Without a unified, spatial, and up-to-date data system, the processes of planning, risk assessment, and preventive action remain limited and insufficiently evidence-based.

In regards to financing, the fire protection system in Serbia is predominantly oriented toward the response phase, while preventive activities receive minimal funding. Although certain segments of prevention—such as the construction and maintenance of firebreaks—are financed, overall investments remain insufficient. Most available resources continue to be directed toward response while preventive activities are minimally supported. There are no clearly defined budget lines for key preventive interventions, which significantly limits the possibility of systemic landscape fire risk management. The absence of structured financing for these activities results in prevention remaining sporadic, insufficiently planned, and largely dependent on short-term local initiatives.

Although administrative boundaries are important for system organisation, in practice landscape fires do not recognise such divisions, which requires much broader and more consistent regional and cross-sectoral coordination.

However, one of the key challenges is the insufficient integration of meteorological data into operational planning. Even though the Republic Hydrometeorological Service regularly monitors the Fire Weather Index (FWI), these data are not used in real time nor systematically incorporated into local-level risk assessments.

Protected areas, as well as other sensitive regions, do not have their own meteorological stations providing information on humidity, temperature, and wind, which further reduces the ability to accurately assess risk and respond in a timely manner.

This is further compounded by the insufficient integration of scientific and research institutions into the fire management system. Instead of incorporating scientific analyses, forecasting models, and modern methodologies into operational assessments, the system largely relies on the experience of field services and existing administrative practices. Universities, research institutions, and protected area managers possess relevant data and expertise, yet no formal mechanism exists to enable their systematic inclusion in decision-making processes.

Operational challenges are further intensified by incomplete records and the inconsistency of cadastre data with actual field conditions. A large number of parcels registered in the cadastre as meadows, pastures, or other agricultural land have, over the years, become overgrown with forest and shrub vegetation, thereby turning into high-risk fire areas. However, they are not formally included in forest management plans nor in preventive measures applied to state-owned forests. This creates “grey zones”—areas without clear institutional responsibility, especially in conditions of mixed ownership and insufficient coordination between the cadastre, local governments, and protected area managers.

Insufficient spatial integration of data further exacerbates this challenge, as the real estate cadastre is not connected with forest management plans, spatial plans, vegetation maps, or satellite data. As a result, planning documents often rely on outdated or incomplete information, which directly affects the quality of risk assessments and the operational planning of fire protection measures.

Although the Republic Geodetic Authority is developing digital tools such as the “Smart Parcel” concept—which enables the integration of data on land use, vegetation, and the degree of overgrowth—these tools are still not linked with forestry, planning, or meteorological systems. If such integration were to take place, it would be possible to obtain a more reliable and dynamic picture of fire risk at the level of each individual parcel, significantly improving the planning and implementation of preventive activities in the field.

As Serbia seeks to improve its fire prevention strategies, this chapter aims to provide an overview of the strengths and weaknesses it faces in its efforts to protect its landscapes from the hazards of landscape fires.

Strengths

- Well-organized legislative framework providing a basis for effective fire management.
- Regular updates from the Republic Hydrometeorological Service (RHS) to relevant institutions during the fire season on weather conditions that pose a risk for landscape fires.
- The existence of separate fire information systems
- Public awareness initiatives promoting fire prevention measures during the summer season.
- Extensive research and studies on landscape fire management.
- A model for predicting forest fire occurrence is currently under development.
- The Republic Geodetic Authority is developing digital tools such as the “Smart Parcel” concept

Weaknesses / Limitations

- Lack of harmonization between laws and insufficient enforcement.
- Insufficient awareness and engagement of local communities regarding the importance of fire prevention, as well as limited promotion of socially responsible behaviour.
- Absence of a unified fire information system with a standardized methodology.
- Insufficient number of specialists in landscape fire management at the regional level.
- Overlapping responsibilities between institutions, potentially causing confusion and inefficiency.
- Fragmented forest ownership hindering effective forest management.
- Inefficient intersectoral communication, obstructing collaboration and joint decision-making.
- Inadequate penal policies.
- Lack of “lessons learned” from past fire incidents.
- Absence of regulations addressing abandoned land overgrown with combustible material posing a fire risk.
- Lack of regulations and measures for fuel management.
- Depopulation and aging of rural populations.
- Outdated property cadastre.
- Extensive agricultural practices such as burning crop residues.
- Trend of abandoning traditional practices, such as livestock grazing.
- Climate change.
- Afforestation with conifer species in habitats unsuitable for them.
- Frequent changes in the political environment (political instability).
- Insufficient forest openness (lack of accessibility and visibility).
- Undefined financing of preventive measures
- Energy infrastructure as an increasing source of fire risk
- Insufficient interdisciplinarity in the development of planning documents and risk assessments
- Narrowly defined requirements for obtaining a fire protection licence

Despite notable progress in fire prevention, significant gaps still limit the effectiveness of measures and protection systems. Inconsistencies in legislation and insufficient enforcement, coupled with the absence of a comprehensive approach to fire management, remain serious challenges. Moreover, limited education, awareness, and engagement of local communities, along with insufficient promotion of socially responsible behaviour, reduce support for fire prevention efforts. Additional obstacles include inefficient intersectoral cooperation, overlapping institutional responsibilities, and an outdated cadastre, all of which impede proper management and risk assessment. The lack of regulations and measures for fuel management, as well as the absence of a unified fire information system, further affect coordination and response speed.

In addition to professional personnel, it is essential to develop local community resources by engaging residents through municipal and local authorities, in collaboration with civil society organizations. Special attention should be given to establishing and supporting volunteer fire brigades through awareness campaigns, education, training, and financial and organizational assistance. Collaboration with environmental and nature protection organizations is equally crucial. All local resources should be accurately mapped at local, regional, and national levels—including volunteer fire brigades and civil society organizations—and integrated into operational networks to enhance their effectiveness, particularly in fire prevention.

Financial support for these activities should be secured from the budgets of the Republic of Serbia, autonomous provinces, and local government units, to fund programmes or fill gaps in resources for initiatives of public interest that are vital for fire prevention, awareness-raising, and fostering responsible behaviour. Other ongoing challenges include extensive agricultural practices such as residue burning, depopulation and aging of rural populations, and variable climatic conditions that increase fire risk. The practice of afforestation with conifer species in unsuitable locations also represents a long-term issue, alongside the shortage of skilled personnel essential for effective management and prevention.

These shortcomings underscore the need for a comprehensive approach that integrates multiple sectors and focuses on the proper regulation and implementation of preventive measures. Enhancing the legislative framework, improving communication and cooperation between institutions, raising public awareness of the importance of fire prevention, and introducing the Landscape Fire Management (LFM) approach into formal and informal education are all key steps toward strengthening long-term landscape fire management capacities. Integrating LFM principles into educational curricula—particularly in forestry, ecology, environmental protection, agriculture, and emergency management—would help develop a skilled workforce with a holistic understanding of the interactions between ecosystems, human activities, and fires.

Preparedness

Preparedness in landscape fire management is essential for minimizing risks and ensuring an effective response when fires occur. Preparedness involves pre-planned activities and capacity building that enable a rapid and efficient response to fires, including training, logistical readiness, clear protocols, and the allocation of responsibilities among relevant actors.

Readiness, adequate equipment, and infrastructure are crucial for successfully protecting lives and property, particularly during large-scale firefighting operations and subsequent restoration efforts. Therefore, it is necessary to enhance the capabilities and technical resources of firefighting units, as emphasized in the Fire Protection Strategy. Challenges include limited accessibility due to insufficient road networks, difficult terrain in affected areas, lack of water sources and supporting infrastructure, and financial constraints that hinder the adoption of modern technological solutions.

Additionally, the early fire detection system is underdeveloped, and operational plans are lacking among many forest users. Inadequate personnel training, the absence of systematic education, and limited media coverage of fire protection topics further reduce the capacity for preventive action. These shortcomings

highlight the need to strengthen the preparedness component within the landscape fire management system.

It is important to emphasize that the system for responding to landscape fires in Serbia is largely organized according to the administrative boundaries of municipalities, cities, and districts, rather than according to divisions that follow the natural dynamics of risk. Since fires do not stop at cadastral or administrative lines, situations frequently arise in which several municipalities—or even districts—respond separately, without predefined joint tactical plans, exercises, or resource-sharing models. This is particularly evident in areas with high cumulative risk (e.g., Tara – Zlatibor – Mokra Gora – Višegrad – Srebrenica), where territorially and operationally connected response is essential. In practice, this lack of regional coordination leads to delays in interventions, higher costs, and greater material damage, as units from neighbouring districts are mobilized only after the fire has already developed into an advanced stage.

Examples from the region, particularly from Croatia, demonstrate that it is possible to establish effective models of regional cooperation based on joint, preventive, and synchronized deployment of multiple firefighting units in cases of reported potentially dangerous fires in high-risk zones. This approach is built on the idea that early, simultaneous engagement of a larger number of units is far more economical and efficient than later mobilization once the fire has already spread over a larger area. Statistics from such systems show that a rapid, coordinated, and sufficiently strong initial attack significantly increases the likelihood of containing a fire in its early stages, thereby reducing costs, risks, and the duration of interventions. These practices have already been recognized in parts of the region as effective and accepted as part of a non-normative but functional operational model.

These experiences suggest that, in Serbia as well, establishing regional operational zones, joint plans, and predefined protocols for coordinated response could significantly strengthen the landscape fire protection system.

Although the previous section highlighted that administrative boundaries do not represent real boundaries for fire spread and that effective management is possible only through regional and cross-sectoral cooperation, there remains a significant lack of basic operational tools that would enable such cooperation in practice. National reports, plans, and strategic documents exist, but field-level tactical maps are missing—maps that would include access roads, water intakes and other water sources, vegetation typology, logistical points, and critical zones.

Such maps are not used by local firefighting units nor by protected area managers, which substantially prolongs response times at the moment a fire breaks out: units must first identify access routes and water sources instead of immediately engaging in tactical action. The absence of field databases and joint operational maps further complicates coordination between municipalities, districts, and neighbouring management structures, especially in cases where fires cross administrative boundaries.

Serbia is in the process of implementing the universal “112 Emergency Call System,” which aims to enable coordinated and efficient intervention and assistance in emergency situations, in line with European Union standards and practice. This system requires well-defined operational procedures, adequate technical infrastructure, enhanced operational readiness, and trained personnel meeting European standards. However, the 112 system is not yet fully functional. Despite existing technical preparations and the regulatory framework, its full implementation and the integration of all relevant services are still pending. Once fully operational, the system is expected to significantly improve coordination, reduce response times, and increase the effectiveness of interventions in landscape fire situations and other types of emergencies.

Based on an analysis of strengths, weaknesses, threats, and opportunities in fire preparedness, it is clear that Serbia has a solid foundation for further improvement of its landscape fire management system.

Strengths

- Existence of a Risk Management Administration as well as organizational units at the local government level within the structure of the Ministry of Interior (MIA).
- Availability of qualified human resources.
- Existence of an interactive digital database providing real-time risk data for specific locations. Good equipment and the existence of early fire detection systems, but only within certain organizations
- International cooperation through knowledge and resource exchange.
- Annual subsidies from the Forest Directorate to forest users for the construction and maintenance of forest roads and fire breaks.

Weaknesses

- Absence of a unified emergency number that citizens can call in urgent situations.
- Limited accessibility to certain areas due to insufficient road networks, which may hinder the rapid and efficient arrival of firefighting personnel and equipment.
- Lack of water supply points and other supporting infrastructure.
- Inadequate response systems hindering rapid and effective fire management.
- Misalignment between spatial and administrative management and the need for regional coordination models
- Underdeveloped early fire detection system.
- Insufficient media coverage
- Limited accessibility and openness of roads in vulnerable areas.
- Lack of operational plans among all forest users.
- Absence of systematic fire protection education, resulting in insufficiently trained personnel within institutions.
- Licensing limitations

Serbia has established a Disaster Risk Registry, an interactive digital platform that provides real-time information on risks at specific locations. This resource enables decision-makers to access timely data, significantly enhancing the speed and efficiency of crisis response (22 October 2022).

Although the establishment of the Risk Register represents an important step toward strengthening the information capacities of the system, limitations remain in the application of modern technologies that would make this database even more effective in operational work, as the integration of contemporary technologies into the preparedness system is still insufficient. Although modern satellite-based early fire detection services (e.g., OroraTech, EFFIS, Copernicus) are increasingly accessible and represent a valuable resource for improving preparedness, their use has not been institutionalized within the Ministry of Interior or other competent structures. Instead of being part of prescribed procedures, these tools are used sporadically and mainly thanks to the initiative of individuals or project-based efforts. Such insufficient systemic integration reduces the potential for early warning and rapid response to landscape fires.

Despite progress in the domain of digital and spatial information, the human and institutional capacities required to use these data have not been proportionally strengthened. The existing system of professional training and licensing in the field of fire protection in Serbia is not sufficiently adapted to the specific characteristics of forest and other landscape fires. In the training materials used for preparing members of volunteer firefighting units, as well as in the manuals for professional fire protection examinations, topics related to fires in natural and rural areas are included only minimally—typically as one or two

short segments without concrete models, procedures, tactics, or risk analyses relevant for operations in different vegetation types and terrains.

Although there is a clear training structure—consisting of theoretical and practical components for volunteer units and a separate fire protection exam for those performing fire protection duties—these programs are largely based on the technical aspects of fire safety, while the specific elements of landscape fire management remain insufficiently developed. As a consequence, planning documents and risk assessments are often prepared without a deeper understanding of natural processes, fire behaviour in vegetation, meteorological influences, and the principles of managing the early stages of landscape fires.

In regards to expert licensing, the current legal framework favours technical and technological disciplines, while other relevant fields—such as atmospheric physics, biotechnical sciences, or forestry (which is formally categorized under technical and technological sciences)—do not have sufficiently prominent status in the qualification process for fire protection managers. In this regard, there is room for refining regulatory provisions so that fields such as physical sciences are adequately recognized within the licensing system.

In summary, Serbia possesses important prerequisites for effective preparedness — qualified professional staff, existing emergency management headquarters, interactive real-time digital risk databases, and accessible early detection systems and statistical data that can support forecasting and planning. However, these advantages remain only partially utilized due to insufficient compliance with legal obligations, limited training and systematic education, weak media and public awareness, uneven equipment levels at the local level, and the absence of a strategic approach to workforce renewal.

A particular challenge is the insufficient integration of modern technologies into operational procedures, as well as the limited influx of young professionals, which threatens the long-term sustainability of the system. For this reason, it is essential to strengthen continuous training, introduce the LFM concept into formal education, develop mentorship programmes, and improve cooperation with universities and schools.

For the preparedness system to fully fulfil its role as a key component of landscape fire management, coordinated efforts across all sectors are needed — from improving technical equipment and human capacities to integrating technological tools and strengthening public awareness — in order to ensure timely, coordinated, and effective response to increasing risks.

Preparedness along with prevention is the cornerstone of the landscape fire management system. By enabling timely, coordinated, and effective responses, it substantially reduces risks to the environment, property, and human safety, forming the foundation for a resilient and adaptive approach to fire management in Serbia

Fire suppression

Landscape fire suppression encompasses a range of approaches and techniques aimed at controlling and extinguishing fires. By combining various methods—such as firebreaks, fuel management, aerial firefighting, deployment of ground crews, new technologies, remote detection, and inter-agency cooperation—authorities can work toward effective suppression while minimizing damage to ecosystems, property, and human lives. At the operational core of the **Sector for Emergency Management of the Ministry of Interior** are professional fire and rescue units, currently numbering 3,737 personnel. Their engagement spans multiple types of incidents, not limited to fires alone. Since landscape fire can occur anywhere, at any time, and often without warning, the department places particular emphasis on professionalism and timely response. The Rulebook on Fire Protection Organization by Fire Hazard Categories defines both the technical equipment and the number of firefighters required for each entity to ensure adequate protection.

The Helicopter Unit of the Ministry of Interior of the Republic of Serbia plays a vital role in aerial firefighting. Equipped with several types of helicopters and specialized water-carrying systems, the unit provides a rapid and effective response during wildfires in open landscapes. Their intervention is

particularly important in hard-to-reach areas and in situations where aerial support is critical to halting the spread of fire.

Volunteer fire associations are formally part of the fire protection system in the Republic of Serbia, and their legal status and operations are regulated by the Law on Volunteer Firefighting. They are citizen associations that must meet prescribed requirements regarding equipment, organization, and member training, with professional training conducted by the Sector for Emergency Management (SEM), and the Ministry of Interior issuing official certificates of competence. In practice, however, significant limitations affect their operational capacity and independent functioning. A large number of volunteer fire associations operate within the same facilities as professional fire and rescue units (FRUs), use their infrastructure, and often transfer their own equipment to the professional units. Although this cooperation model does not necessarily prevent volunteer units from functioning independently—as demonstrated by several positive examples (e.g., the Volunteer Fire Association Požega)—in practice, it often results in dependence on professional structures.

One of the most significant issues is the situation in which members or commanders of professional fire and rescue units simultaneously hold positions in the governing bodies of volunteer associations. In such cases, a formal and sometimes even successive subordination of volunteer fire associations to the Sector for Emergency Management emerges, reducing their operational autonomy and the potential for developing an independent volunteer sector—an arrangement that is not aligned with common European standards of volunteer firefighting.

On the other hand, where the leadership of a volunteer association operates independently, and relations with professional units are clearly regulated (including agreements on the use of equipment and premises), volunteer fire associations can represent a valuable resource within the preparedness and response system, particularly in local communities with limited professional capacities.

One of the key challenges in Serbia's volunteer firefighting system is the lack of genuinely operational volunteers. In many volunteer associations, most members are professional firefighters, while the number of citizens who are trained and actively involved in interventions is extremely low. This creates the appearance of a developed volunteer network, even though in practice there are no local teams capable of rapid response during the early stages of forest and vegetation fires.

Historically, the decline of volunteer firefighting during the 1990s left many associations active only formally, without conditions for operational functioning. This trend has partially continued: some volunteer associations exist mainly for auxiliary activities (e.g., servicing fire extinguishers), while their units—although formally registered in accordance with regulations—are not operational in reality.

The existing legal framework (the “Law on Volunteer Firefighting”) does not clearly differentiate between formal and operational membership, which complicates the assessment of the actual capacities of volunteer units. Although internal documents such as statutes and Volunteer Fire Service Rules prescribe different categories of members (operational, active, supporting, youth, veterans, honorary), this internal classification is not fully linked to legal obligations and is not always consistently applied.

To improve the system, future amendments to the law could consider introducing a formal definition of an operational member, with clearly defined criteria in terms of training, health capacity, and volunteer status. Additionally, clearer regulation of the status of professional firefighters within volunteer associations—allowing them to be active, but not operational members in the municipality where they are employed—could contribute to greater independence of the volunteer sector and strengthen its operational capacity.

Nevertheless, positive examples such as the Volunteer Fire Association Požega demonstrate that a well-organized and independent volunteer fire association is possible within the current system when clear leadership, integrity, and good cooperation with professional units are in place. These examples indicate that, with appropriate legal amendments and support from local communities, it is possible to significantly strengthen the role of volunteer units in landscape fire management.

Although fire suppression is the responsibility of the Sector for Emergency Management and does not fall within the scope of forest management planning, certain measures included in forest management plans can significantly contribute to and facilitate wildfire suppression (Milanović, S. 2019). The Law on Forests (Official

Gazette RS, No. 30/2010, 93/2012, 89/2015, and 95/2018 – other laws) establishes the obligation of forest owners and users to implement forest protection measures, safeguard forests and forest lands against degradation and erosion, adhere to forest management plans, and enforce other measures prescribed by the law and its by-laws. Furthermore, the law stipulates that forest users and private forest owners are responsible for protecting forests against destruction and other unlawful activities.

In practice, when fires occur on privately owned lands, state-owned forest enterprises often contribute to suppression efforts with their available human and technical resources. This is understandable given that boundaries between private and state-owned forests are not always clearly delineated in the field, which allows fires to spread rapidly to adjacent stands. In many cases, private forest owners—particularly those living far from their properties—do not participate in suppression efforts. In such situations, suppression is carried out by forest users’ services in cooperation with fire and rescue units (National Strategy for Protection and Rescue in Emergency Situations, 2011).

The strengths and weaknesses of Serbia’s fire management system with respect to fire suppression are presented in the following table.

Strengths

- Readiness and high level of expertise of the fire and rescue units within the Sector for Emergency Management of the Ministry of Interior and certain volunteer fire associations
- Training of forestry sector employees in certain organizational units
- Involvement of the forestry sector in fire suppression (public enterprises and national parks contribute with their own resources, knowledge of wildfire behaviour, and familiarity with the terrain, which enables faster and more effective response)
- Existence of a well-equipped helicopter unit for rapid response and reconnaissance (10 helicopters), as well as other modern technologies (such as drones)
- Engagement of local communities in firefighting actions

Weaknesses

- Limited accessibility of terrain due to an insufficient road network, which may hinder the rapid and effective deployment of firefighting personnel and equipment
- Lack of specialized firefighting equipment and other resources in some regions
- Lack of coordination and communication among sectors
- Members of the Sector for Emergency Management are also members of firefighting associations, which makes the overall number of firefighters appear unrealistic
- Insufficient human resources
- Volunteer fire associations – a potentially significant resource, but with pronounced systemic limitations
- Lack of operational volunteers and the formal existence of volunteer units

An analysis of strengths and weaknesses in fire suppression, as well as identified threats and opportunities, shows that significant challenges continue to limit system efficiency. The network of professional and volunteer firefighting units, trained personnel within the forestry sector for initial fire suppression, and available technical capacities provide a solid foundation on which further progress can be built.

However, shortcomings such as the lack of specialized equipment and rapid-response vehicles in high-risk regions, limited use of modern technologies like drones and satellites, and insufficient coordination and communication among sectors, continue to affect the speed and effectiveness of interventions.

Effective landscape fire management in terms of response requires a systemic approach that integrates modern equipment, trained personnel, and functional intersectoral cooperation. Although Serbia has

established solid foundations, further progress depends on continuous modernization, better use of available financial and technological resources, and a strategic shift toward prevention as the most cost-effective and sustainable form of protection.

Post-fire management

Landscape fire management does not end with suppression. Once the flames are extinguished, it is essential to secure the resilience of both communities and ecosystems. Post-fire management represents another crucial component of the fire protection system, as it encompasses measures that enable the recovery of affected areas, prevent soil degradation, and reduce the risk of future fires. In the face of increasingly frequent landscape fires that threaten natural resources and local communities, it is vital to strengthen rehabilitation systems through professional restoration techniques, continuous monitoring, and the engagement of stakeholders from different sectors, including local authorities, NGOs, and community organizations.

An integrated approach that brings together technical, ecological, and social dimensions of post-fire management allows not only for faster recovery but also for the development of long-term resilience. This involves a combination of reforestation, erosion control, habitat restoration, risk monitoring, and community education. Only such a holistic approach can contribute to creating a sustainable, safer, and fire-resilient landscape.

It is important to underline that this process cannot be reduced to mere technical remediation of damages. Post-fire management must include mandatory ecological assessments and formal environmental impact evaluations to ensure long-term sustainability and preserve ecological balance. Special attention must be given to protected natural assets, ecologically significant areas, and sites forming part of ecological networks (e.g. Natura 2000, Emerald Network, IBA, IPA, PBA, OECM). Neglecting this perspective risks implementing remediation measures that may inadvertently harm biodiversity, degrade habitats, or undermine natural values.

The integration of ecological assessments into post-fire management offers the advantage of identifying risks in time and undertaking adequate measures for protection and restoration. Conversely, their omission can lead to long-term ecological damage and the irreversible loss of natural resources. Compared to fire prevention and suppression, post-fire management receives significantly less attention (Barbati et al., 2009). Yet, its importance is evident.

In Serbia, landscape fires are still largely viewed as emergency events requiring intervention, and far less as complex ecological and economic risks with long-term consequences. Within the existing system, there are no nationally harmonized criteria or methodologies for assessing damage to biodiversity, land degradation, CO₂ emissions, loss of forest resources, nor for evaluating economic impacts such as restoration costs, loss of yields, effects on tourism, or damage to infrastructure.

In addition to the absence of specific assessments for protected natural areas, Serbia also lacks comprehensive, general damage assessments for forest, agricultural, rural, and urban landscapes, which prevents a realistic understanding of the overall consequences of fires at the national level.

Such data are essential for informed decision-making in the domain of prevention, climate change adaptation, and economic justification of investments in preventive measures, early detection, and systemic preparedness. Without such analyses, the system remains oriented primarily toward reaction rather than strategic risk management.

It is important to note that modern scientific work in this area has been initiated and according to findings from the scientific article *Monitoring post-fire forest scars in Serbia using Sentinel-2 satellite data*, Europe records more than 65,000 forest fires annually, burning an area of around half a million hectares. The proposed method for monitoring forest scars in Serbia combined spectral and textural characteristics of land cover types within post-fire study sites. The study examined the optimal combination of features

for mapping land cover after fire, as well as the stability of the BAIS2 index across the vegetation period from May to September. This methodological approach was successfully tested for assessing vegetation recovery on contrasting post-fire sites. The method can be considered an improvement on recent studies classifying burn scars and could also be applied to other temperate regions. It may support the evaluation of vegetation response to fire and contribute to effective restoration. These findings can also inform forest management planning and guide reforestation measures (Brovkina O. et al., 2020).

Under the Serbian Law on Forests, forest owners and users are obliged to restore fire-affected areas by adopting a rehabilitation plan. These post-fire rehabilitation plans include both short-term and long-term measures to mitigate fire impacts, as also outlined in the Fire Protection Strategy of the Republic of Serbia. It is worth noting that, prior to the 2018 amendments, Article 16 of the Law on Fire Protection required the adoption of a Remediation Plan for eliminating the consequences of fire. However, this article was removed in the updated version of the law.

The strengths and weaknesses of Serbia's fire management system, in relation to the rehabilitation of burned areas, are presented in the following table.

Strengths

- Availability of significant capacities for seedling production
- Existence of legal frameworks and planning documents for post-fire management
- Availability of professional staff within public forest enterprises preparing legally required rehabilitation plans
- State support within available resources

Weaknesses

- Insufficient funding for post-fire restoration
- Lack of adequate planting material (in terms of species and quality) to implement forest rehabilitation plans
- Inadequate monitoring protocols, data collection methods, and analytical tools may limit the ability to assess the long-term impacts of interventions
- Untimely interventions to mitigate post-fire hazards. Delays in implementing management measures can exacerbate erosion, sedimentation, and other post-fire impacts, making recovery more difficult
- Inefficient coordination and cooperation among stakeholders—including government agencies, NGOs, private landowners, and local communities—which can result in duplication of efforts and conflicts over management priorities
- Limited experience in post-fire landscape rehabilitation
- Insufficient scientific research in this field
- Lack of mandatory environmental impact assessments for landscape fires, particularly in protected and ecologically sensitive areas.
- Absence of nationally harmonized criteria and methodologies for biodiversity damage assessment
- Lack of analysis of ecological and economic consequences

Based on the analysed strengths and weaknesses in post-fire management, it is clear that Serbia possesses certain potential for effective rehabilitation of affected areas, primarily due to the existence of a legal framework, professional capacities, and state support. Additionally, the availability of seed and planting material provides a solid foundation for recovery.

However, the rehabilitation process is constrained by numerous shortcomings, such as incomplete fire records, lack of experience and post-intervention monitoring, as well as insufficient scientific research to support evidence-based decision-making. Furthermore, there are serious threats, including shortages of qualified personnel, risks to biodiversity, and the selection of unsuitable species for reforestation.

Given the limited experience in the rehabilitation of burned areas and insufficient research in this field, it is necessary to particularly strengthen intersectoral cooperation, involving not only the public sector but also civil society organizations that combine activism and expertise, as well as the academic community, which can contribute through both scientific research and concrete, evidence-based proposals for post-fire rehabilitation.

Post-fire management must include mandatory environmental impact evaluation, especially in protected natural areas and ecologically significant sites. Given the specific risks to which these areas are exposed, such evaluations must be legally required, along with the preparation of environmental damage reports and restoration plans. These reports should be aligned with the Law on Nature Protection and the Law on Environmental Impact Assessment, with the Institute for Nature Conservation and the Ministry of Environmental Protection included as mandatory actors in the assessment and approval of measures.

In this context, the way forward is to make the most of available opportunities—especially EU funding—and to tailor reforestation efforts to local climatic conditions. By taking a strategic approach that includes staff training, better monitoring, scientific guidance, and careful selection of plant species, it is possible to build systems that strengthen landscape resilience to landscape fires and support the long-term health and stability of natural ecosystems.

IX Guidelines for Landscape Fire Management

Effective landscape fire management is essential for protecting communities, ecosystems, and resources from the devastating impacts of fires. In recent years, marked by increasingly frequent and intense fire events, the development and implementation of comprehensive **Guidelines for landscape fire management** have become imperative.

The guidelines provide a key framework for **prevention, preparedness, response, and recovery**, enabling all relevant stakeholders—through a participatory approach in their development—to work collectively to reduce fire-related risks and ensure sustainable management of natural resources. Their purpose is to establish a foundation for **informed and effective decision-making** by enhancing the preparedness, resilience, and adaptability of the landscape fire management system.

This chapter also highlights the obstacles that hinder the implementation of effective fire protection programmes, including **insufficient inter-institutional communication, limited integration of fire management into the education system, slow administrative processes, challenges in sparsely populated areas, the expansion of neglected and overgrown lands, and the impacts of climate change.**

Against this backdrop, the set of recommendations presented is aimed at **strengthening the existing landscape fire management system in the Republic of Serbia.** It provides a clear roadmap for decision-makers, land managers, emergency services, and local communities, with the goal of enhancing resilience to fire risks, preserving valuable ecosystems, and ensuring the sustainable use of natural resources.

While conceptually it is desirable to structure the guidelines according to the phases of **prevention, preparedness, response, and recovery**, in practice, these phases often overlap. Therefore, the following list of guidelines integrates these phases, reflecting the interconnected nature of fire management activities in the field.

Promotion of fire safety education from an early age

To foster a society that prioritizes fire safety, it is essential to introduce fire management principles into the curriculum from the earliest stages of education. Integrating content on fire prevention and preparedness raises awareness of the importance of preventing fires and cultivates a sense of responsibility toward the environment.

Strengthening communication and cooperation among relevant institutions

Effective fire management in open landscapes relies on robust communication and collaboration between institutions. Good communication and cooperation enable timely sharing of information, resources, and expertise, leading to better coordination and reduced fire impacts. Efficient management requires collaboration across all phases – prevention, preparedness, suppression, and post-fire management – with

clearly defined roles and integrated data-sharing systems, as well as coordinated restoration activities in affected areas.

Clearly defined inter-institutional roles and responsibilities

Defining the roles and responsibilities of institutions is crucial for effective landscape fire management. This prevents overlapping activities, facilitates coordination and collaboration, and ensures a more rational use of resources for prevention and emergency response.

Use of media for fire prevention

Media outlets are a powerful tool for disseminating fire prevention messages. Cooperation with media platforms can help reach a wider audience and increase the impact of awareness campaigns.

Raising awareness of fire prevention

Public awareness plays a key role in reducing the risk of fires. Launching national campaigns to educate citizens on fire prevention, responsible land management, and the importance of reporting potential hazards is vital.

Development of early warning systems

An effective early warning system is a key prerequisite for timely preparedness and response to landscape fires. It enables authorities and communities to anticipate fire risk, mobilize resources, and implement preventive measures before ignition or escalation. The development of such systems should include risk modelling based on weather conditions, vegetation type, topography, and historical fire occurrence. Integration of Geographic Information Systems (GIS) and remote sensing technologies enhances spatial and temporal accuracy, supporting early alerts and informed decision-making.

Development of early fire detection systems

Early fire detection is essential for minimizing fire spread and damage. Modern detection systems rely on real-time monitoring through satellite imagery, drone surveillance, automated camera networks, and thermal sensors. These technologies enable rapid identification and verification of fire outbreaks, allowing emergency services to respond promptly and effectively. Establishing centralized digital platforms for data collection and information sharing among relevant agencies further improves coordination and operational efficiency during the initial stages of a fire event.

Enhancing inspection and monitoring processes

To detect potential fire hazards promptly, it is necessary to establish a more effective inspection and monitoring system. This includes regular assessments of fire-prone areas and the application of stricter prevention measures.

Improvement of legal framework to strengthen fire management systems

Clearly defined legislation enables the effective implementation of landscape fire protection measures and the enforcement of penal policy, providing a legal basis for the proper functioning of the system.

Construction and maintenance of forest roads

Forest roads facilitate rapid access for firefighting teams, which is crucial for timely response, efficient deployment of personnel and equipment, and reducing the time needed to localize and extinguish fires.

Systematic assessment of fire risk to define preventive measures

This approach allows for identifying the most vulnerable areas and creating operational, digital, and interactive maps, supporting rapid and effective planning for prevention and intervention.

Encouraging the leasing of abandoned or unmanaged land

Local governments and competent institutions should establish incentive mechanisms to encourage individuals, communities, and legal entities to lease and utilize abandoned or unmanaged land. The objective is to promote active and responsible land use, reduce fire risk, and support sustainable management of natural resources. Incentives may include financial or administrative benefits for maintaining land in good condition through regular vegetation management, fuel reduction, and the application of preventive fire protection measures.

Implementation of measures from forest management plans as part of fire prevention

The systematic implementation of measures defined in forest management plans plays a crucial role in reducing landscape fire risks. Well-designed silvicultural practices—such as thinning, stand structuring, selection of fire-resistant tree species, and maintenance of ecological balance—contribute to minimizing fuel loads and enhancing the overall resilience of forest ecosystems. Integrating fire prevention objectives into forest management planning ensures long-term sustainability and the protection of forest resources.

Increasing the participation of deciduous tree species in reforestation

Reforestation efforts should prioritize the diversification of tree species, with a particular emphasis on increasing the proportion of deciduous species. Such diversification helps prevent the formation of monocultures, enhances ecological resilience, and reduces landscape fire susceptibility.

Establishing an annual forum on landscape fire management

Competent institutions should explore solutions for organizing an annual forum on landscape fire management. The forum should convene experts, local authorities, landowners, and other relevant stakeholders to review and evaluate all fires that occurred during the previous fire season, assess the implementation of planned management measures, regulations, and enforcement of penal policies, identify gaps and propose improvements to the existing fire management system.

Institutionalizing the forum ensures sustained stakeholder engagement, systematic knowledge exchange, and continuous enhancement of preventive and operational capacities for landscape fire risk reduction.

Strengthening regional and international cooperation through knowledge and data exchange

Neighbouring countries and regions should establish formal agreements for data and experience sharing related to fire prevention, preparedness, and response. Such cooperation allows adoption of successful practices, more efficient resource allocation, and faster emergency response, reducing overall fire risk and damage.

Regular training of personnel in landscape fire management

Continuous training ensures that all personnel involved in land management and fire response are familiar with the latest techniques, safety protocols, and preventive measures. This practice increases professional competence and enables faster and more efficient emergency response, reducing potential damage.

Promotion of volunteer firefighting

Supporting volunteer firefighting programmes can complement existing professional units' capacities, ensuring a stronger and more effective response to fires.

Addressing property and legal issues

Well-defined legal frameworks and regulated property rights are fundamental for effective land and resource management, which is critical for landscape fire prevention and control. Clearly established owner-

ship and usage rights facilitate the planning and execution of activities such as forest road maintenance, creation of buffer zones, and controlled vegetation management. Legal clarity also mitigates the risk of disputes, ensuring faster emergency response and enhanced protection of people, property, and natural resources.

Provision of a unified landscape fire information system

The objective is to develop an integrated information system that centralizes the collection, storage, and accessibility of all landscape fire-related data. All relevant monitoring sectors and agencies would contribute to this shared database, enabling more efficient data analysis, expedited emergency response, enhanced preventive planning, and systematic tracking of trends and risks at the national level.

Joint efforts and community involvement through initiatives

Effective fire management requires collaboration among state institutions, local communities, NGOs, and scientific institutions. Community involvement is crucial not only post-fire but also in prevention and suppression, fostering a sense of ownership and promoting sustainable practices and fire awareness among the population.

Enhancing investment in scientific research

Scientific research is essential for the advancement of innovative technologies and the development of effective strategies for landscape fire prevention, mitigation, and post-fire recovery.

Provision of targeted information and education for landowners and land users

Providing forest and agricultural landowners and users with accurate information and targeted educational programmes enhances their engagement in landscape fire prevention and overall fire management, thereby strengthening the effectiveness and resilience of the entire system.

Addressing the specificities of managing burned areas in protected zones (level I protection)

Managing burned areas in protected zones requires a tailored approach, taking into account the restrictions imposed by their protected status. It is necessary to develop customized restoration plans that respect natural values, biodiversity conservation, and sensitive ecosystem functions, while simultaneously preventing the risk of fire recurrence.

State subsidies for the revitalization of burned areas (grants, tax reductions, etc.)

Government incentives can significantly facilitate the restoration of burned lands. This includes financial support, grants for reforestation or natural habitat restoration, as well as tax relief for entities involved in land rehabilitation. Such instruments promote sustainable management and accelerate the recovery of ecosystem functions.

Integrating environmental considerations in post-fire management

Current practices often prioritize material assets, such as timber or infrastructure, while overlooking ecosystem services, biodiversity, and long-term sustainability. Post-fire management should mandate environmental impact assessments, particularly for protected and ecologically sensitive areas. These assessments must be legally required, include reports on environmental damage and rehabilitation plans, and be aligned with the Law on Nature Protection and the Law on Environmental Impact Assessment. The Institute for Nature Conservation and the Ministry of Environmental Protection should be involved as mandatory evaluators and approvers of all proposed measures.

Expert involvement in species selection and availability of planting material

Effective post-fire management and rehabilitation rely on informed species selection for reforestation. Engaging forestry and biological experts helps ensure that chosen species are well adapted to local conditions, strengthen forest resilience, and reduce the likelihood of future fires. Moreover, readily available, high-quality planting material enables swift and efficient reforestation of burned areas, promoting faster ecosystem recovery and supporting biodiversity conservation.

Development of post-fire ecosystem monitoring protocols

Protocols should assess biodiversity loss, impacts on soil and water quality, as well as risks of erosion and invasive species spread.

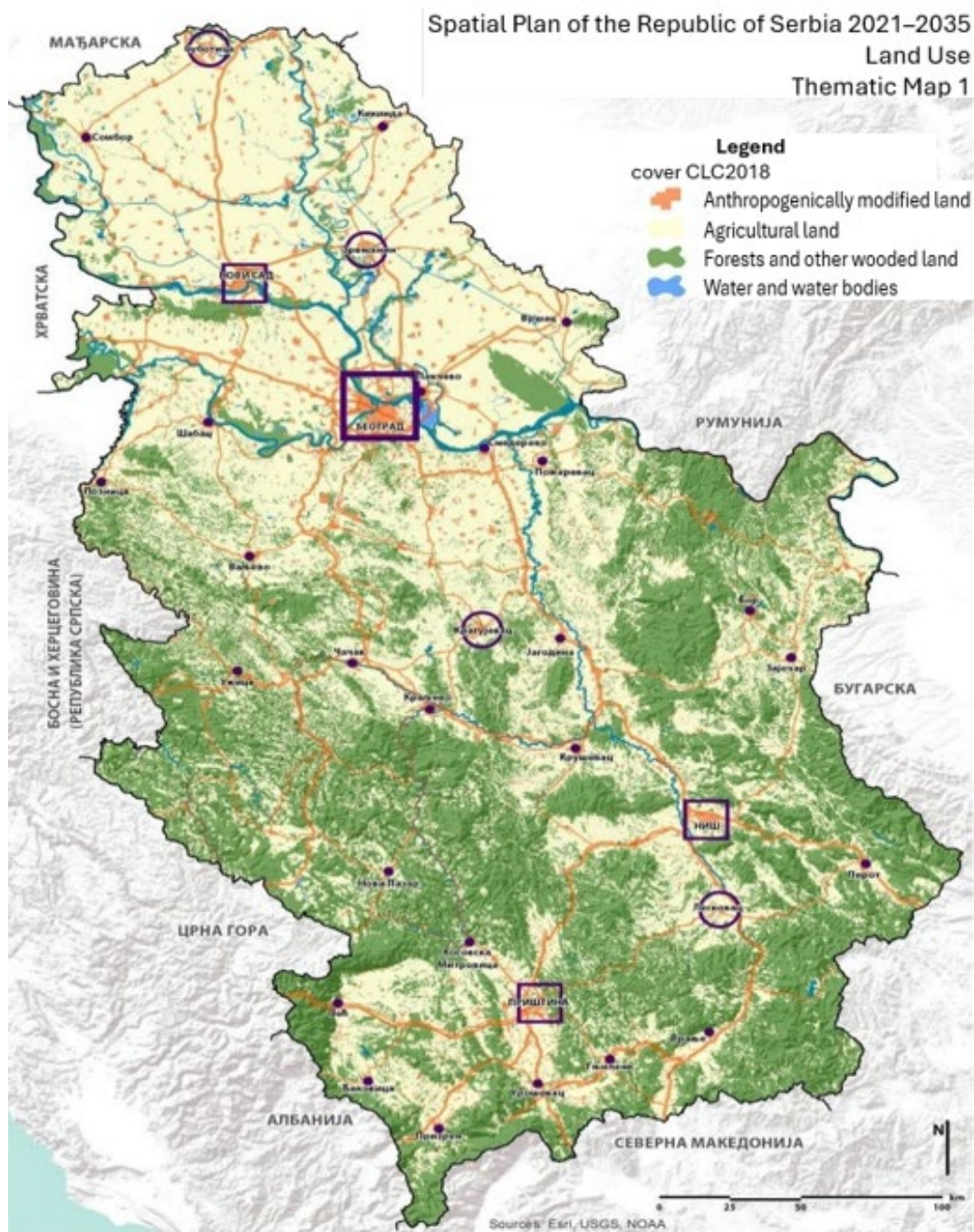
The above guidelines provide a foundation for the systematic improvement of fire management. They will be further specified through an Action Plan, which will outline concrete activities, deadlines, responsible parties, and success indicators, enabling the practical implementation of strategic objectives. The Action Plan will form an integral part of the future Landscape Fire Management Strategy in Serbia, ensuring an efficient, sustainable, and adaptive system capable of meeting contemporary challenges. This integrated approach promotes not only reactive but also preventive and adaptive fire management, aligned with best practices, modern technologies, and the need to protect people, property, and the environment.

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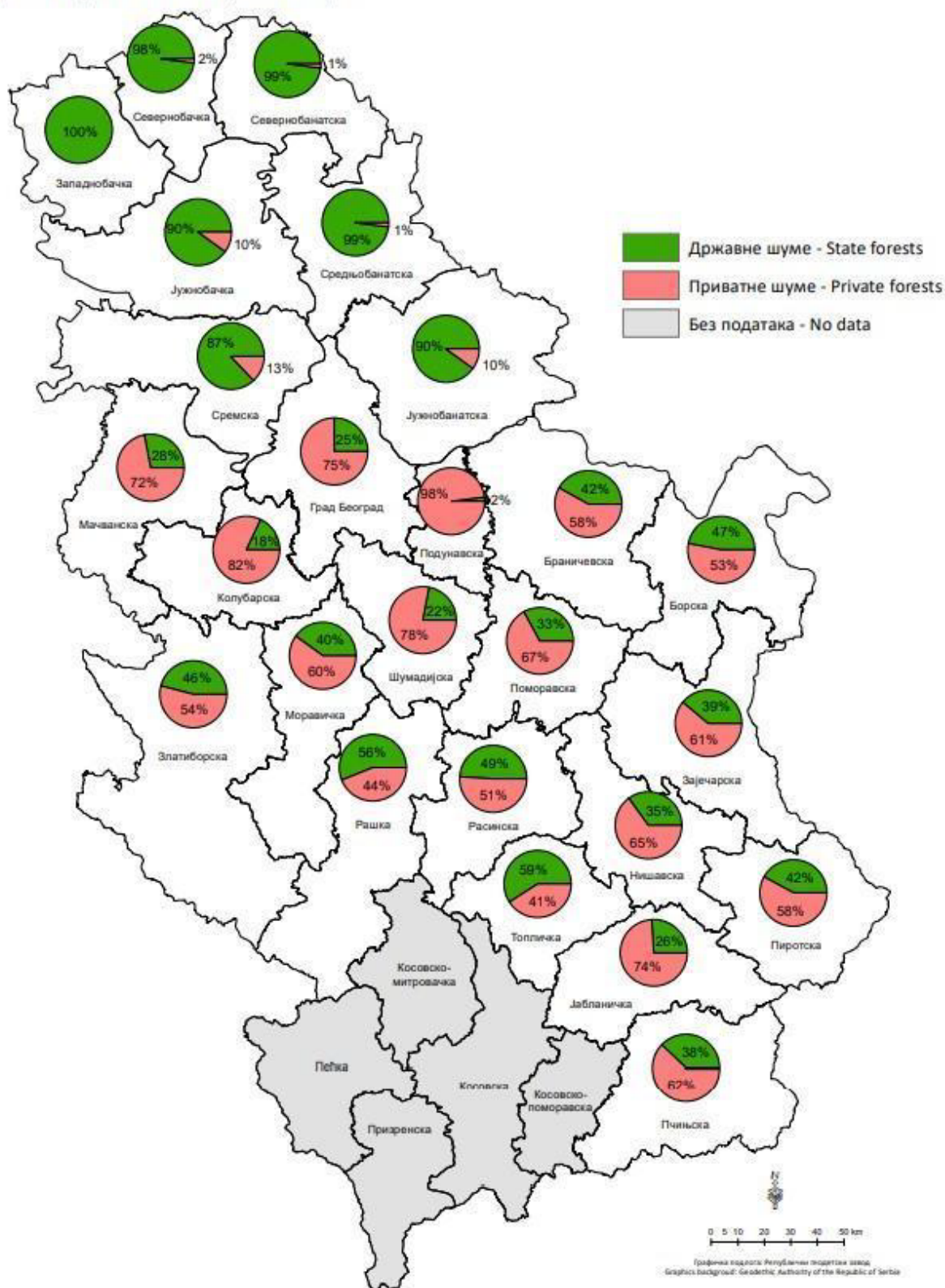
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X. Annexes (maps, tables, illustrations, graphs, etc.)

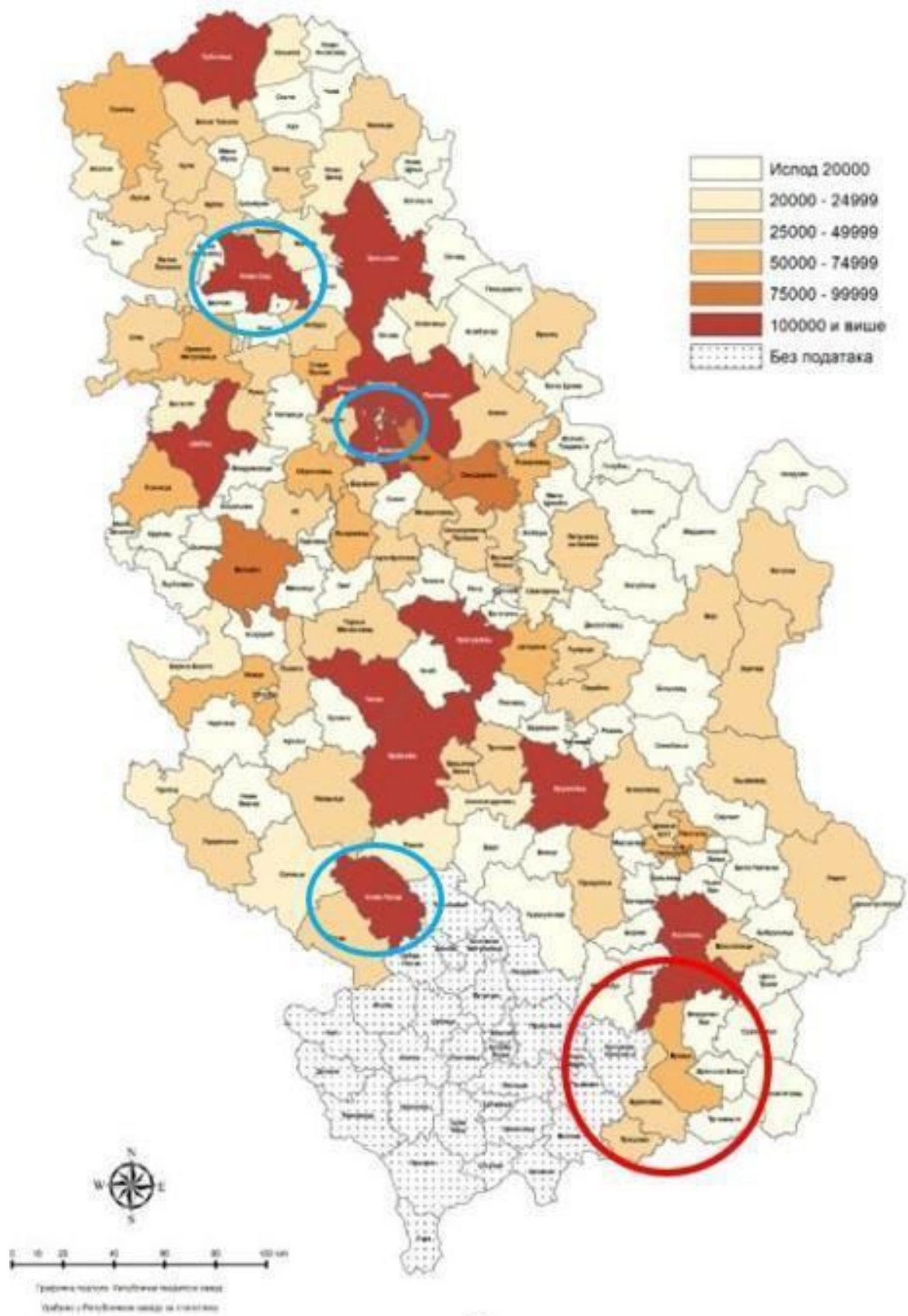


Annex1. Land use structure (Draft spatial plan of the Republic of Serbia, 2021)

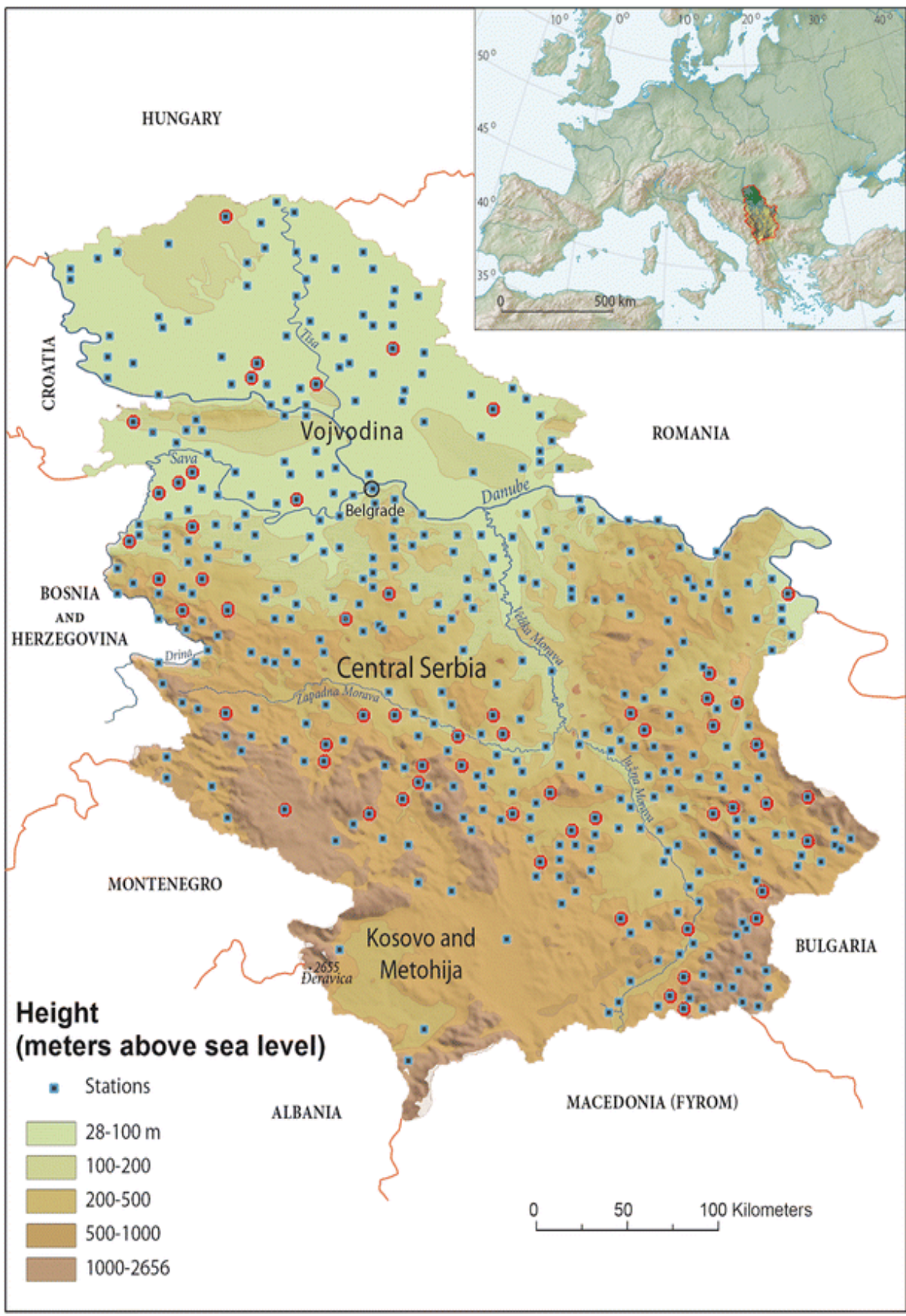
Мапа: Однос државних и приватних шума по областима, %
 Map: State and private forests' ratio by area districts, %



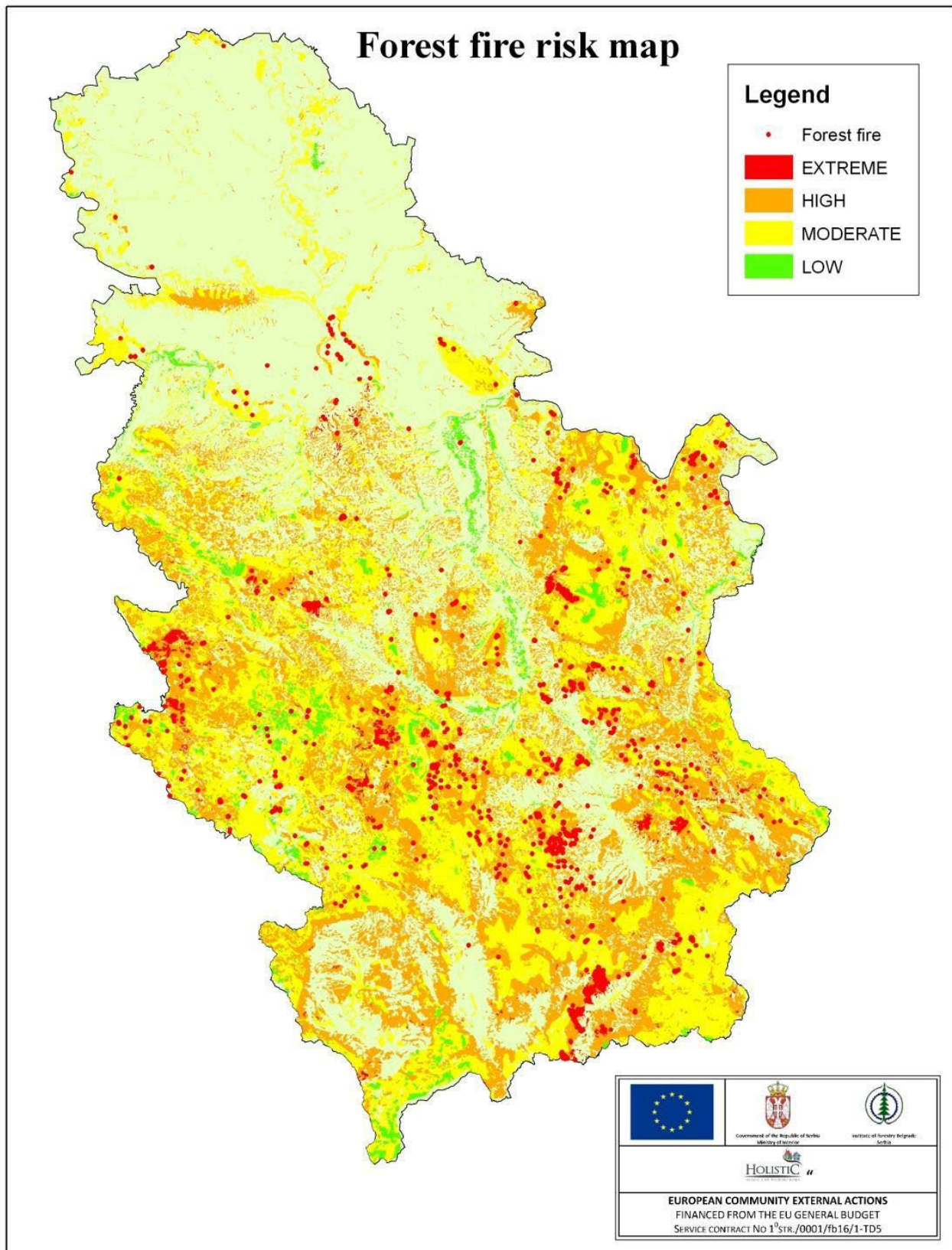
Annex 2. Ratio of state and private forests by region (Statistical Yearbook, 2021)



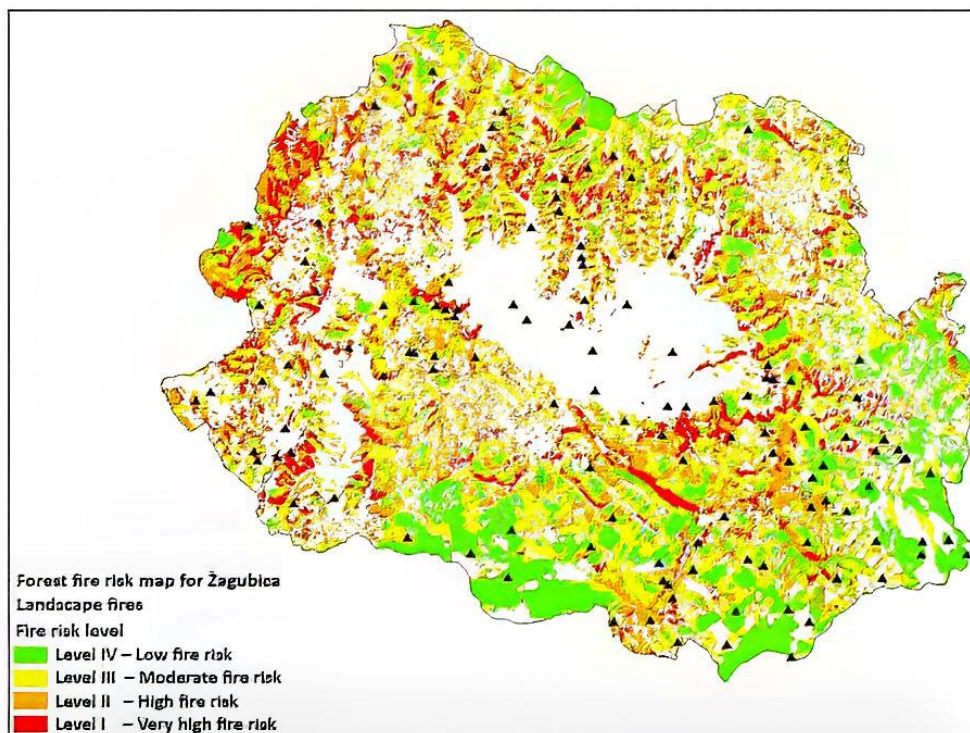
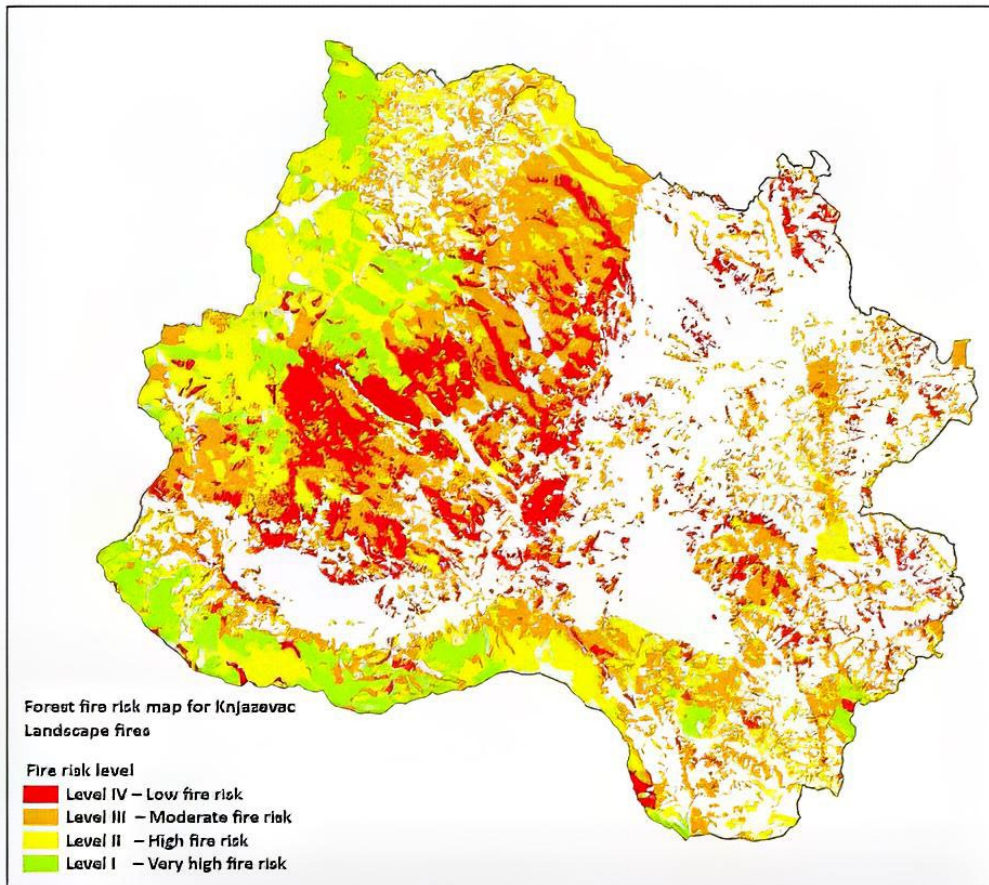
Annex 3. Municipalities with the largest decrease and increase in population (Statistical Office of the Republic of Serbia)



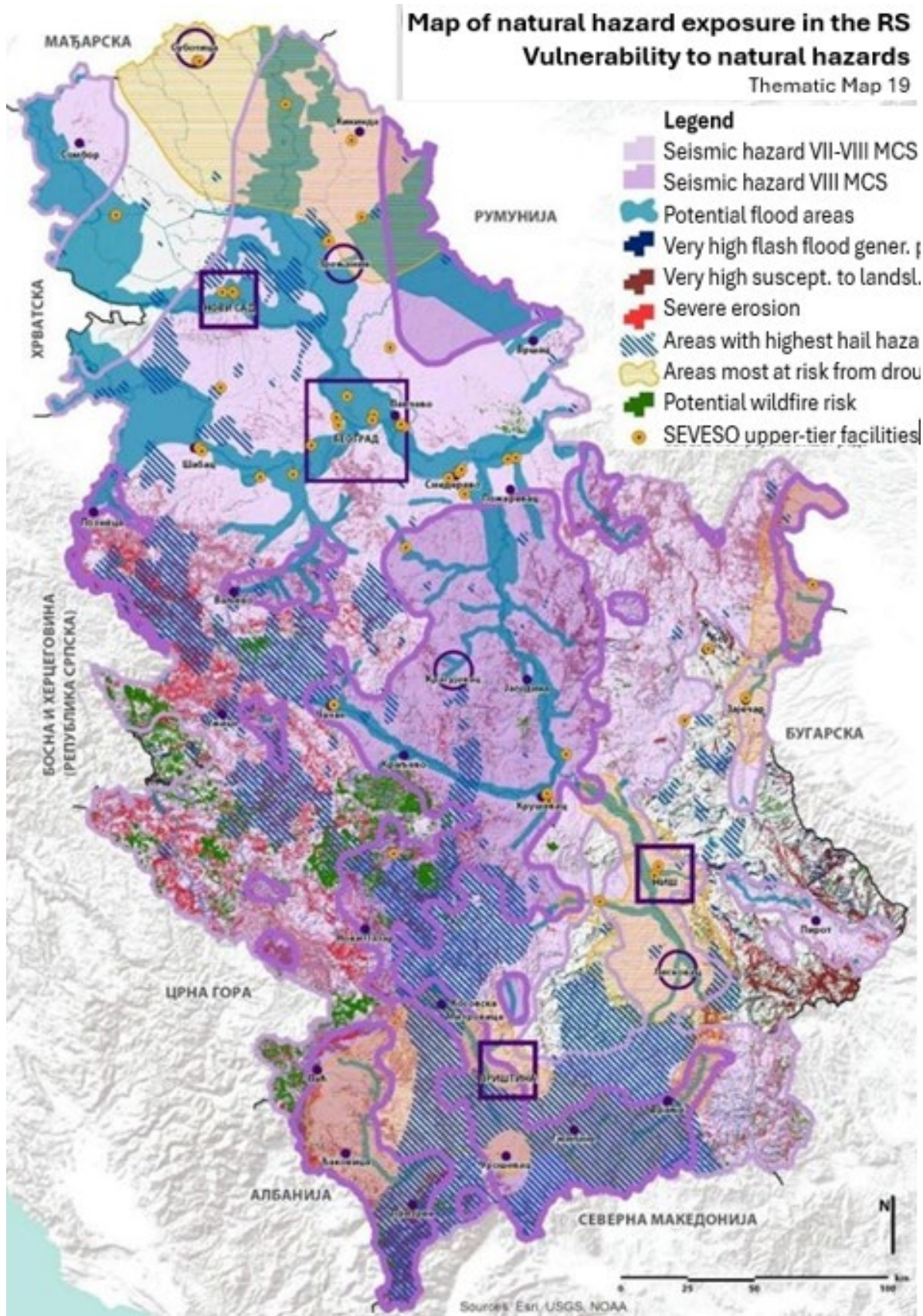
Annex 5. Relief of Serbia and location of precipitation stations



Annex 6. Forest fire risk map for the territory of Serbia



Annex 7. Forest fire risk map for the Municipalities of Žagubica and Knjaževac



Annex 8. Map of natural hazard exposure in the Republic of Serbia (Draft spatial plan of the Republic of Serbia for the period 2020–2035)

