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ШУМАРСТВА И ВОДОПРИВРЕДЕ

Regional Fire Monitoring Center - RFMC

LANDSCAPE FIRE MANAGEMENT REPORT ON THE LEVEL OF REPUBLIKA SRPSKA, BOSNIA AND HERZEGOVINA



2023

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PHARMACHEM

HELVETAS

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- Firefighters Association of Republika Srpska
- Institute of Statistics of Republika Srpska
- Ministry of Agriculture, Forestry and Water Management of Republika Srpska
- Ministry of Interior
- Ministry of Spatial Planning, Construction and Ecology
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List of Abbreviations

BAM Bosnia and Herzegovina convertible mark
BiH Bosnia and Herzegovina
CLC CORINE Land Cover
EU European Union
FSC Forest Stewardship Council
FWA Forest Wood Assortments
GHG Greenhouse gasses
IPCC Intergovernmental Panel on Climate Change
LEAP Low Emissions Analysis Platform
LFM Landscape Fire Management
NDCS Nationally Determined Contribution
NGO Non-Government Organisation
PEF Public Forest Enterprise
RS Republika Srpska
SPI Standardized Precipitation Index
UXO Unexploded Ordnance
WB West Balkan

Introduction and definitions

The countries of the Western Balkan (WB) region have gone through a period of societal, economic, and social transformation in the last three decades. 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 the 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 Republika Srpska, Bosnia and Herzegovina 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 Republika Srpska, Bosnia and Herzegovina sounding board, the LFM Network members were actively involved in a dynamic feedback process of preparation of the first Landscape Fire Management Report on the level of Republika Srpska, Bosnia and Herzegovina 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 Republika Srpska with the support of the Regional Fire Monitoring Center (RFMC) for the Southeast Europe/Caucasus Region as partners of the LFMWB Programme.

In 2023, the LFM Network members of Republika Srpska, Bosnia and Herzegovina 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 Republika Srpska, Bosnia and Herzegovina, 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 LFM report includes findings of the LFM Network members in Republika Srpska, Bosnia and Herzegovina 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 Republika Srpska, Bosnia and Herzegovina. 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 on the level of Republika Srpska, Bosnia and Herzegovina was ensured through continuous communication among the LFMWB Country Project Staff in Republika Srpska, Bosnia and Herzegovina seconded by the Ministry of Agriculture, Forestry and Water Management as a drafting person of the report as well as the LFM Network members of Republika Srpska, Bosnia and Herzegovina 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 Republika Srpska, Bosnia and Herzegovina 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.

"We owe it to ourselves and to the next generation to conserve the environment so that we can bequeath our children a sustainable world that benefits all."

Wangari Maathai

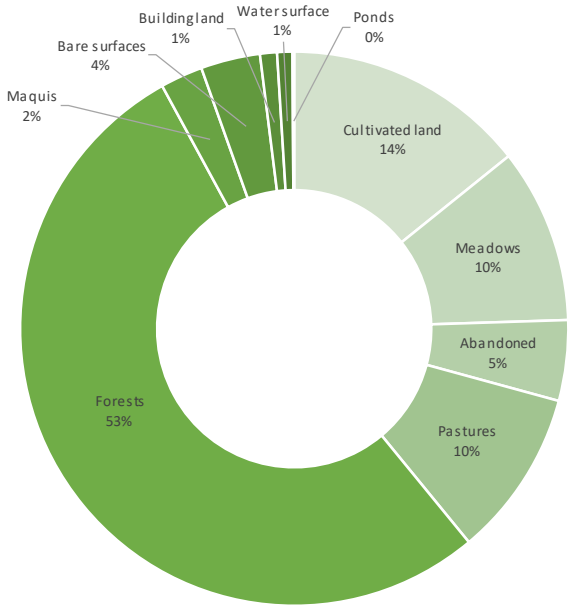
Land use

Among the most fundamental of human behaviours is the occupation and acquisition of land to sustain a livelihood. "Land use" is the term that describes the landscape patterns emerging from these activities. More formally, as the FAO describes it: "land use is characterized by the arrangements, activities and inputs by people to produce, change or maintain a certain land cover type. Land use defined in this way establishes a direct link between land cover and the actions of people in their environment." A variety of other definitions of the term land use can be found in relevant literature, but the common central theme is the concept of human intervention in the processes that shape the land.

The uncontrolled and irrational land use and environmental degradation have taken on global dimensions and objectively pose a threat to the preservation of natural resources. Therefore, the rational utilisation of overall space, especially renewable and non-renewable resources, becomes an imperative for further development.

The territory of Republika Srpkska, Bosnia and Herzegovina is situated between 42° 33' 18" N and 45° 16' 36" N, and 16° 12' 18"E and 19° 37' 44"E, that is, it covers northern and eastern parts of the geographical area of Bosnia and Herzegovina, respectively. The surface area of Republika Srpska, excluding Brčko District, is 24,641 km^2. The surface area of Brčko District of BiH, which, according to paragraph 11 of the Final Arbitrary Decision on Brčko District of BiH, is a condominium, that is, a shared territory of Republika Srpska and the Federation of BiH, is 493 km^2. (Republika Srpska Institute of Statistics)

Forests make up most of this land, with 1,314,889 hectares dedicated to forests and forest land. Of these forested areas, 23% is privately owned, with the remaining 77% being state-owned. This makes Republika Srpska an important player in the forestry industry and a key provider of resources for the region. (PEF Forests of Republika Srpska, Cadastre 2022)



Graph 1. *Land use in the RS based on the land cover map and the method of use for the year 2017:* ***Source of data:*** *The basis of the protection, use and arrangement of the agricultural land of Republika Srpska as a component of the land use planning process; Agricultural Institute of RS Banja Luka, Institute for Agrochemistry and Agroecology*

In addition to its forests, Republika Srpska also boasts a large agricultural sector, with 1,008,000 hectares dedicated to agriculture practice. Of this land, 816,000 hectares are cultivable, providing ample opportunities for crops and livestock farming. Republika Srpska is an important contributor to the local and national economy, with its agriculture sector providing jobs and supporting regional development.

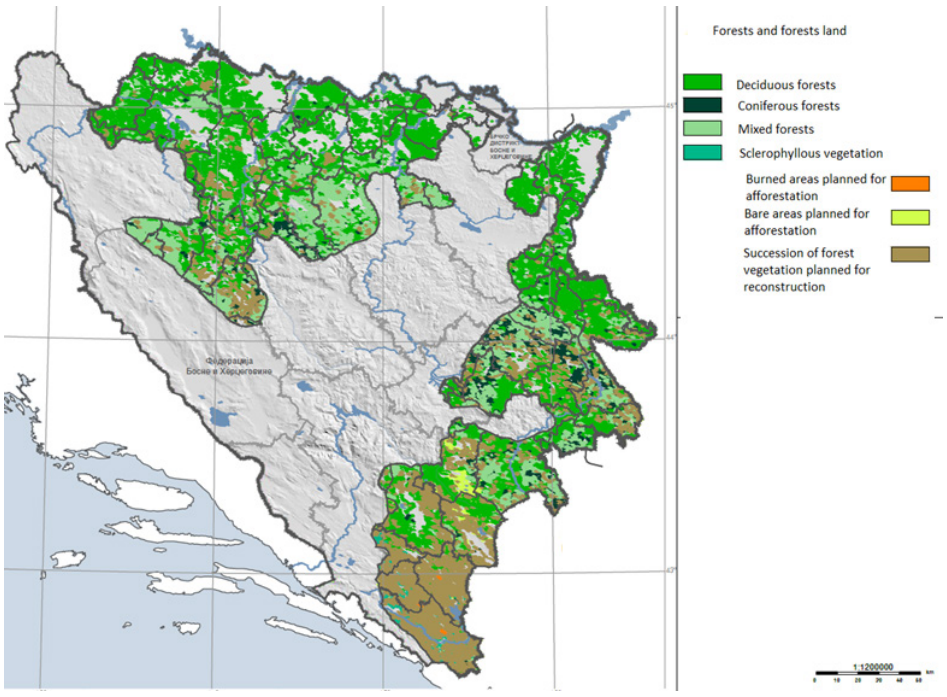
Special attention should be given to the category of land covered by maquis vegetation, which is of great importance for fires. Maquis is a type of dense Mediterranean shrub vegetation, widespread in the Herzegovina region. It predominantly represents secondary vegetation that arises after the destruction of forests. Maquis is composed of evergreen shrubs with sclerophyllous and ericoid leaves, individually low trees, as well as shrub-like forms. The height of maquis usually does not exceed 4 m. Maquis develops in biotopes that cannot support the growth of tall trees (dry and rocky slopes of Herzegovina) or in areas of anthropogenic degradation of natural evergreen Mediterranean forests.

As evident from the preceding chart, there is officially 5% of abandoned land in Republika Srpska, amounting to 1200 square kilometres. However, the situation on the ground is even more alarming as the prevalence of such abandoned land is steadily increasing.

In conclusion, Republika Srpska is a significant region in terms of land use, with a large proportion of its land dedicated to forests and agriculture. The region is well-positioned to meet the needs of its residents, with a mix of land uses that support a high quality of life. Further details on the land use of Republika Srpska can be seen in the graphs that follow.

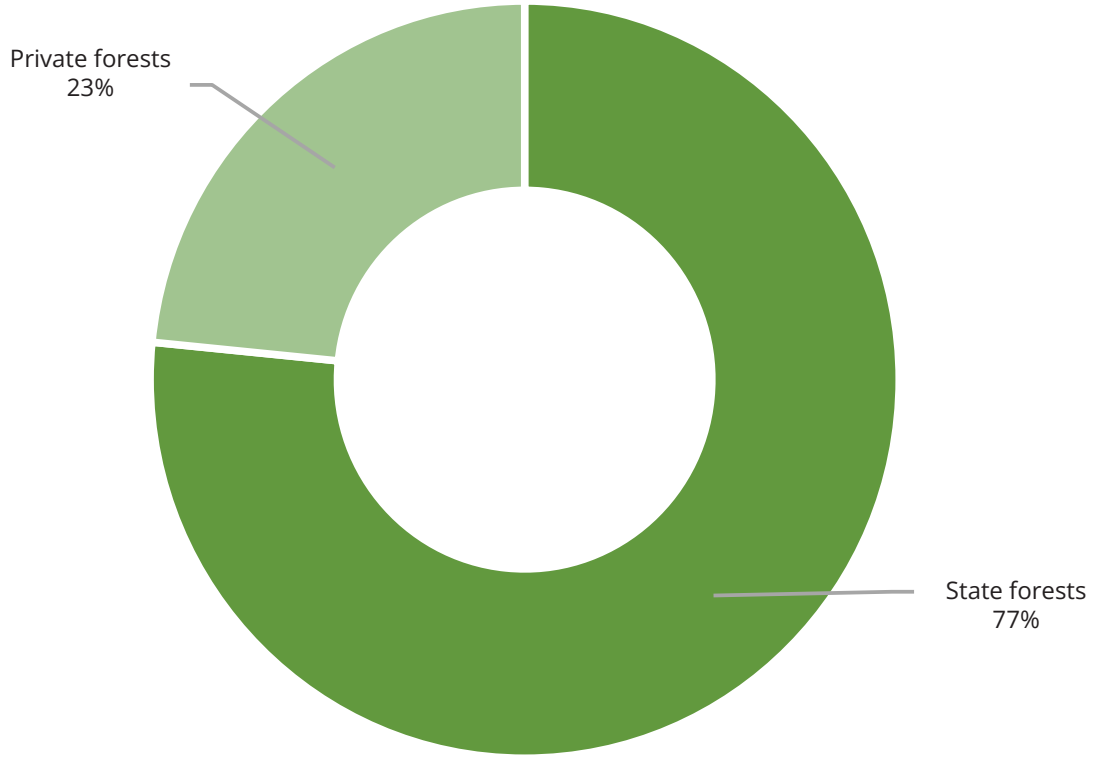
1.1. Forests and Forest Land

Forests and other forest products are among the most important natural resources of Republika Srpska. The total area of forests and forest land in Republika Srpska, according to the data of the Cadastre of Forests and Forest Land (PEF "Šume Republike Srpske" a.d, 2022) is 1,314,889 ha or 53% of the total area of Republika Srpska. Republika Srpska owns 1,011,217.69 ha (76.90%) of forests and forest land, while forests and forest land belonging to other legal and natural persons take up 303,671.78 ha (23.10%) of forest area.



Map 1: *Forests and forests land in Republika Srpska:* ***Source of data:*** *Town Planning Institute RS*

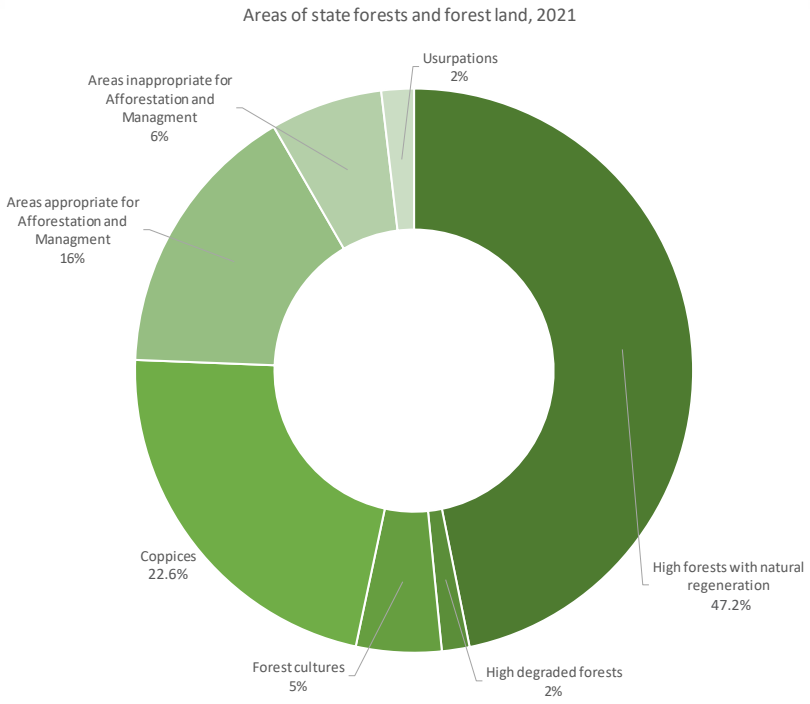
State forests account for the annual gross production of Forest Wood Assortments (FWA) of around 2,782,000 m^3, while the private forests account for about 477,000 m^3, which amount to a total of 3.259.000 m^3. The annual net production of FWA is around 2,033,000 m^3, which is mainly realized up to 100%. The share of conifers in the total production of FWA is around 45%, while the remaining 55% is made up of hardwoods.



Graph 2. *Private/state forests and forest land:* ***Source of data:*** *Cadastre of forests and forest land in Republika Srpska, PEF Šume RS*

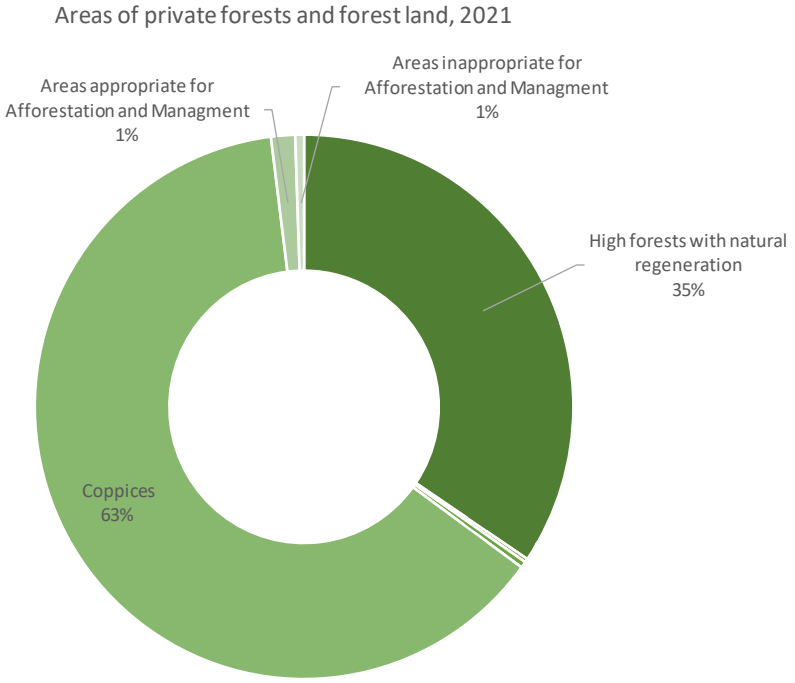
An increase of area under forests and forest land has been noted in the period 2008-2016 (data provided by the P.E.F. "Šume Republike Srpske"). The area under high, naturally renewed forests, which are forests of the highest quality, has increased by 29,426.01 ha (Programme for achieving land degradation neutrality, Banja Luka, 2018). Forests owned by other legal and physical persons are divided into 653,008 cadastral units and owned by 340,000 owners, while the area of usurped forests and forest land is 17,554 ha, or 1% (Forestry Development Strategy of Republika Srpska 2011-2021, (Ministry of Agriculture, Forestry and Water Management, 2012).

The share of high forests in the total forests of Republika Srpska is the highest (644,511 ha or 47.2%), while the coppice forests occupy 353.454 ha or 22.6% of the area. Forests owned by Republika Srpska include the forests and forest lands of three National Parks (27,059 ha or 1% of territory of RS), and industrial forest plantations (7,383 ha).



Graph 3. *Areas of state forests and forest land, 2021:* ***Source of data:*** *Cadastre of forests and forest land in Republika Srpska, PEF Šume RS*

Of the total area of cultures in Republika Srpska, coniferous cultures account for 97.31%, broadleaf cultures for 2.19%, and mixed coniferous and broadleaf cultures for 0.5%. Such a high proportion of coniferous cultures is highly unfavourable due to the significant risk of fires. (Stanivuković, 2021.)

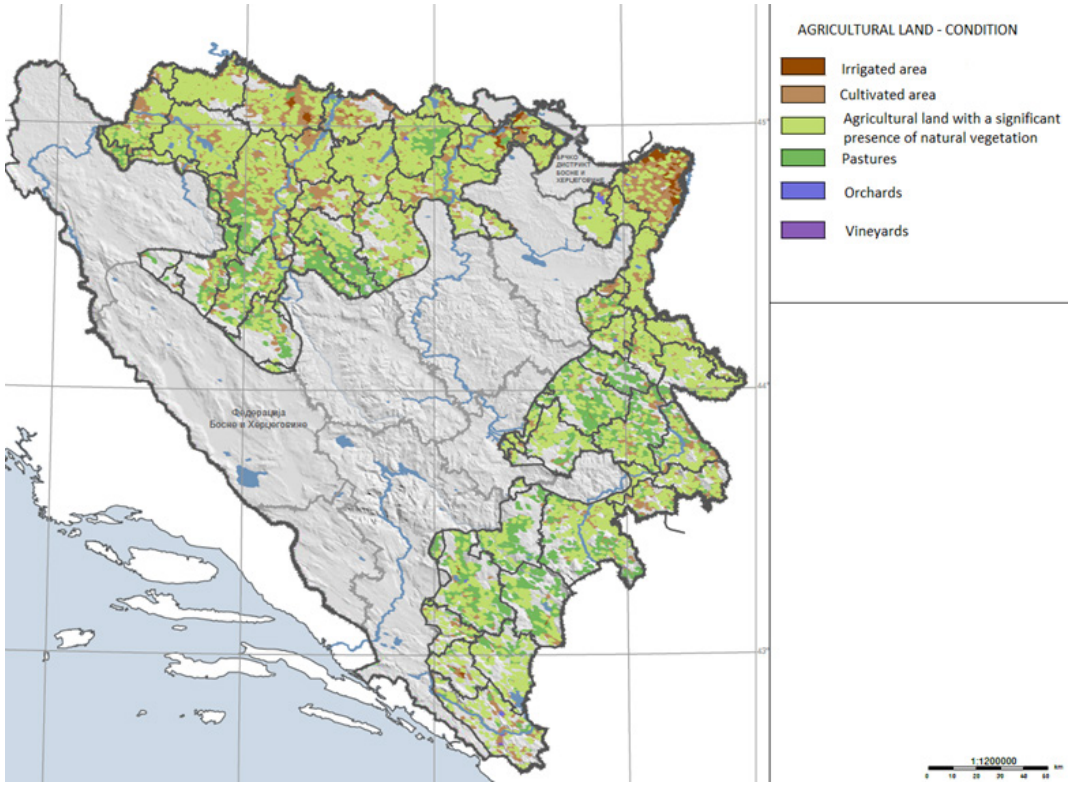


Graph 4. *Areas of private forests and forest land, 2021:* ***Source of data:*** *Cadastre of forests and forest land in Republika Srpska, PEF Šume RS*

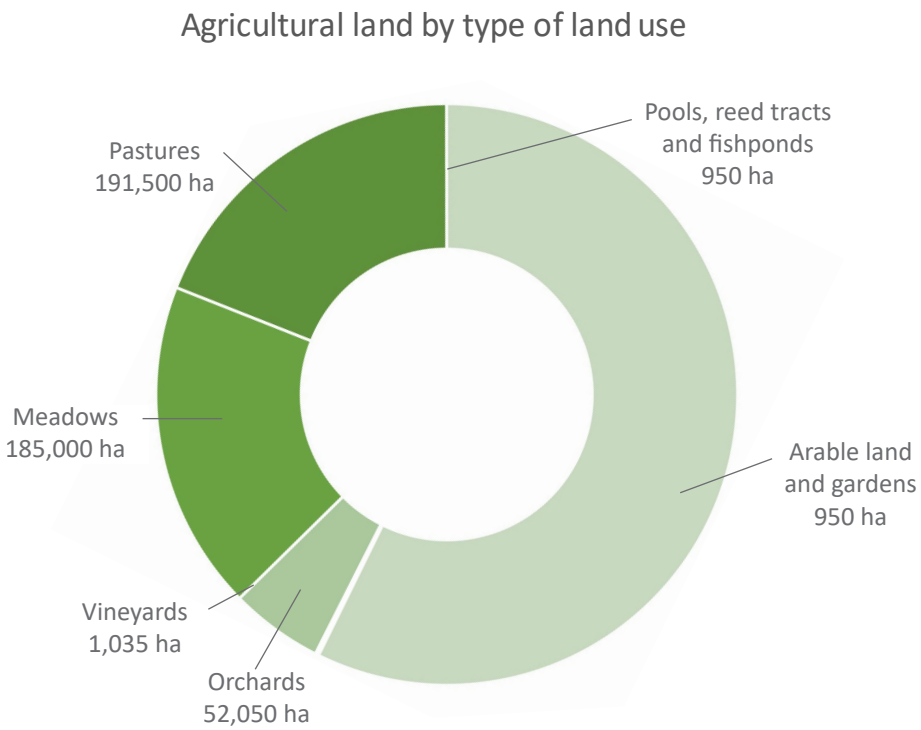
The condition of private forests is characterised by the following: large areas of coppices (about 63% of the total area of private forests), resulting from unplanned work and unauthorized logging during the past period, particularly in abandoned rural areas; minimal areas of degraded forests are being converted into a generative form of forest cultivation; utilization of habitat potentials is unsatisfactory, leading to increasing degradation and regression of cultivated forms; unresolved property and legal affairs contribute to further fragmentation of ownership, while issues of usurpation complicate management; the cadastre of private forest conditions is not organized, and timely updates of changes are lacking; spontaneous forest expansion beyond forest areas; large number of owners (0.8 ha per owner with an average cadastral parcel size of 0.45 ha); poorly defined parcel boundaries and unclear property relations as well as absence of clear demarcations between state-owned forests in Republika Srpska and private forests.

1.2. Agricultural Land

Based on the data from the strategic-planning document "Bases for protection, development and use of agricultural land in Republika Srpska as a component of the land use planning process, 2009", (Ministry of Agriculture, Forestry and Water Management of Republika Srpska and the Institute for Agriculture of RS, 2009), over the period 2002-2007, the non-agricultural area increased by 180,802 hectares, or 8%. Out of the total area under pastures, around 3.3% transitioned into the category of neglected pastures, and around 33,000 hectares were turned into non-agricultural land. There has been a significant increase in agricultural land that is not cultivated, and is typically overgrown with shrubs, succession, weeds on uncultivated land, thus resulting in what may be considered as land degradation due to lack of its natural production potential utilisation.



Map 2: *Agricultural land, current condition:* ***Source of data:*** *Institute for urbanism of Republika Srpska*



Graph 5. *Agricultural land by type of land use*

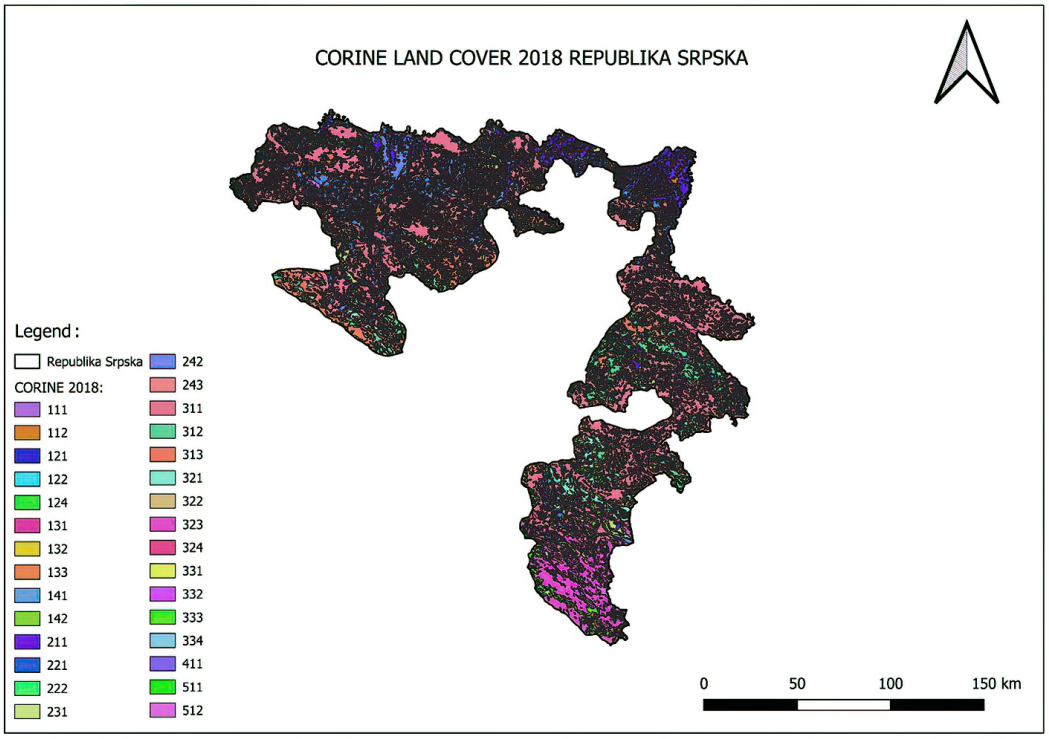
Generally speaking, Republika Srpska has a relatively preserved environment as its rural area dominates more than half of the territory covered by forests. Communal infrastructure is impoverished in some areas, which indirectly endangers the environment components: water, air, and land. The processes of urbanisation and construction of transport infrastructure result in increasing of environmental pressure. In some locations, residential and commercial buildings and roads are being built over the highest quality agricultural land. In such cases, land use changes should be better controlled by spatial planning (Institute for Urban Planning of Republika Srpska, 2013).

Abandonment of land cultivation results in an invasion by forest species, a process which would lead to forest formation. This generates the most dangerous types of light fuel accumulations with a high level of continuity in the horizontal and vertical distribution of the fuel, in which ignitions can easily spread, take on high speeds and intensities and are extremely difficult to control.

CORINE Land Cover

Spatial and environmental changes accelerated due to the dynamic historical period upon Republika Srpska formation and the following development period. The extent of these changes can be determined by comparing satellite images obtained from different acquisition periods. By processing images, with the support of geographic information systems, it is possible to create a database that aims to analyse spatial processes in a specific area in order to determine quantitative and qualitative parameters. In this way, the trends of spatial development (e.g., excessive logging, land cover damage, water pollution, etc.) and potentially vulnerable components of the environment can be monitored. The data for Republika Srpska were collected from CORINE Land Cover (CLC) database for 39 European countries.

Comparing official cadastral data related to the forest cover of private properties with data from remote sensing through the Coordination of Information on the Environment (CORINE Land Cover) programme from 2018, it was found that there is an additional 250,000 hectares of forest cover on private land. This in effect represents vegetation successions in different stages or classification of former orchards as forests, which undoubtedly requires a more active approach to the future categorization and purpose of this space. Historical conflicts related to land use, such as clearing forests for agricultural production, have shifted direction due to depopulation. Currently, the most significant conflicts arise between forestry and unplanned urbanization, concession activities in the mining sector etc.



Map 3: *CORINE Land Cover 2018 for Republika Srpska*

The wealth of habitat diversity on the territory of Republika Srpska is also confirmed by the data related to the CORINE land cover (CLC) programme of typification and analysis of habitat diversity. The data show that on the territory of Republika Srpska it is possible to distinguish 28 (31 classes in Bosnia and Herzegovina), out of a total of 44 classes of the third level of the CORINE Land Cover Nomenclature registered on the territory of the whole of Europe. The analysis determined that 61.07% of the area of BiH is covered by forest and other natural vegetation, while 36.70% is agricultural land. Land under the category of artificial surface occupies 1.48%, while 0.66% is classified as water surfaces and 0.10% as wetlands.

1.3. Mined Area

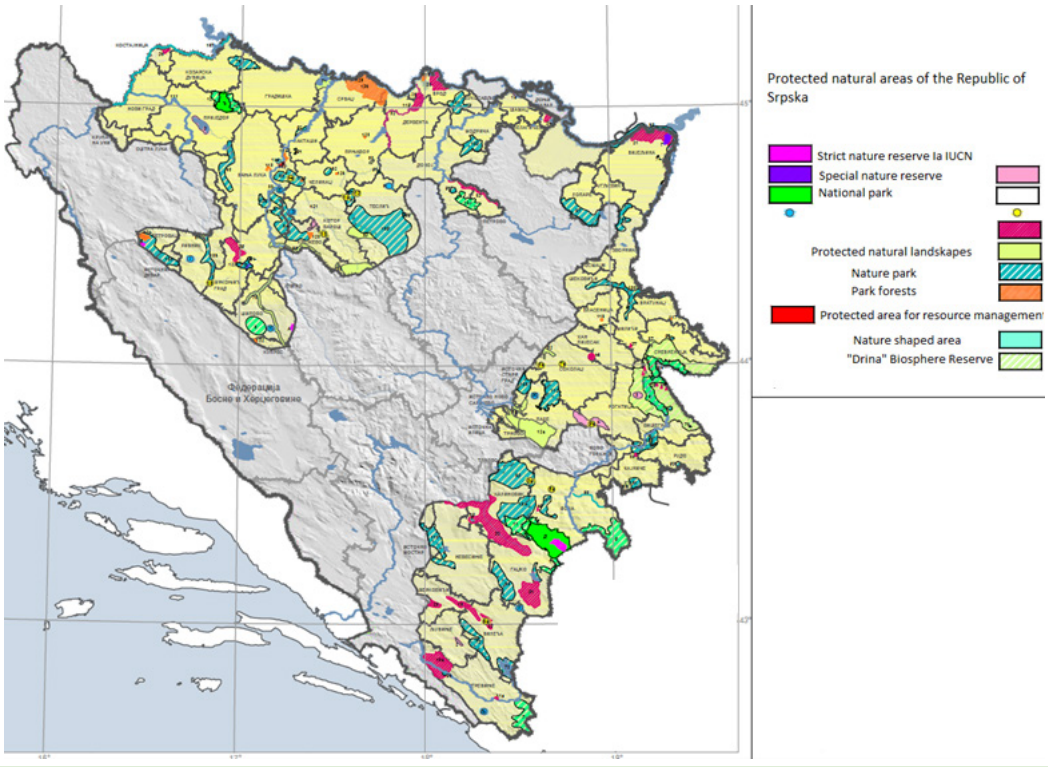
Landmines are a serious issue in Republika Srpska. The country was heavily affected by the Bosnian Civil War in the 1990s, during which landmines were extensively used. Today, many areas remain littered with unexploded ordnance, posing a significant threat to the local population. According to the Mine Action Strategy of BiH 2009-2019, it is estimated that around 501 km^2 of Republika Srpska is still under mines. Moreover, landmines also pose a serious challenge to firefighting efforts in the region. The presence of

landmines makes it difficult for firefighters to access affected areas, and it also increases the risk of accidental explosions. This situation can lead to prolonged firefighting operations, which can result in more significant damage to the environment and infrastructure. The terrains contaminated with unexploded ordnance (UXO) are problem not just for firefighters but for management of these areas as well. The Republika Srpska government, in partnership with international organizations, has made significant efforts to clear landmines and educate people about the dangers they pose. However, progress has been slow, and the problem remains a significant challenge. It is essential to continue raising awareness about the issue and to invest in mine clearance programmes to ensure the safety of local communities.

1.4. Protected Areas

In accordance with the current legislation, the area under protection is 73,038 hectares, which is a 2.96% of the territory of Republika Srpska. Currently, 34 areas are protected: two strict nature reserves, three national parks, 17 natural monuments, three protected habitats, six nature parks and three resource management areas. Two categories (II – national parks and V – protected landscapes) occupy the largest areas under protection, while the other categories (I – strict nature reserve, III – natural monument, IV – protected habitat and VI – area for sustainable use of natural resources) occupy smaller area. Only in category Ib - special nature reserve, no area is still protected.

Republika Srpska has 3 separate areas based on international agreements and conventions. One is a Ramsar area, one is a UNESCO natural resource of world importance ("Janj" Virgin Forest), while one area is on the UNESCO Tentative List.



Map 4: *Protected natural areas of Republika Srpska:* ***Source of data:*** *Institute for urbanism of Republika Srpska*

Landscapes and open spaces, pose as dynamic categories which constantly undergo changes under the influence of as a dynamic category, constantly changes under the influence of natural and anthropogenic factors. Therefore, before making decisions, it is necessary to have as accurate data as possible so that those decisions are well-founded. One of the basic shortcomings of the planning system in Republika Srpska is the lack of a reliable information-documentation basis, primarily regarding the structure of the current spatial use.

The management of land use plays a pivotal role in addressing the escalating challenge of landscape fires in Republika Srpska. As observed, there is a substantial increase in uncultivated land, accompanied by significant forested areas. This intricate balance between unused and forested land necessitates a thoughtful and strategic approach to fire management to ensure the protection of both natural resources and communities.

The expansion of uncultivated land poses a heightened fire risk, as dry vegetation and combustible materials become prevalent, increasing the potential for fire ignition and spread. Hence, proactive land management strategies are crucial in mitigating the occurrence and severity of wildfires.

In conclusion, addressing the evolving challenges of landscape fires in Republika Srpska requires a balanced and strategic approach to land use management. By synergising efforts to mitigate fire risks in uncultivated land while implementing robust forest fire prevention measures, the region can bolster its capacity to manage wildfires effectively and safeguard its invaluable natural resources. The collaborative spirit of all stakeholders is essential in realising a more fire-resilient and sustainable future for Republika Srpska.

II Demographics

As of the 2013 census, Republika Srpska, BiH (excluding the Brčko District) has a total population of 1,228,423 and a population density of 49.9 inhabitants per square kilometre. Republika Srpska, BiH comprises 49% of the land area of Bosnia and Herzegovina and is home to 34.79% of the country's total population. The overall life expectancy in Republika Srpska at birth was 77.15 years in 2019. The total natality rate in Republika Srpska is, as of 2019, 1.34 children per mother—one of the world's lowest. In 2019, the total number of live births, according to the Republika Srpska Institute of Statistics (RZS), was 9,274. That same year, the number of deaths was 15,081, resulting in a natural population decrease of 5,807 inhabitants. Along with this natural population decrease, the entity faces considerable emigration. A large number of people have left the entity in recent years for the nearby European Union and beyond.

Depopulation is the dominant socio-economic process during the last 30 years period. The population of Republika Srpska was estimated to 1.428 million in 2000. The 2013 official census stated around 1.2 million. The estimation for 2018 is 1.147 million (Republika Srpska Institute of Statistics, 2018).

The Republika Srpska is administratively divided into municipalities, and these municipalities are further divided into urban and rural areas. In the last 30 years, there has been significant migration within Republika Srpska. Unlike the Federation of Bosnia and Herzegovina, which is a complex political and territorial community consisting of cantons, Republika Srpska is organised as a unitary entity. This means that between the units of local self-government (as the lowest level of government) and the entity government, there are no intra-governments, be it cantons, counties, districts, or regions. Municipalities are the basic territorial units of local self-government, which are established as parts of a settlement – for one settlement or for more than one settlement. Normatively, just like in the Federation of Bosnia and Herzegovina, Republika Srpska has accepted a monotypic model of municipality mentioned above, which means that all municipalities have the same competencies and powers; i.e., the legal status of all municipalities is equal, regardless of their size, number of inhabitants, level of development, or any other characteristics. The entity of RS has 58 municipalities. A city/town may be established by law in an urban area constituting a coherent geographical, social, economic, historical, and territorial unity with an adequate level of development. A city/town that does not have in its composition multiple municipalities (two or more) has the competencies that are conferred to it, i.e., which pertain to municipalities. There are currently seven cities/towns in the entity of Republika Srpska: Banja Luka, East Sarajevo, Bijeljina, Doboj, Prijedor, Trebinje and – as of 2022 – Laktaši.

Significant migration towards urban centres, specifically the cities of Banja Luka, Bijeljina and Doboj, has led to urbanization and growth of urban areas, while rural areas have seen a decrease in population growth. In addition to migration from rural areas to cities, there has also been migration out of Republika Srpska to other parts of BiH and abroad, resulting in a decrease in population in some municipalities.

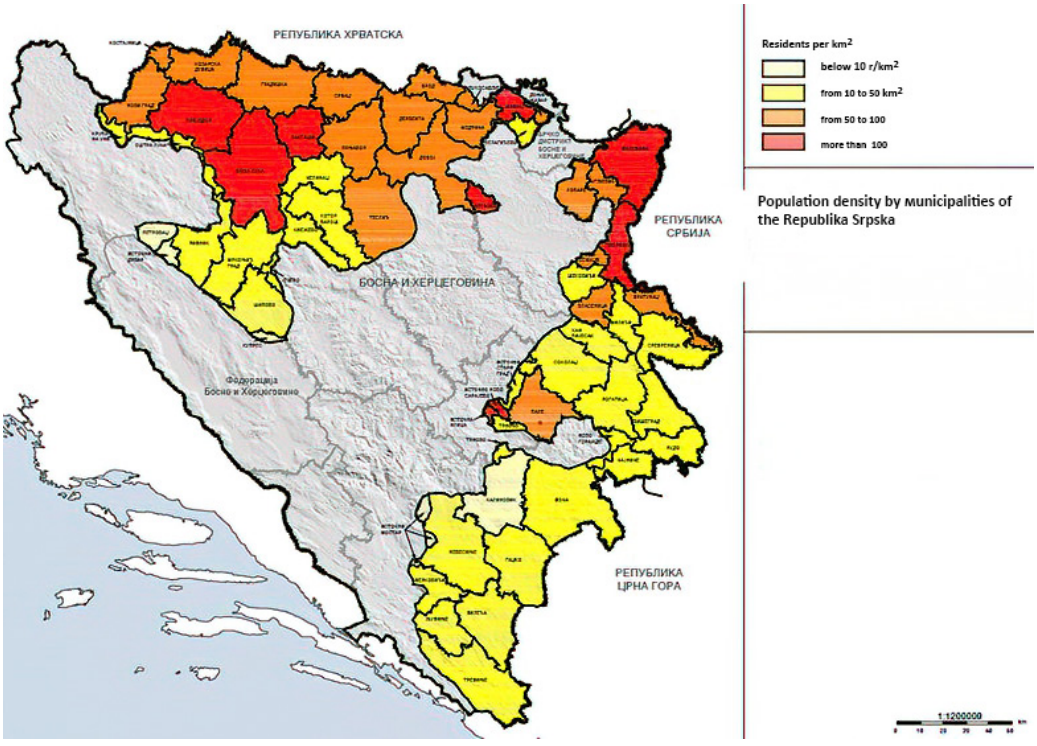
The poor economic situation and political instability in the post-war era have resulted in a growing trend of emigration from BiH, especially in the last ten years or so. Due to incompleteness of official data, the volume and direction of migration from year to year is difficult to determine with precision.

2.1. Spatial Distribution of Population

Population density is conditioned by natural and geographical predispositions, but also by differential overall social, economic, and demographic development. In view of this, it may be stated that the main characteristics, and the greatest challenges, of contemporary distribution of population in Republika Srpska are the distinct unevenness and disparities in regional development.



Map 5: *Population distribution by municipalities (1 Dot=500 persons):* ***Source of data:*** *Census 2013*

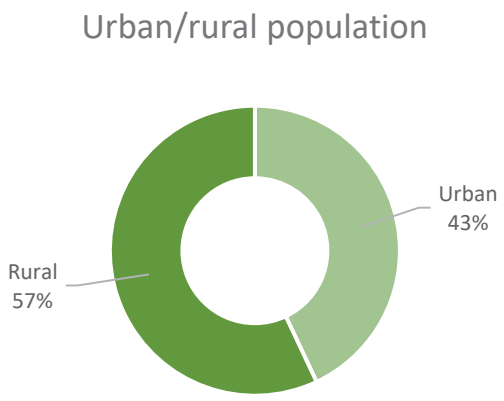


Map 6: *Population density by municipalities of Republika Srpska:* ***Source of data:*** *Institute for urbanism of Republika Srpska*

In terms of spatial demographics, two cycles of strong movements and redistribution of population may be singled out in BiH, of which the end effect was emptying of rural areas. The first one evolved during the industrial development of the country (mostly in the period from 1960 to 1980), when the accelerated growth of population in towns was achieved, resulting in the demographic decline in villages and conditioned the later spatial and polarized demographic development of Bosnia and Herzegovina.

In the period from 1948 to 1991, the urban population increased 3.7 times, to 1.7 million inhabitants. That was 38% of the total population in 1991, which means that the country was still predominantly rural.

The second cycle of great distribution of population, this time driven by ethnic factors (Marinkovic, Majic, 2018), occurred during the last decade of the 20th century, when the war caused a wave of forced migrations. Thereby, the greatest number of refugees and displaced persons fled into large towns, which in turn caused the vacating of rural areas. (Radic, 2010). The new internal political and territorial organisation of BiH, implemented based on the Dayton Peace Agreement in 1995, led to changes in settlements and urban system of Bosnia and Herzegovina, which in a very complex way influences the regional development of the country (Marinkovic, Majic, 2018; Radic, 2010). According to the 2013 census, the urban population decreased to 1.5 million, but its share in the total population increased to 43%. On the other hand, there is intensifying trend of population decline and decline of population density in rural and mountain areas. The trend has since continued with variable intensity, but the most startling shift from agrarian to industrial society took place in little over a decade (UNDP, 2013: 68).



Graph 6. *Urban/rural population in Repubika Srpska:* ***Source of data:*** *Census 2013.*

2.2. Population Dynamics

BiH was traditionally one of the most distinct emigration regions in the former Yugoslavia. During the entire second half of the 20th century, the migration balance was negative. Chronologically, the greatest outflow of population was recorded in 1960s, when the average annual negative migration balance rate was -0.63%. During this period, emigration to Serbia and Croatia was dominant, which began with a planned colonisation from 1945 to 1948 (Spasovski, 1995).

During the last decade of the 20th century and early 21st century, negative migration balance assumed unexpected proportions with the large refugee waves during the war. Yet, the data for the period 1991-2013 should be interpreted having in mind the complexity of BiH statistics and the fact that census is not the best source for tracking external migration.

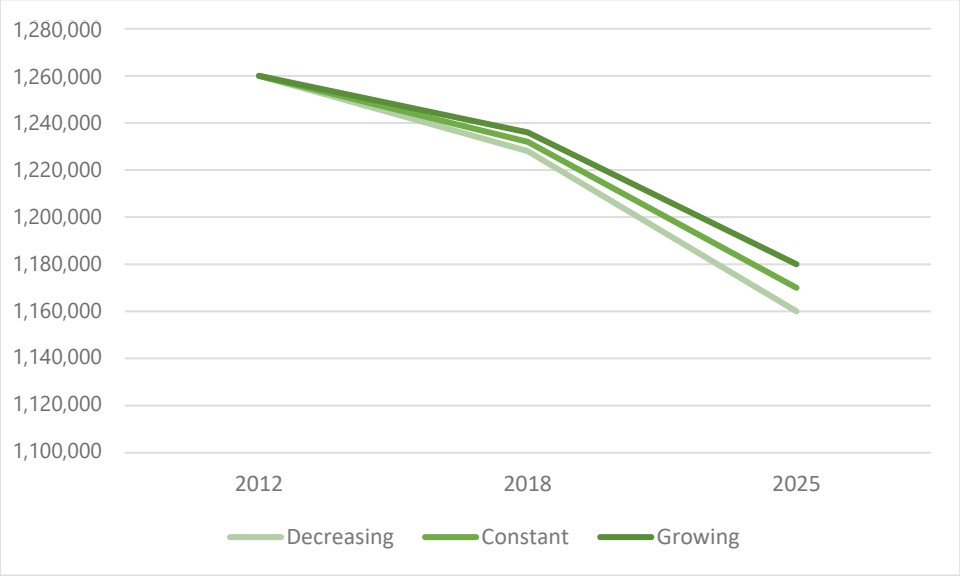
According to the World Bank, 1.471 million citizens of BiH lived abroad in 2005 (or 38% of total population) ranking the country second in the world. In 2013, 1.699 million citizens were recorded abroad (or 44.5% of total population). The main destination countries are Croatia, Serbia, Germany, Austria, the USA, Slovenia, Sweden, Switzerland, Australia, and Canada (World Bank Group, 2016).

2.3. Future Trends

All scenarios for population prospects show that further population decline in BiH is an unstoppable process, especially because the positive effect of the previous young age structure cannot be expected due to the consequences of war. According to the median-variant projection of the UN (World Population Prospects 2017), the total population of BiH could decrease to 2.685 million until 2050. This variant is based on the assumption of a slow recovery of the total fertility rate from 1.22 to 1.42 children per woman.

The following defines the usual basic assumptions needed for population projections for Republika Srpska (fertility and mortality rate assumptions are of particular significance):

- Absence of disaster assumption. It is assumed that in the projected period there will be no wars, devastating earthquakes, epidemics or famine in this and the neighbouring areas;
- Gender structure of live births assumption. Based on long-term averages, it is assumed that 110 boys will be born for every 100 girls in the entire projected period;
- Fertility assumption. There is no single assumption made concerning fertility trends, as is the case with other factors influencing future population growth. When designing the projections, three levels of fertility were assumed: declining, constant, and increasing.



Graph 7. *Projected number of inhabitants in Republika Srpska according to different assumptions of fertility trends:* ***Source of data:*** *Proposal to amend the Spatial plan of Republika Srpska until 2025*

In case of declining fertility, a level of 1.1 children per woman is assumed at the end of the projected period in 2025. Constant fertility assumes an unchanged level of 1.2 children per woman in the projected period. The assumed constant fertility level is slightly higher than the current one due to the belief that population policy measures and media campaigns in favour of increasing births will still give some results. In the case of increasing fertility, a level of 1.3 children per woman is assumed in 2018, which is also below the level required for a simple replacement of generations.

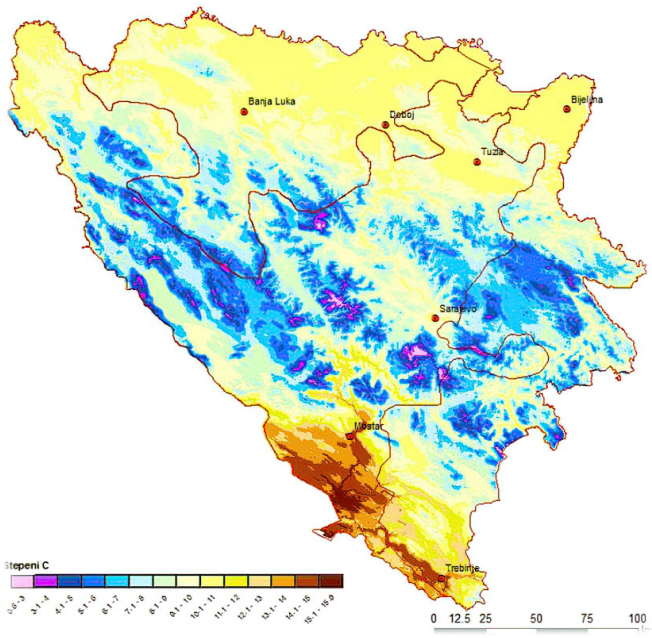
In conclusion, the examination of demographic trends within Republika Srpska reveals a notable decline in population numbers over recent years. This reduction in residents has led to an increased expanse of uncultivated land, which, unfortunately, has become susceptible to overgrowth. The expansion of unmanaged vegetation not only poses ecological challenges, but also significantly elevates the risk of wildfires. The correlation between the dwindling population and the unchecked growth of vegetative cover accentuates the urgency for proactive measures in land management and fire prevention. Addressing this issue requires not only demographic considerations, but also a strategic approach to land utilization and wildfire mitigation efforts to safeguard both communities and natural landscapes. It is imperative to recognize the interconnectedness between demographic shifts and landscape dynamics in order to develop comprehensive solutions that ensure the sustainable coexistence of people and environment.

Ultimately, there is a need for an integrated approach to fire management that takes demographic aspects into account. A comprehensive understanding of the link between the population, land management, and fire risk is crucial in fostering more resilient ecosystems and sustainable communities. Understanding and adequately incorporating demographic factors enable more efficient preparations, faster responses, and better community protection from wildfires.

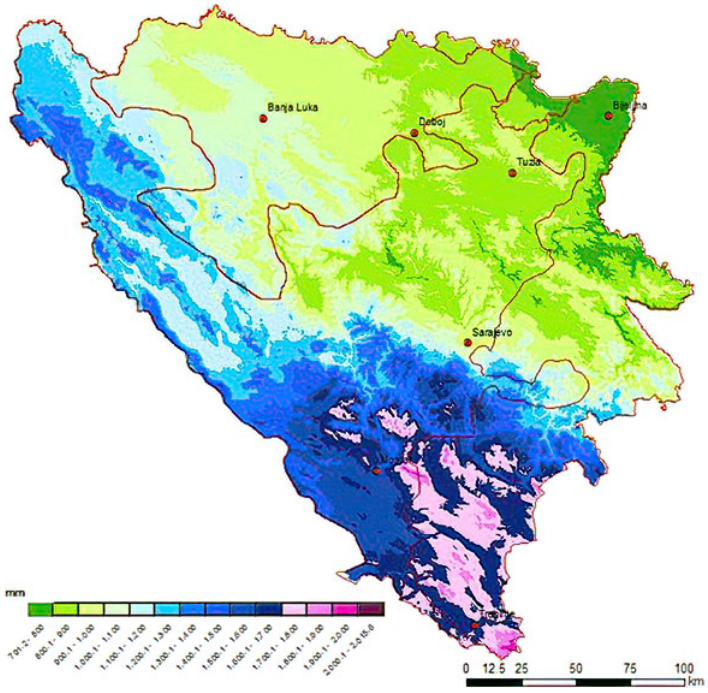
III Climate Characteristics, Climate Change Scenarios and Nationally Determined Contributions (NDCs)

Climate and its influence play an important role in the threat of wildfire occurrence. Many authors (Pyne et al. 1996, Flannigan and Wotton 2001, M. Flannigan et al. 2009, Živanović 2010, Allen CD et al. 2010 Xystrakis et al. 2013) suggest that the occurrence of fire depends on climate and humidity of fuel. Martin et al. (2001) hold that fire is closely associated with climate. The greatest risk of fire appears during summer months, when air temperatures are high, and the moisture content in the air and fuel moisture is reduced (Živanović 2014).

The climate of Republika Srpska is determined by basic climatic factors - geographic position, geological base, terrain (topographical relief), proximity to the Mediterranean Sea and coverage of the terrain with plant life. In addition to these basic factors, meteorological factors also play an important role, which significantly affect the climate of Republika Srpska. As part of the general circulation of the atmosphere over the Balkans, and therefore over Republika Srpska, there is a frequent change of polar and tropical air masses as well as influx of cold arctic air in the winter period. This takes place under the direct influence of synoptic systems, cold and warm fronts, cyclones from the Atlantic, from the Mediterranean and the Adriatic Sea, and anticyclones in the summer period, most often from the Azores, and from Central Europe and Siberia in winter.



Map 7: *Mean annual temperature in Republika Srpska for the period (1961-1990):* ***Source of data:*** *Threat assessment for natural disasters and other accidents of Republika Srpska, CZRS 2013*



Map 8: *Average annual precipitation in Republika Srpska for the period (1961-1990):* ***Source of data:*** *Threat assessment for natural disasters and other accidents of Republika Srpska, CZRS 2013.*

The various climatic factors affecting the territory of Republika Srpska result from natural factors and the rules of general circulation of air masses in this region. Thus, there are three climate types over the territory of Republika Srpska, and these are:

1. Northern Peri-Pannonian region, with its moderate continental climate,
2. Alpine and Pannonian climate,
3. Modified Mediterranean – Adriatic climate.

a) Climatic Characteristics of the Peri – Pannonian Region

This region's climate is characterised by moderately cold winters and warm summers. Average annual air temperature ranges for this climate type are from 12° to 19°C.

Average monthly air temperature ranges in the warmest month, July, are from 21° to 23°C. Average monthly air temperature ranges in the coldest month, January, are from -0.9° to -0.2°C. The absolute maximum air temperature is 41°C, while the absolute minimum temperature is -30°C, which leads to the conclusion that annual temperature amplitude is high, with the highest value of 71°C. Average amount of precipitation has the value of 1,050 l/m^2 in the west, and 750 l/m^2 in the east. Precipitation amount decreases from the west to the east, but the precipitation throughout the year is well distributed. Throughout the year, this region has around 1,900 sunshine hours. Košava, a cold and squally wind, blows in the far east of the Peri-Pannonian region during winter. Other winds blowing in this region result from the current circulation of air masses.

b) Alpine and Pannonian Climate

This climate covers the largest part of Republika Srpska. Mountain ranges are characterized by short and cool summers, and cold and snowy winters, with high snow cover which persists for a long time.

Average annual air temperature is between 5°C and 7°C, while for the coldest month – January – the average monthly air temperature is between 2.5°C and -3°C. The absolute minimum temperature is below -30°C, and the absolute maximum temperature is up to 35°C. Therefore, temperature amplitude for this region is high.

Annual precipitation sum is over 1,200 l/m^2. Annually, there are approximately 1,850 sunshine hours. Hilly terrain, as well as hollows and valleys are characterised by a somewhat milder climate. Average annual air temperature in the areas with Alpine and Pannonian climate is around 10°C. Annual precipitation amount level is between 700 and 1,000 l/m^2.

Winters are moderately cold, with snow, common temperature inversions and fog. Summers are moderately warm.

c) Modified Adriatic Climate and Climate of Humine and Rudine

The southern region of Republika Srpska, also known as lower Herzegovina, is characterised by modified Adriatic climate. This region is called Humine, as opposed to the region called Rudine, which covers the higher mountainous parts of the karst of Herzegovina and is characterised by a variant of both the Alpine climate and the climate of Humine.

This climate type is characterised by the impact of the Adriatic Sea. Summers are very warm, with approximately 2,400 sunshine hours. Average annual air temperature is between 14°C and 14.7°C. The absolute maximum temperature is 41°C, while the absolute minimum temperature goes below zero, and its lowest value is -8°C.

The average annual rainfall ranges from 1,500 to 2,000 l/m^2 although there are also rainy places, with an average of 2,000– 2,500 l/m^2 (Domaševo, Donje Zimlje, Kruševica, Ždrijelovići ...) while in the far south this amounts to as much as 2,500–3,000 l/m^2 (Ubla-Bogojević Village, Grab, Zabica Donja, Vrbanj etc), which is around the European maximum. The three-day rainfall is at the level of the highest rainfall in Europe, along with the Montenegrin mountain coast (Krivošije, Crkvice).

The distribution of precipitation is unfavourable, since autumns and winters have the highest amount of precipitation, while summers bring droughts, having the lowest amount of precipitation. This region is characterised by north-eastern wind called "bura" and south wind called "jugo". "Bura" is a squally north and north-eastern wind which blows during winter, often reaching storm force. "Jugo" blows when there is high air pressure over Africa, and low air pressure over the Adriatic Sea. It blows throughout the year, and usually brings rain. Trebinje, the warmest city in Republika Srpska, is located in this region. Unlike Humine climate, Rudine climate is characterised by lower temperatures during both summer and winter, with snow being a regular occurrence during winter.

3.1. Drought

Drought as a meteorological phenomenon develops slowly, covers wider areas, and leaves far-reaching consequences for the population, the economy, and the environment. It used to be mostly associated with climate types and areas that traditionally have very little rainfall. In the last 50 years, the occurrence

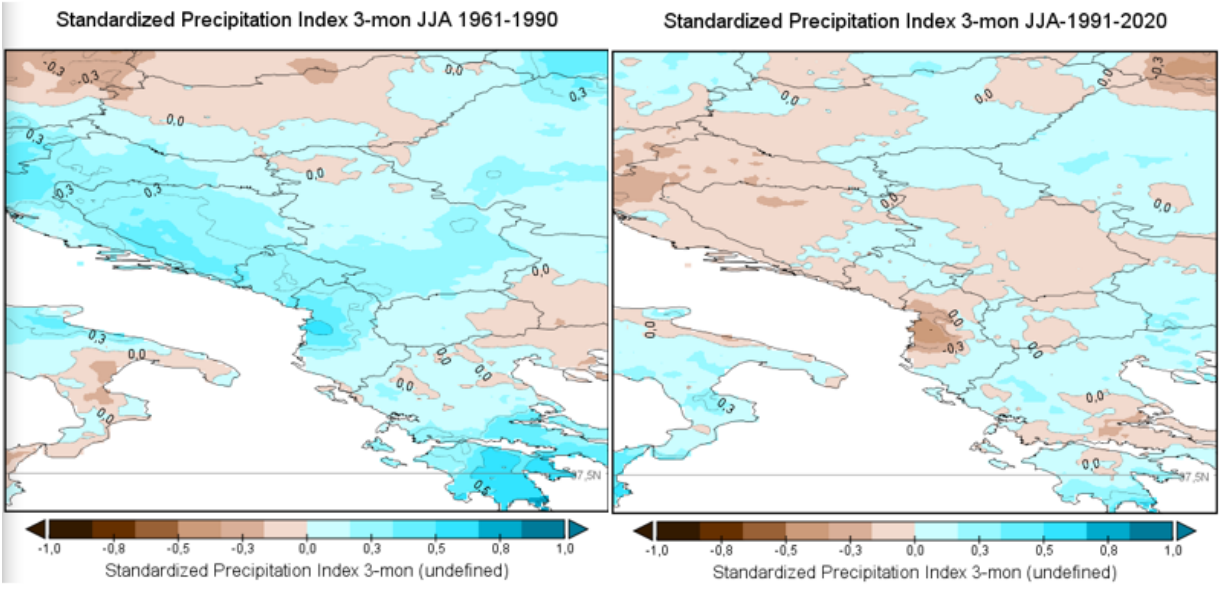
of drought has become more frequent in the temperate latitudes of the continents, including Europe. Climate projections for the next 10 to 30 years indicate that the problem of drought will be even more pronounced. Republika Srpska was not spared from this either.

Meteorological drought occurs due to a lack of precipitation for a longer period in a certain area, that is, it represents a negative deviation of precipitation from the norm established for a longer period of years in a certain area. Depending on the time of occurrence, droughts can be related to different seasons, and they differ in duration. That is why it is very important to find an adequate distribution of the probability of dry periods, so as to be able to predict the risks of future droughts.

Hydrological drought represents a large lack of water in rivers, drying up of small and medium-sized watercourses and groundwater. Underground droughts can be a good indicator of hydrological drought and are based on estimates of groundwater levels and their filling and emptying.

Agricultural drought occurs due to lack of precipitation and loss of water from the ground layers of the soil due to evaporation. When it occurs in the vegetation season, it interferes with the normal growth and development of plants, and the drying of the deeper layers causes soil infertility and drying of agriculture products. Drought is also determined through the ratio of actual and potential evapotranspiration, through the so-called Drought coefficient and through the standardized precipitation index (SPI). A negative value of the SPI index indicates a drought, and a transition to positive values indicates the end of the drought.

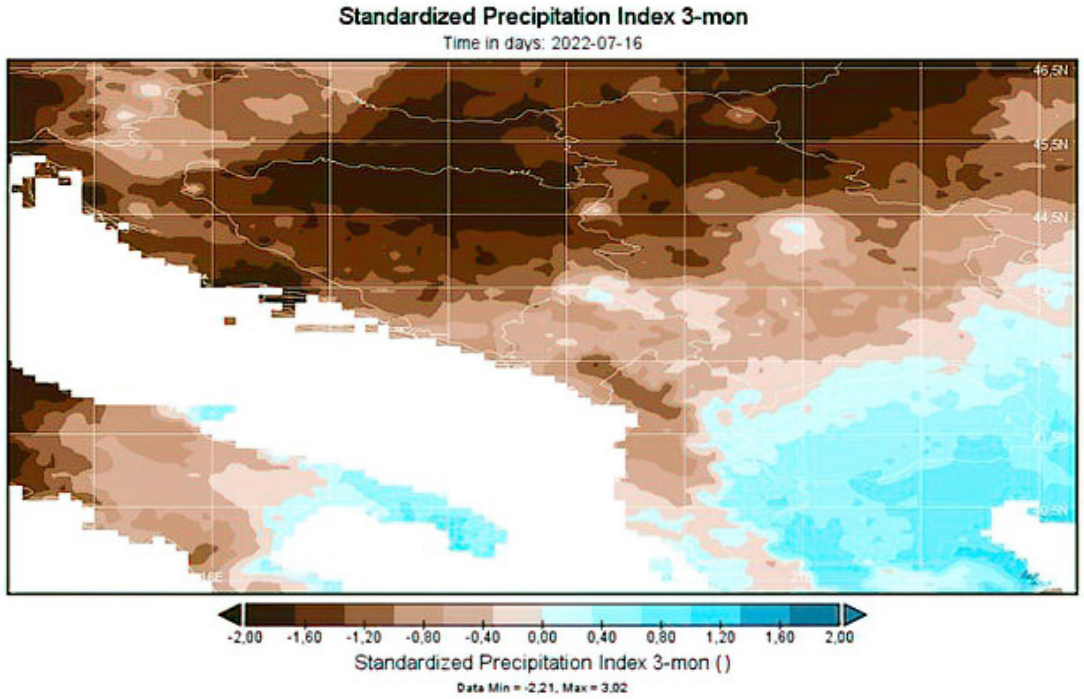
Drought is also determined through the so-called ratio of precipitation and potential evapotranspiration (P/PET), through the so-called drought coefficient (equal to the number of days with precipitation divided by the total number of days), dry days (number of days with precipitation less than 1 mm/day), consecutive dry days (maximum number of consecutive days with precipitation less than 1mm), longest dry period (maximum length of consecutive dry days with precipitation <1) and through the standardized precipitation index (SPI). A negative value of the SPI index indicates a drought, and a transition to positive values indicates the end of the drought.



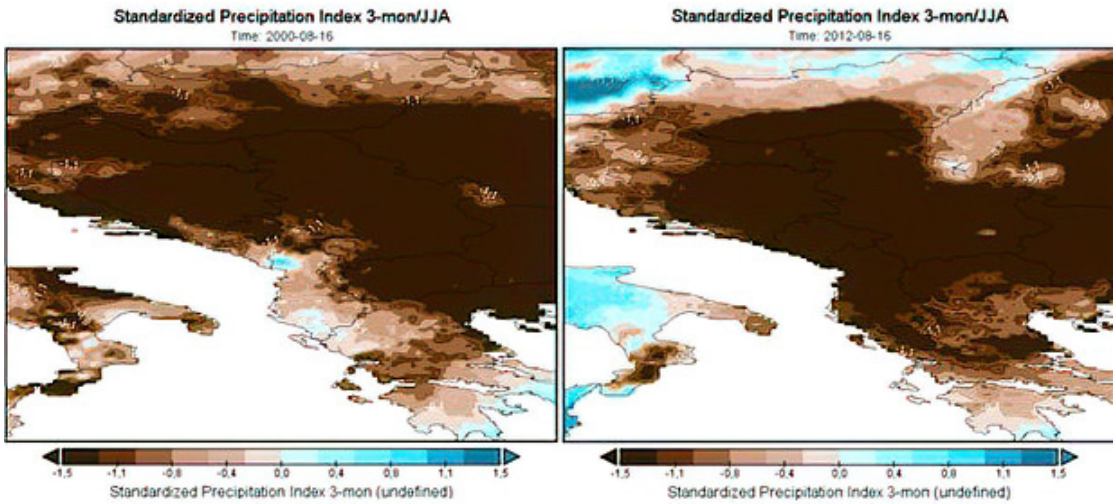
Map 9: *SPI-index 3-months for the climatological summer:* ***Source of data:*** *https://surfobs.climate.copernicus.eu/dataaccess/access_eobs_indices_months.php (Data analyse and visualisation: RHMS RS/Climatology*

Drought in Republika Srpska occurs periodically, with the decade 1981-1990 clearly standing out, but it was also frequent in the last 20 years, occurring in 2000, 2003, 2007/2008, 2011, 2012, 2015, 2017, 2021, 2022. June 2021 witnessed the lowest precipitation levels since 1861. This marked a significant historical event, as the amount of rainfall recorded in June was the lowest in over 160 years. This unprecedented dry spell in June 2021 highlighted the long-term climatic variations and underscored the importance of monitoring and understanding changing weather patterns in the context of historical data.

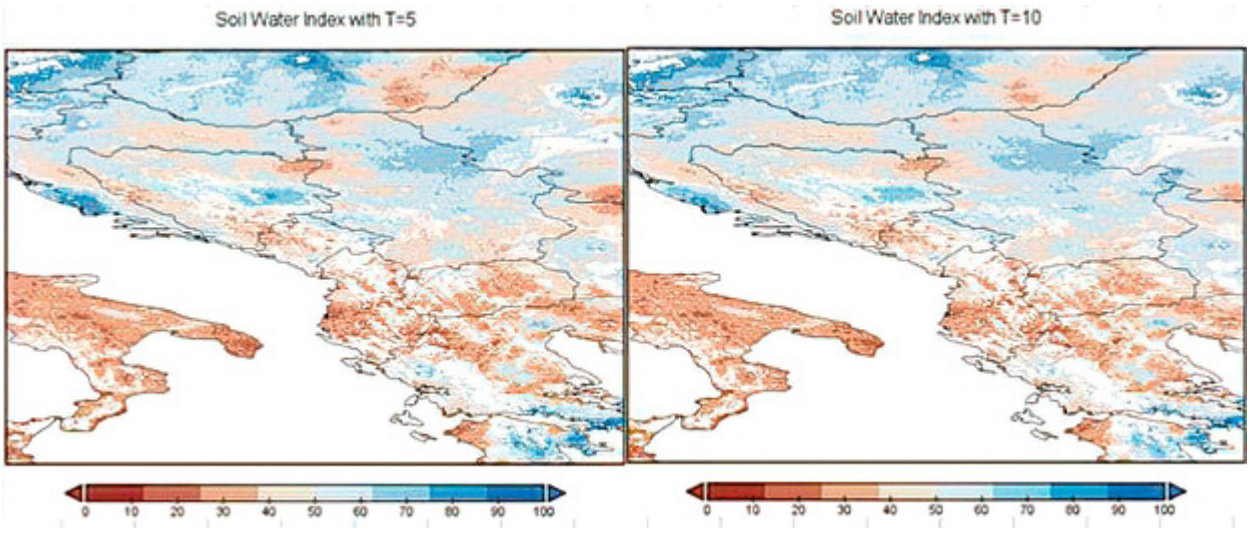
All this is closely related to the general circulation in the atmosphere, which is mostly influenced by the North Atlantic Oscillation (NAO) and the Arctic Oscillation (AO). In Republika Srpska, the absolute minimum SPI (Standardized Precipitation Index) value was recorded at many stations, and the drought occurred already in the spring, and it also existed in the summer months.



Map 10: *SPI-index 3- months (May, June, July); (Data analyse and visualisation by RHMS RS/Climatology)*



Map 11: *SPI-index 3- months (Jun, July, August) (Data analyse and visualisation by RHMS RS/Climatology according https://surfobs.climate.copernicus.eu/dataaccess/access_eobs_indices_months.php)*



Map 12: *Soil Water Index (SWI) on 23 august 2023, satellite based daily moisture index; (Data visualisation RHMS RS/Climatology)*

Frequent occurrence of drought is not characteristic only for the 20st and 21st century. Monastery records and weather chronicle testify huge drought in 1768, 1779, **1781-known by huge forest fires**, 1784, 1793/94 **drought from November to May**, **1797,** 1803, 1807, 1820, 1830, 1834, 1836, 1839, 1842, 1848, 1855, 1863...

Throughout Republika Srpska, museums and monasteries house a wealth of records documenting droughts as well as fires often accompanying them throughout history. These invaluable archives provide a unique insight into the challenges faced by the region and its people, offering a historical perspective on the impact of droughts and the devastating fires that followed.

..."The year 1781 was marked by intense heat and suffering ". (Note in the record of the Orthodox monastery in Beočin, Ilok area)"

"1781 A great drought appeared in the Sarajevo region, with the grass suffering the most. It dried up completely, which left the animals without food. The meadows in the glades were not mowed, and the whole face of the earth looked yellow, as if it had been burnt. Grain and other food were expensive... The drought continued, green vegetables and grass were absent from the gardens and meadows. The trees also dried up and the black resin flowed from the top of Kap near Sarajevo. Throughout Bosnia and Romania, there were forest fires in which everything down to the grass was burnt..." (Note from Sarajevo)"

"1797... Since there was no rain for a long time before the month of August, the drought was such that there was no greenery on the hills, nor in the plains. The earth dried up to the depth of a man's height. The fruit that was ripe perished. Everything that was sown, everything except the winter grain, did not come up, which brought a terrible scarcity. Water sources also dried up. A miracle that, they say, hadn't happened in 80 years." (Note from Sarajevo)"

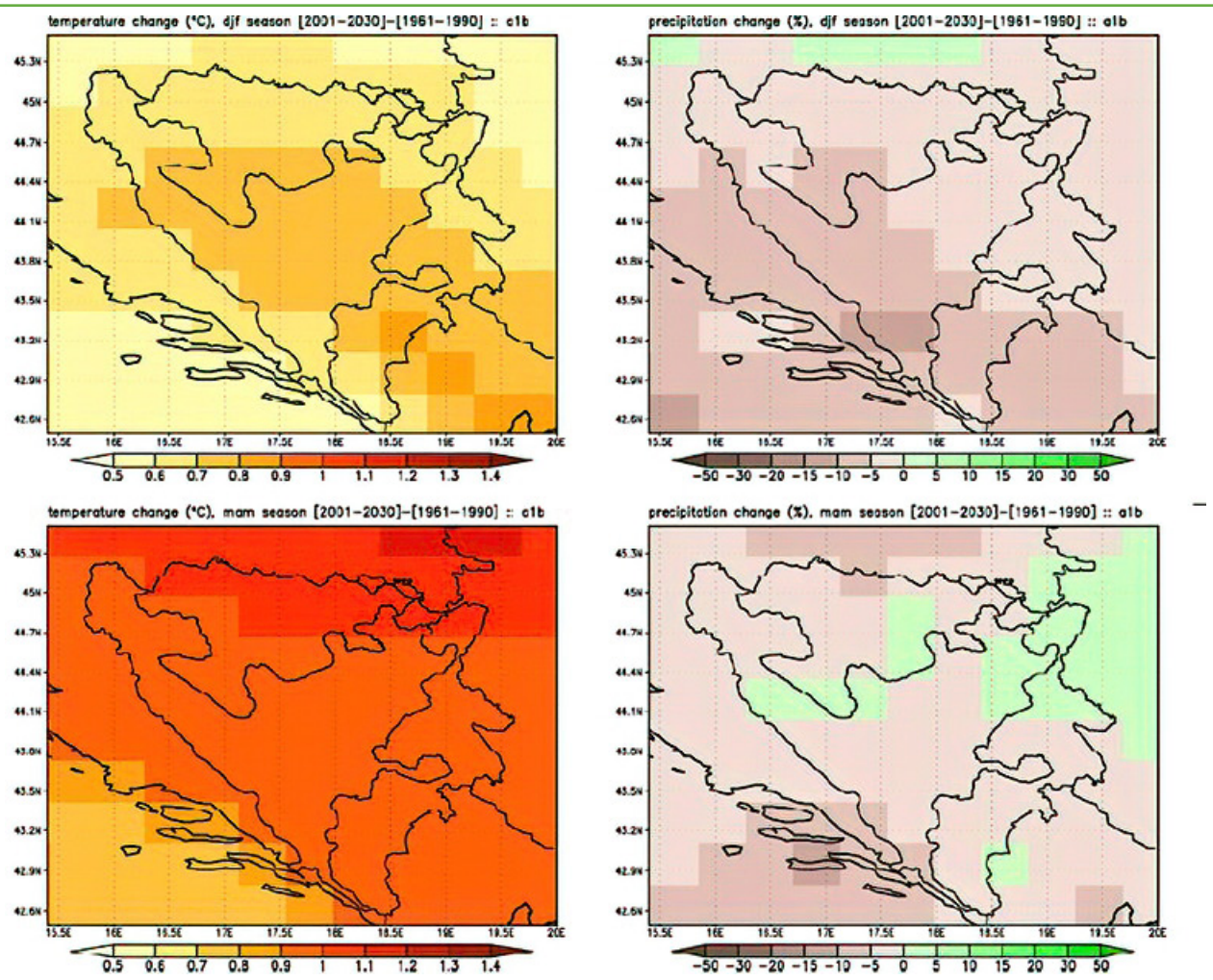
3.2. Climate Change Scenarios

Climate Scenarios until 2030

A1B Scenario, 2001-2030

Source: *Đurđević, V, Trbić, G, Vujadinović. M.: Development of climate models in Bosnia and Herzegovina, Second national report on climate change of Bosnia and Herzegovina according to the UN Framework Convention on Climate Change-UNFCCC.*

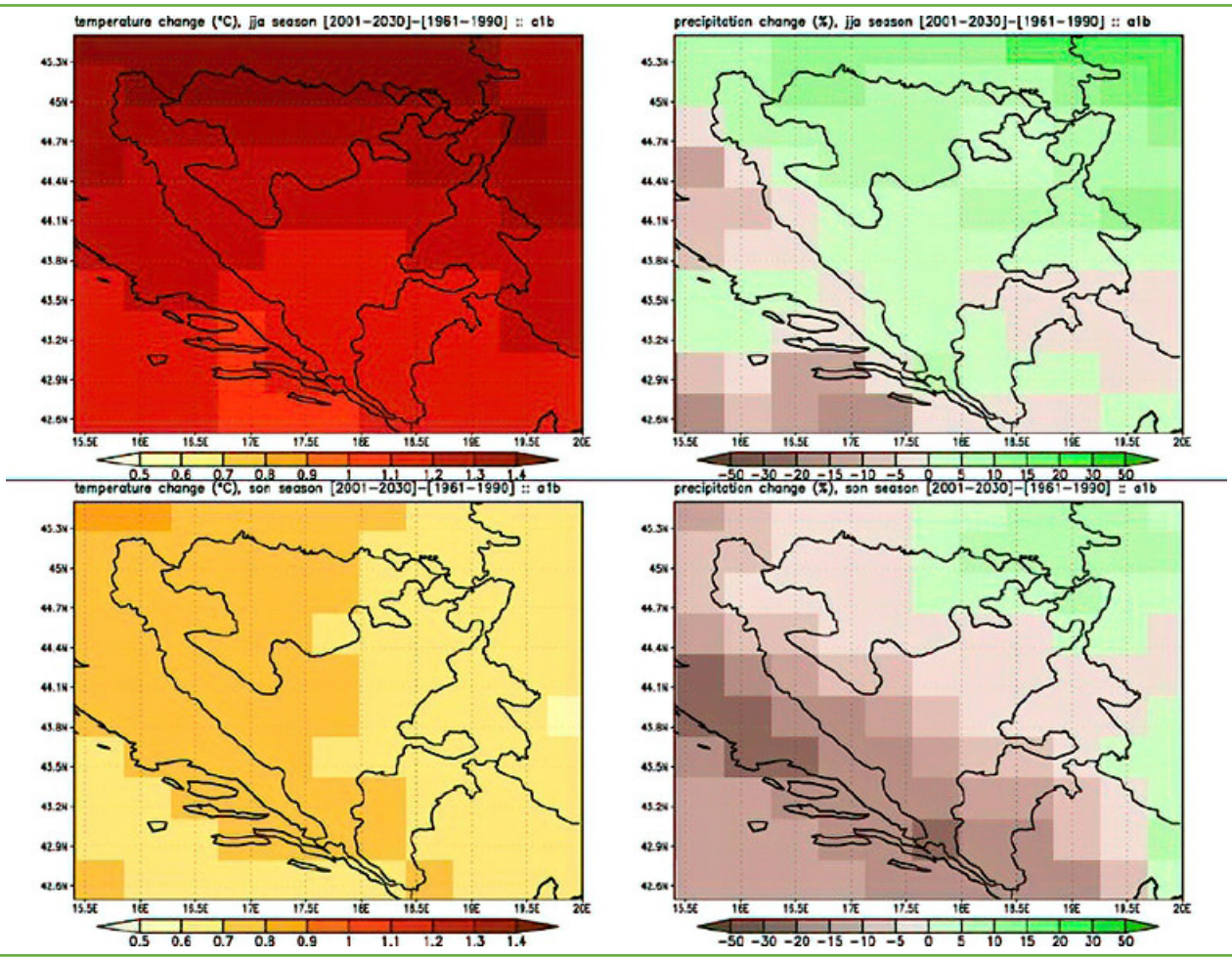
Projected changes in air temperature and precipitation were calculated for the period 2001-2030. in relation to the base period 1961-1990. Changes in temperature are given in °C and changes in accumulated precipitation in %.



Map 13: *Change in temperature in °C and precipitation in % for the winter season. (Temperature change in °C (left) and precipitation in % (right) for the winter season -DJF (above) and the spring season - MAM (below)*

According to the results of the model, the mean seasonal temperatures during the observed thirty-year period 2001-2030 range from +0.6°C to +1.4°C, depending on the season and area. The biggest changes are found during the summer season (JJA) with values of +1.4°C in the north and +1.1°C in the southern parts. For the winter season (DJF), the changes are around +0.7°C. For the spring season (MAM), the expected changes are slightly higher compared to the winter season, with values from +0.8 to +0.9. The autumn season (SON) is characterized by a change from +0.6 to +0.8.

According to the results of the model, it is evident that both positive and negative changes in precipitation are expected. Positive changes, i.e. an increase in precipitation, can be expected for the spring season (MAM), dominantly for the northern and northeastern parts, +5%, and for the summer season (JJA) on almost the entire territory, except for the southeast, with a maximum of 15%.



Map 14: *Change in temperature in °C (left) and precipitation in % for the JJA and SON seasons (Change in temperature in °C (left) and precipitation in % (right) for the JJA season (top) and the SON season (bottom)*

On annual level, the expected temperature change ranges from 0.8 to 1°C with higher values in the north. The change in precipitation at annual level is negative on the entire territory from 0% to -10%, except for the northeast where the change is positive up to +5%.

It can be concluded that increased temperatures and reduced precipitation are very likely to cause increased fire hazard conditions in currently affected areas with the possibility of extending to areas in

which fires have not been frequent so far or have been absent. The fire season will be longer and more severe increased dry spells and droughts, and higher temperatures, particularly maximum temperatures, will very likely increase the frequency of extreme fire hazard conditions and with it the probability of fires, particularly of large fires. The postfire regeneration potential of many areas will very likely suffer from reduced precipitation and increased probability of drought. If, as it happened in the past, drought is concomitant with large and widespread fires, this would mean that the potential for recovery after a large extension fire could be at risk, thus adding capacity to vegetation change. Increased frequency of fires may cause many wooded areas to become shrublands (Moreno et.all. 2008).

Areas with the average annual air temperature above 12°C, rainfall up to 800mm/m^2 and the average annual relative humidity of up to 70% are especially vulnerable to fire. Balance of plant cover mostly depends on air temperature and precipitation. As a climate element, temperature has a dominant impact on vegetation and the possibility of emergence and spread of fires. The probability of a wildfire depends, inter alia, on total rainfall (Ćurić et al. 2013). Trends in the deficit and surplus of daily, monthly, and annual rainfall affect the status of combustible materials and the possibility of fire (Ćurić and Živanović 2013). Based on the available climate data, it is possible to derive relevant information about wildfire potential in a given area (Chandler C et al. 1983).

3.3. Nationally Determined Contributions (NDCS) in Republika Srpska

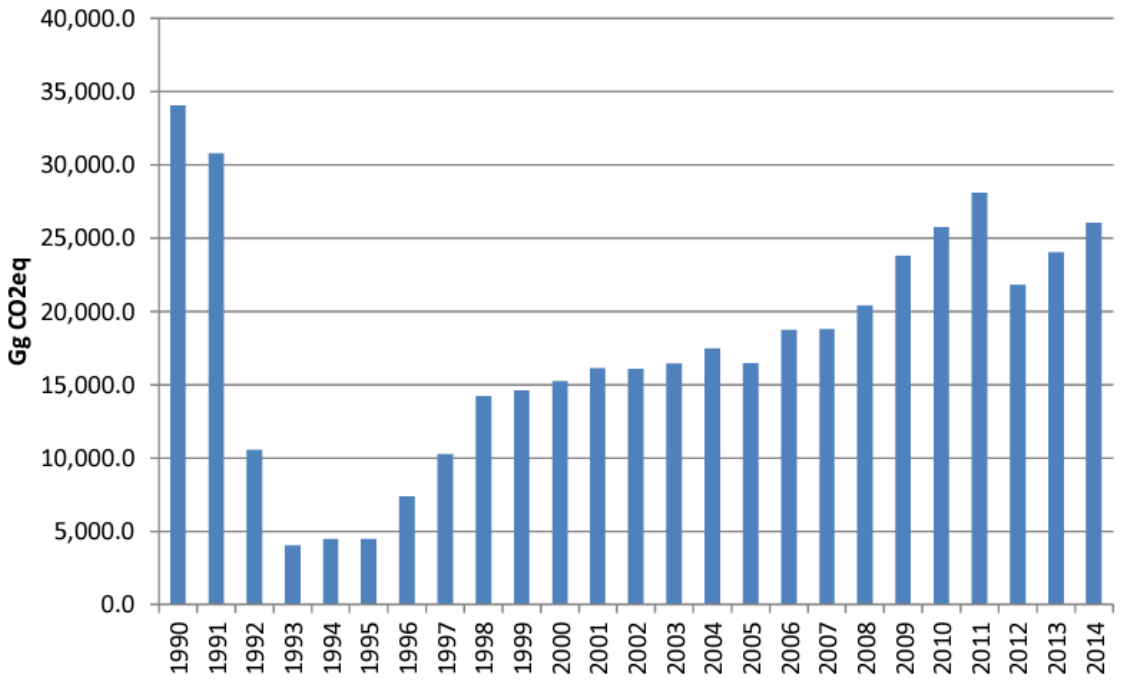
BiH adopted its Updated Nationally Determined Contributions (NDC) to the UNFCCC in 2021 and published its Third National Communication (NC3) and Second Biennial Update Report on Green House Gas Emissions in 2016. The country's climate change adaptation and planning mechanisms are governed by the Ministry of Foreign Trade and Economic Relations, which is responsible for coordination of climate change adaptation and mitigation activities as well as coordination with governmental bodies and institutions at the international level in relation to climate change commitments and environmental protections. The country's adaptation plans are also in line with the submitted application (February 2016) to ascend to EU membership. BiH is aiming to have an established green economy by 2025 to support its membership to the EU. BiH institutions are facing significant challenges to develop and implement strategies, plans and programmes for climate change adaptation. The federal government is working to introduce stronger institutional and legislative frameworks to support various sectors approach complex climate change challenges and integrate needed work within sectoral strategic plans. (Trbic, G. et al. 2017)

Climate change is one of the greatest challenges that humanity is facing today as it affects all aspects of the environment and the economy and threatens the sustainable development of the society. Bosnia and Herzegovina, as a country where the negative effects of climate change are already visible, appreciates the importance of addressing this challenge and is making every effort to render these initiatives successful. GHG emissions in BiH in 2014, which is also the last year for which the inventory has been made to date, amounted to 26,062 Gg (Gigagrams) CO_2eq GHG emissions in 2014 amounted to about 7.38 tons of CO_2eq per capita, which is about 15% less than the average of EU countries (EU28) for the same year. GHG emissions per unit of GDP for BiH amounted to 1.87 kg CO_2eq per euro in 2014, while the EU average was 0.39 kg CO_2eq per euro, which indicates inefficient use of resources, primarily energy. The key challenge in the process of climate change mitigation is to use the transition to a low-carbon (low-emission) economy for achieving the sustainable economic development and social cohesion goals, while taking account the existing structure of the economy and the time required for its transition. Through investing in GHG emission reduction projects and programmes, there is a great potential for economic growth, employment opportunities and business risk reduction. The present document Nationally Determined Contribution (NDC) of BiH was prepared in accordance with the Decision 1/CP.21 of the Paris Agreement and it is a revision of the first Intended Nationally Determined Contribution – INDC submitted by BiH in

October 2015. Compared to the INDC, the NDC of Bosnia and Herzegovina includes a section on climate change adaptation and the updated section related to contribution to climate change mitigation which now includes more ambitious targets for reducing GHG emissions.

3.3.1. Climate Change Mitigation – Background Information

3.3.1.1. Current emissions As a member of the UNFCCC, BiH is required to report on GHG emissions. Through the development of the first three National Communications and two Biennial Update Reports on GHG emissions, inventories of emissions from 1990 to 2014 were made. The inventories were made by applying the 1996 IPCC methodology. The development of inventories for 2015 and 2016 is in progress by applying the 2006 IPCC methodology, and their completion is planned for the first quarter of 2021. With this in mind, information on GHG emissions is much more reliable compared to the period when the INDC was produced, and, in addition, the national capacities for their monitoring have been improved. This enabled more reliable emission projections and thus the definition of the targets arising from international treaties. Next graph shows the GHG emission trend from 1990 to 2014.



Graph 8. *Annual GHG emissions in Bosnia and Herzegovina*

The highest emissions were recorded in 1990 and they amounted to 34,040 Gg CO_2eq. The emissions were significantly reduced during the 1992-1995 period, after which they started increasing. In 2001, they amounted to 12,030 Gg CO_2eq, which is just over one third compared to 1990. Subsequently, primarily due to the growth of emissions in the energy sector, total emissions exceeded 20,000 Gg CO_2eq (in 2008). Emissions from other sectors were more than halved between 1990 and 2001, due to a reduction of more than 80% in industrial emissions and 50% in the agricultural sector. The highest emissions after 1990 were recorded in 2011 and they amounted to 28,107 Gg CO_2eq, which is about 83% of 1990 emissions.

The rise in emissions in 2011 primarily occurred due to increased power generation from coal-fired power plants. Year 2012 saw a significant drop in emissions as a result of a smaller share of thermal power plants in power generation. Emissions in 2014, the last year for which the inventory has been made to date, amounted to 26,062 Gg CO_2eq, which is about 23.5% less compared to 1990. Based on the analysis of emissions per capita, emissions in 2010 almost reached the levels of emissions per capita in 1990 (5.18 tons of CO_2eq per capita annually in 2008), however they are still among the lowest values in Europe. In 2014, emissions per capita amounted to about 7.38 tons of CO_2eq, which is about 15% less than the EU average. However, if a comparison is made in relation to gross domestic product, emissions in BiH are nearly five times higher than in the EU. GHG emissions per unit of GDP for BiH amounted to 1.87 kg CO_2eq per euro in 2014, while the EU average was 0.39 kg CO_2eq per euro. These statistical data illustrate the economic and social situation of BiH, which is trapped in poverty, with relatively low GHG emissions, but even lower per capita gross domestic product, which indicates inefficient use of resources, primarily energy.

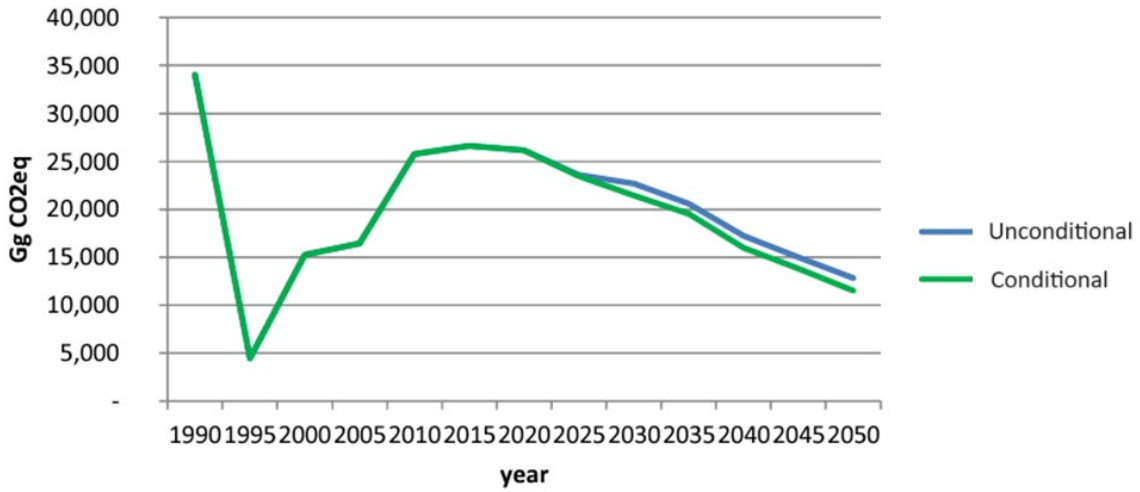
3.3.1.2. Emission Reduction Targets

When setting GHG emission reduction targets, it should be taken into account that BiH is a signatory to the Paris Agreement and a member of the Energy Community. Under the Paris Agreement, emission reduction targets are set on a voluntary basis. This means that it is up to each country to consider its own situation and assess which level of emission reductions is in line with its sustainable development. Thereby, the level of international assistance to reduce GHG emissions is expected to be commensurate with the ambition of the targets. As a member of the Energy Community, BiH has an obligation to harmonise its energy sector with the Acquis Communautaire and to base its climate targets on those of the EU, but it also has the possibility to set its own target with an adequate explanation of the ambition of such target. When setting the target for reducing GHG emissions by 2030, the commitments of BiH deriving from both treaties/agreements are considered. In setting GHG emission reduction target, the following sectors are covered: power sector, district heating, construction, transport, industry, agriculture, forestry (carbon sinks), waste and the cross-cutting sectors. The following GHGs are considered: carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons. Defined reduction targets include the periods up to 2030 and up to 2050, with the 2025 target indication. In consultations with the Secretariat of the Energy Community, year 2014 was selected as the baseline year. This is the last year for which an official inventory of GHG emissions was completed. It should be noted that in 2014 BiH suffered catastrophic floods, which was reflected in the level of economic activities and indirectly caused certain reduction in GHG emissions. To be able to compare the reduction target with the INDC targets, the target is also expressed in relation to the 1990 emissions. Based on consultations with key stakeholders, the GHG emissions reduction target has been set such to leave room for the construction of planned substitute/new coal-fired power plants with a total capacity of 1,050 MW6 until 2030. This is 350 MW more than provided for in the moderate renewable scenario of the Framework Energy Strategy of BiH until 2035; however, it is less compared to the other three scenarios of the same Strategy. Compared to the scenario of the Entity working groups, the installed capacity of new coal-fired power plants provided for in this document is lower by 1,600 MW and compared to the scenario of optimised/least-cost indicative plan, it is lower by 400 MW. Construction of substitute thermal power plants is justified by the need for gradual decarbonisation of mining areas. It would take much more than 10 years to create a sufficient number of job posts in noncoal-related activities. The option with 750 MW of substitute and new coal-fired power plants was also analysed, which implies more intensive international assistance on decarbonisation with an additional focus on assistance in fair transition of mining areas. This option implies the construction of another thermal power plant next to block 7 in the Tuzla thermal power plant. Meeting the targets of both options is dependent on receiving international assistance and participation in international financial mechanisms for reducing GHG emissions. The unconditional target of reducing GHG emissions for 2030 is 12.8% (excluding GHG sinks) compared to 2014. The conditional target (with more intensive international assistance, especially for the fair transition of mining areas) for 2030 is 17.7% (excluding GHG sinks) compared to 2014. An overview of GHG emission reduction targets of BiH compared to the emissions from 2014 is shown in next table.

Target/Year	2025	2030	2050
Unconditional	9.10%	12.80%	50%
Conditional	9.80%	17.50%	55%

Table 1. *GHG emission reduction targets for BiH (compared to 2014 emissions)*

Next graph shows GHG emissions from 1990 to 2050 in line with the previously described targets. Emissions until 2014 were taken from the inventory, and emissions from 2014 until 2050 were modelled in LEAP, taking into account measures by individual sectors.



Graph 9. *GHG emissions in BiH by 2050 according to emission reduction targets*

This graph shows the cessation of the two-and-a-half-decade long trend of emission growth until 2020, which is due to operating hours limitation in most of the inefficient coal-fired thermal power plants and the commissioning of a certain number of RES plants. However, this is sufficient to stop the growth trend only. The decrease in emissions begins with the commissioning of more efficient thermal power plants, which enables decommissioning of a number of existing thermal power plants. In parallel, the resources of the mines will be gradually used to produce RES (biomass cultivation, space for solar power plants, etc.). Measures are also being implemented in other sectors, especially in the construction sector: reducing the use of coal and heating oil with the implementation of energy efficiency measures to reduce heating and cooling needs, increasing the efficiency of heating and cooling systems, energy efficiency labelling and banning imports of used heating and cooling equipment, etc. Reform of the incentive system for RES will be aimed at encouraging decentralisation of the energy system and implementation of community energy projects. Under the unconditional target option, the emission reduction after 2025 is milder than under the conditional target option because more power is generated in the new coal-fired power plants (1,050 MW vs. 750 MW). Emissions in 2030, according to the unconditional target, amount to 22,726 Gg CO_2eq, which is by 12.8% less compared to 2014. In the same year, according to the conditional target, emissions are 21,501 Gg CO_2eq, which is by 17.5% less compared to 2014. Emissions in 2050, according

to the unconditional target, amount to 13,031 Gg CO_2eq, which is by 50.0% less than in 2014. In the same year, according to the conditional target, the emissions amount to 11,728 Gg CO_2eq, which is by 55.0% less than in 2014. It is very important to emphasise that both targets are characterised by the following:

- Cessation of the long-standing emission growth trend in the short term
- Ambitious reduction of GHG emissions in a relatively short period (2014 – 2030)
- Halving of emissions by 2050 compared to 2014

In addition, it is important to point out that the presented targets mean a reduction in GHG emissions for slightly more than one third by 2030, and almost two thirds (about 66%) by 2050 compared to 1990. Taking into account the size of the GHG sinks in 2014 and emissions according to the conditional target in 2050, net emissions in 2050 would amount to around 5,330 Gg CO_2eq, which is about 80% less compared to the net emissions in 1990.

In order to achieve the defined targets, it is necessary to implement measures that are demanding both in terms of planning and finances. To achieve the targets under both options (unconditional and conditional target), BiH will need a strong international assistance for capacity building, training, technology transfer, establishment of financial mechanisms to encourage decarbonisation, preparation of necessary research and project documentation, as well as project financing itself. In case of the option that defines the conditional target due to faster decarbonisation of the power sector (which requires a higher level of effort on decarbonisation of mining areas), international assistance should be more intensive. Meeting the foregoing defined and described targets will greatly depend on the developments concerning the COVID-19 pandemic, which can have a significant impact on the entire economy.

IV Existing Landscape Fire Management System

For the purposes of this report, the term Landscape Fire Management system includes the organization of all institutions (ministries, agencies, directorates etc.) and civil society organizations (NGOs, professional associations and other stakeholder) at national level that participate (directly or indirectly) in the creation or implementation of measures for wildfire prevention, preparedness and suppression as well as the sustainable use of fire in ecosystem/land management.

4.1. Major Stakeholders Within the Existing System

Identification and analysis of stakeholder impact on Landscape Fire Management is an important step of the sustainable strategies and plans implementation in this field. As a general explanation, the involvement of Landscape Fire Management stakeholders requires the proper identification of individuals, institutions or organizations that can influence the goals and objectives of Landscape Fire Management, by playing a crucial role in the phases pre- and post-fire occurrence. Different stakeholders such as government, community, individuals, academia, NGOs and the private sector are important pillars of increasing landscape resilience.

In Landscape Fire Management context, a stakeholder can be described as any entity that can affect and be affected by Fire Disaster Management. According to UNISDR there are different actors that play an important role in the disaster management process such as national and local governments, NGOs, academia, regional institutions, corporations, media and last but not least, the communities, especially the most vulnerable ones. Harrison et al. claim that stakeholder theory should take in consideration the decision maker roles, their decisions and who takes advantage of the outcomes of those decisions. According to Freeman (1984) and Savage et al. (1991), stakeholders have an interest in the actions of an organization, and they have the ability to influence them or they can be affected by the achievement of the organization's objectives. Stakeholders experience or anticipate experiencing the harm and benefits of an organization. A latest definition describes the stakeholder as someone who has input in decision making as well as who benefits from the decision making results. Stakeholders have two different approaches to Landscape Fire Management, known as proactive and reactive approaches. The stakeholders react in a proactive manner when they plan and conduct activities before the fire happens, such as mitigation and preparedness. These activities aim to tranquilise the adverse impacts of Landscape Fire effectively. On the other hand, if stakeholder activities involve response and recovery, they are embracing a reactive approach. Even though the attitude of stakeholders toward Landscape Fire Management is defined by two different approaches, most studies conclude that stakeholders tend to resolve problems caused by fire by reactive approaches. Both national and local authorities in almost all Western Balkan countries are becoming more aware of the need to develop long-term risk reduction approaches, with a multistakeholder participation approach.

However, as suggested in previous studies, local government units in Republika Srpska lack sufficient knowledge about Landscape Fire risks and vulnerabilities of their communities as well as appropriate disaster risk reduction measures and risk assessment programs at the local level, particularly for smaller communities. In other words, the disaster response and planning capacity at municipal levels could be enhanced.

List of major stakeholders in terms of Landscape Fire Management in Republika Srpska:

- Association of Municipalities and Cities of the Republic of Srpska
- Association of private Forest Owners "Our Forest"
- Associations of Agricultural Producers of the Republic of Srpska
- Directorate for Civil Protection Republic of Srpska
- Firefighters Association of the Republic of Srpska
- Industrial Plantations
- Institute of Statistics Republic of Srpska
- Ministry of Agriculture, Forestry and Water Management of the Republic of Srpska
- Ministry of Interior
- Ministry of Spatial Planning, Construction and Ecology
- National park „Kozara", National park „Sutjeska" and National park „Drina"
- NGO's
- Public Forestry Enterprise "Forests of the Republic of Srpska" a.d.
- Republic administration for geodetic and property-legal affairs
- Republic Administration for Inspection Affairs
- Republic Hydrometeorological Service
- Republic Institute for the Protection of Cultural, Historical and Natural Heritage of the Republic of Srpska
- University of Banja Luka, Faculty of Agriculture
- University of Banja Luka, Faculty of Forestry

Ministry of Agriculture, Forestry and Water Management of the Republic of Srpska

The Ministry of Agriculture, Forestry, and Water Management of the Republic of Srpska stands as the paramount institution within the landscape management framework of the Republic of Srpska. Given its jurisdiction over both agricultural land and forests and forests land, it plays a pivotal role in shaping policies and regulations concerning these domains. In addition to its legislative function, the Ministry assumes responsibility for crafting sub-legal frameworks pertinent to its scope, alongside monitoring the operations of Public enterprises. Furthermore, it actively fosters agricultural development and progression within the region. The Ministry of Agriculture, Forestry, and Water Management of the Republic of Srpska plays a pivotal role in safeguarding the region's forests. Within its diverse responsibilities, the forestry sector is dedicated to the protection of forests, including measures to prevent landscape fires. In addition to Forestry department other departments also play an important role in this issue.

Public Forestry Enterprise "Forests of Republika Srpska" a.d.

Fire protection is an activity of special social interest. Every forest farm within PFE "**Forests of Republika Srpska**" has a special fire protection plan. The fire protection plans include measures and activities aimed

at prevention of fire outbreaks and spreading, fire detection and firefighting, and rescue of people and material goods endangered by fire as well as related obligations and tasks of community authorities. Fire protection plan covers:

- Assessment of forest threat degree
- Preventive forest-breeding measures
- Organisational, material and personnel requirements for plan implementation
- Necessary activities based on forest vulnerability degree assessment
- Plan of informative-propaganda activities
- Staff training plan

The public forestry enterprise "Forests of Republika Srpska" " has received a prestigious FSC™ (FSC™ C013091) certificate for forest management. By definition, "FSC certification of forest management means that forests and forest lands are cultivated according to strict environmental, social and economic standards".

As per FSC-standard principles, i.e. the Forest Protection Guidelines, high protection value is defined as the "Fire-Resistant Forests". The principle emphasizes that these forests can represent a natural barrier to spread of fire. This usually involves natural occurrence of leaves in softwood forests that are very sensitive to fire occurrence.

Although there are no materials strictly separated for this purpose, the protection principles and concepts are known in practice and have been applied for many years. It is of great importance to bring in conifers in unconnected smaller areas that will be crushed by autochthonous deciduous vegetation. Also, the VZV-4a (High protective value) principle defines forests that are important for water supply. In such stands, besides other protective functions they perform, there are also sources of drinking water, which are also used for water supply in the event of firefighting. It is very important to indicate these sources on the map and in practice apply the protection prescribed by FSC principles.

The area managed by the Karst Management Centre is extremely specific and as such has a special management method. In the area of Trebinje, Ljubinje, Bileća and Berkovići, the area of forests and forest land is relatively large and amounts to 138,142 ha (forests owned by the Republic) and 35,152 ha (privately owned forests). Of the total forest area and forest land, the high forests occupy only about 3.5%, which is the reason why more attention is paid to their protection. The largest area is occupied by bushes and thickets, which occupy about 53% of the total area of the state forests. Thickets, although economically almost worthless, ecologically, represent the true richness of karst. Every bush in Herzegovina is extremely important for air purification, soil binding, and erosion prevention and water regime regulation.

PFE "Forests of Republika Srpska" as a user of forests and forest land is organized in 26 forest management units, one development research and planning centre (RDPC) and the Centre for Seedling Plant Production in Doboj and Karst Management Centre in Trebinje.

The Law on Forests of 2009 regulates the policy and planning, management and governing of forests and forest land, forest protection, financing and value of forests, forestry and forest land cadastre and information system in forestry, property relations as well as other issues of importance for forests and forest land in order to promote a sustainable use of forests and forest land and development of forestry.

The forest management plan (FMP) determines the basic guidelines and goals of forest management, measures for improving the state of forests, preservation and strengthening of general forest functions and forest protection. It contains an overview of forest condition as well as the type and scope of work during the 10-year period of the instrument. Forest management is a planning document with ten-year validity. Forest management units are obliged to respect the plans and FMP implementation and adhere to the rules of forest management and forest land prescribed by this document.

The Public Forestry Enterprise "Forests of Republika Srpska" plays a vital role in the fight against wildfires, encompassing both preventive and suppressive efforts. As a responsible steward of the region's forests, it employs effective forest management methods, such as selective logging and reforestation with decid-

uous species, which contribute to reducing fire risks. In the realm of prevention, PFE "Forests RS" focuses on sustainable forest practices, ensuring the maintenance of healthy and well-managed forests.

When wildfires do occur, PFE "Forests of Republika Srpska" plays a crucial role as one of the main pillars in fire suppression. Equipped with skilled firefighting teams and firefighting equipment, they are at the forefront of tackling landscape fires. Their rapid response, coordination with other agencies, and intimate knowledge of the terrain aid in effectively containing and extinguishing wildfires.

By combining their expertise in preventive forest management and their role in swift fire suppression, Forests of Republika Srpska significantly contributes to minimizing the impact of wildfires in Republika Srpska.

Directorate for Civil Protection Republika Srpska

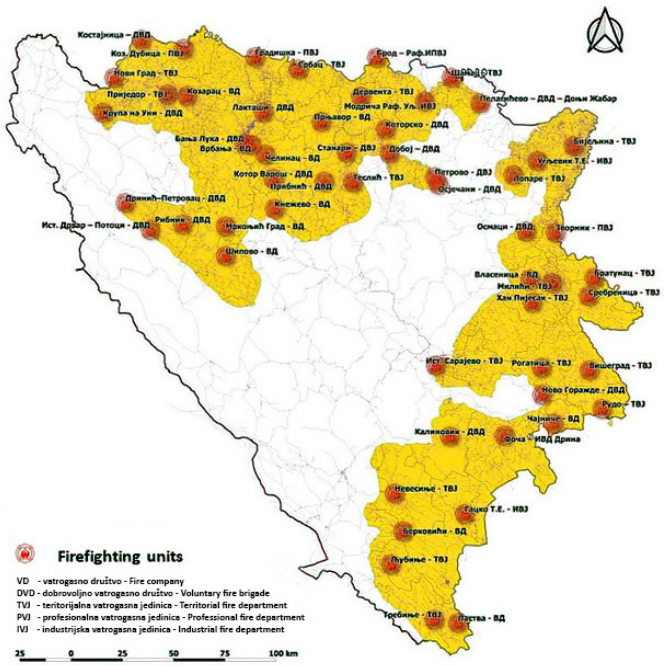
The Directorate for Civil Protection Republika Srpska plays a pivotal role in the fight against landscape fires. As a specialized government body, it is entrusted with coordinating and implementing emergency response measures to safeguard public safety and protect the environment during fire incidents.

Through its proactive fire prevention efforts, efficient emergency response measures, and collaborative approach, it play a crucial role in protecting both human lives and the environment from the devastating effects of wildfires.

Firefighters Association of Republika Srpska

The Firefighters Association of Republika Srpska is a social, non-governmental organisation, which was founded to achieve the common goals of professional firefighting units, firefighting and industrial societies and enterprise firefighting units on the territory of Republika Srpska so as to achieve the fire protection goals and activities in accordance with the Law on Fire Protection.

The Firefighters Association of Republika Srpska has a status of a legal entity as well as a status of an association of public interest for Republika Srpska.



Map 15: *Fire brigade units in Republika Srpska (Author: Dražić S. 2018)*

Republic Hydrometeorological Service

The Republic Hydrometeorological Service is the authoritative institution responsible for a range of critical functions related to weather, climate, and environmental monitoring within the region. Its competencies include weather forecasting, climate analysis, hydrological studies, and collection, analysis, and dissemination of meteorological and hydrological data. The Institute also issues weather warnings, provides valuable information for agriculture, industry, and disaster preparedness, and contributes to environmental protection efforts. Through its work, the Republic Hydrometeorological Service plays a pivotal role in safeguarding public safety and supporting various sectors that rely on accurate weather and climate information.

Republic Administration for Geodetic and Property Affairs

Republic administration for geodetic and property affairs is the primary governmental body responsible for overseeing various crucial tasks and responsibilities. Its jurisdiction encompasses a wide array of duties, including land surveying, land registration, property rights management, cadastre maintenance, and supervision of property-related legal affairs. Moreover, it plays a vital role in ensuring the effective implementation of land-related policies and regulations, as well as the resolution of property disputes within the region of Republika Srpska.

Institute of Statistics of Republika Srpska

The mission of the Institute of Statistics is to provide reliable, high-quality, comprehensive, timely and internationally comparable statistical data, which meet the requirements of decision-makers, researchers, and other domestic and international users, while at the same time presenting the situation and changes in the economic, demographic, and social area, environment protection and natural resources.

National park „Kozara“, National park „Sutjeska“ and National park „Drina“

Republika Srpska, a region known for its natural biodiversity, is home to three remarkable national parks: “Kozara,” “Sutjeska,” and “Drina.” National parks are areas with a large number of diverse natural ecosystems, prominent landscape features and cultural heritage in which people live in harmony with nature, intended to preserve existing natural values and resources, overall landscape, geological and biological diversity, as well as to satisfy scientific, educational, spiritual, aesthetic, cultural, touristic, health-recreational needs and other activities in accordance with the principles of nature protection and sustainable development. The total area of these three National parks is 26,275.20 hectares.

Associations of Agricultural Producers of Republika Srpska

Operating across more than a million hectares of agricultural land in Republika Srpska, the Associations of Agricultural Producers serve as important pillars in the region’s farming community. With an extensive network of farmers, these associations spearhead initiatives to enhance agricultural productivity, ensure sustainable land management, and promote modern farming techniques.

Republic Administration for Inspection Affairs

The Republic's Administration for Inspection Affairs performs inspections, administrative and other professional tasks of inspectoral supervision over the applied regulations which, among other things, relate to: the phytosanitary area and the area of primary plant production and agriculture; forestry, hunting; water, geology, spatial planning, urbanism, construction, ecology, surveying; protection against fire, explosive substances, flammable liquids and gases and giving consent to the appointment of local self-government unit inspectors and direct supervision of their work, as well as the drafting of legal regulations.

Forestry Faculty

The Forestry Faculty of the University of Banja Luka is a higher education institution with a long tradition, good teaching, and administrative staff. The faculty was created in difficult, wartime conditions, but very successfully educates experts in the field of forestry. At the same time, the faculty provides the necessary knowledge for scientific research in various areas of modern forestry science.

4.2. Organizational Setup of the System

In Republika Srpska, the long-standing challenges in fighting wildfires have led to the formation of the current landscape fire management system, which is presented in the scheme below. Although the scheme involves a wide range of stakeholders, including government ministries, public enterprises, state institutions, educational institutions, and non-governmental organizations (NGOs), its effectiveness is hampered by several critical shortcomings. One significant issue is the system's current unwieldy and cumbersome nature. The abundance of participating entities often leads to a lack of streamlined coordination and communication. Consequently, the response to fire incidents can be delayed or inefficient, with various stakeholders potentially duplicating efforts or, in some cases, failing to act in unison. Moreover, the absence of a robust early warning and reporting system further compounds the challenges faced in managing landscape fires effectively. The inability to receive timely information about fire outbreaks hampers the rapid mobilisation of resources, exacerbating the impact of wildfires on the environment and local communities.

Another aspect that requires immediate attention is the limited involvement of educational institutions, including universities and colleges, in the decision-making and advisory process. These academic establishments possess valuable expertise and research capabilities that could significantly contribute to the development of more effective fire prevention and management strategies. By fostering closer collaboration with educational institutions, the landscape fire management scheme can benefit from innovative ideas and evidence-based practices.

Addressing these shortcomings and streamlining the coordination among ministries, public enterprises, state institutions and educational establishments is vital to enhancing the overall efficiency and effectiveness of the landscape fire management scheme in Republika Srpska. By doing so, the region can take significant strides towards protecting its natural heritage and safeguarding communities from the devastating consequences of wildfires.

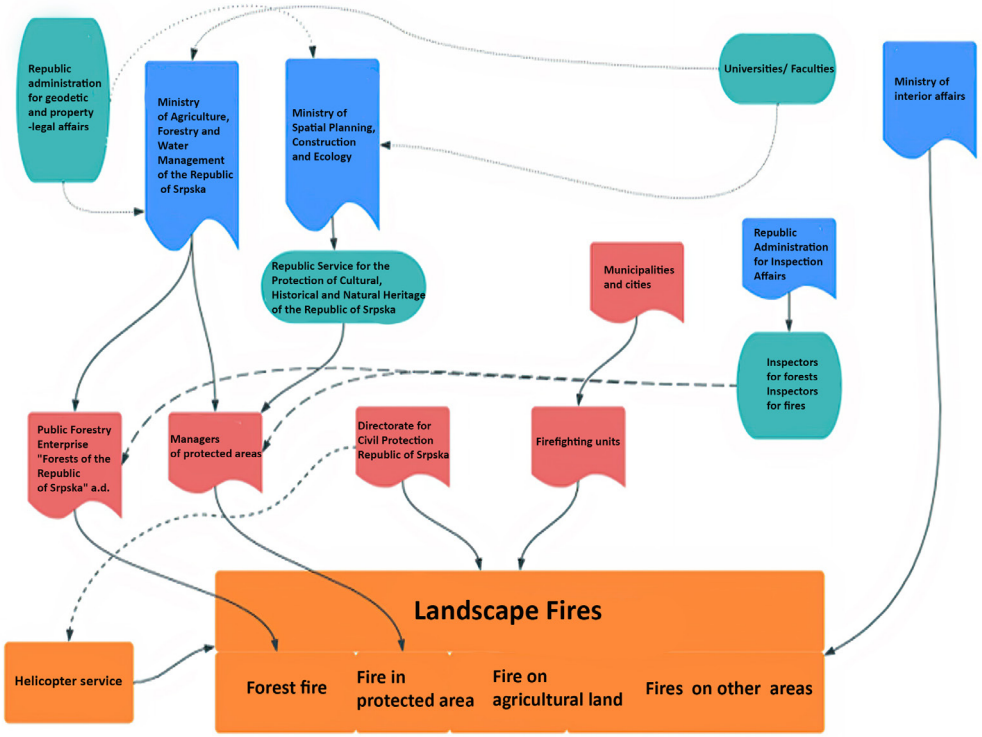


Figure 1: *Simplified Scheme of the current fire management system in Republika Srpska (Interrupted line – advisory role, indirect impact, Full line – direct impact, direct jurisdiction) Source: own ilustration*

4.3. Legislation Regulating This Field

The main documents related to this field:

Law on Fire Protection of Republika Srpska

This Law provides all basic and specific standards and requirements aimed to establish the system of fire protection and prevention on the territory of Republika Srpska, including rights and obligations of companies and other legal entities and bodies, rule of state administration authorities and other bodies, local governments and their duties, entrepreneurs and other individuals as subjects of fire protection measures, specific technical fire protection measures, planning and organization of the mandatory fire protection, fire service organisations, supervision of the implementation of fire protection measures and funding and other financial aspects, all concerning fire protection.

Forest Development Strategy of Republika Srpska for 2011–2021

Forestry in Republika Srpska faces complex changes that must be considered when ensuring sector development. Management and protection of forests should ensure balance between the diverse demands of the society towards forestry and the preservation of forest ecosystems. The aim is to implement the necessary integration of all stakeholders, government institutions, private sector, and local communities in the process of implementation of activities that contribute to the forest development. Considering the societal need for improvement of forest conditions, the Forest Development Strategy of Republika Srpska for the programmed period 2011-2021 was developed and adopted. This Strategy provides the basic assumptions for the sustainable development of forestry, with the main goal of maintaining and improving all forest functions.

A new strategy with a validity period from 2022 to 2032 is currently being developed.

Nature Protection Strategy of Republika Srpska

The Environmental Strategy of Republika Srpska was adopted on 17th November 2022, during a regular session of Republika Srpska Government. The adopted document is an integral part of the Environmental Strategy of Bosnia and Herzegovina – BiH ESAP.

This document covers seven thematic areas: water management; waste management; biodiversity and nature protection; air quality, climate change and energy; chemical safety and noise; sustainable resources management; as well as environmental management.

For each of the thematic areas, Republika Srpska Environmental Strategy established priorities and measures to improve the environment, mitigate and reduce the impact of climate change and strengthen resistance to it, find better compliance of regulations with EU regulations and international agreements in the field of environment, more efficient management of the environmental sector in BiH, ensure better public services in the areas, and integrate issues of gender equality, social equality and poverty. The Strategy also offers indicative financial frameworks for implementing measures.

The Law on Forests of Republika Srpska

This Law regulates the policy and planning, administration and management of forests and forest areas and forest land on the territory of Republika Srpska.

The Law further defines all necessary rules and requirements aimed to regulate the mandatory forest protection, financing and use of forests, Forest Agency duties and obligations, Forest Commission authorities and relations, cadastre and forestry information system, property relations and obligations, as well as other issues of importance for the safe, sustainable and secure management and development of forests. The provisions of this Law shall apply to all forests and forest lands and to all types of property.

Forests are natural resources of common interest, and they enjoy special care and protection in Republika Srpska. The right to use the forest and forest land can be limited when this is in public interest.

The Law on Nature Protection of Republika Srpska

This Law provides the basic provisions and general rules for protection and preservation of natural, biological, geological and landscape diversity, as part of the national environment, here classified as common good in Republika Srpska.

Major objectives of this Law are the preservation and improvement of biological (genetic, species and ecosystem), geological and landscape diversity, which are also the objectives of the National Strategy for Nature Protection and the State of Nature Report (basic document with provisions in accordance with this Law); effective harmonization of human activities, economic and social development plans, programmes and projects with sustainable use of renewable energy and non-renewable energy resources; sustainable use and management of natural resources and goods, facilitating their function by preservation of natural values and balance of natural ecosystems; prevention of human activities and activities that can lead to permanent depletion of biological, geological and landscape diversity as well as disorders with negative consequences in nature; constant monitoring of the state of nature.

This Law further stipulates the classification of all responsible institutions, administrative bodies and natural persons as well as their duties and authorisations to implement various nature protection related activities (article 11-15).

The Law on National Parks of Republika Srpska

This Law regulates various issues of significance for the protection, development, promotion, management, financing, and sustainable use of national parks on the territory of Republika Srpska.

The Law on Agriculture, Food and Rural Development of Bosnia and Herzegovina

The principal objectives of this Law are to: define the framework of institutional structures, competencies, responsibilities, reporting lines, legislative drafting, coordination mechanisms, consultation processes, rights, obligations and enforcement measures at all levels of BiH government involved in development of the agriculture, food and rural sector; define the framework and mechanisms to strengthen competitiveness, the quality of agricultural and food products and the application of standards needed to achieve the dynamic development of the agriculture, food and rural development sector; define the framework and mechanisms required to prepare for association with, and accession to, the European Union and consequential fulfilment of all obligations defined by international agreements related to the sector of agriculture, food and rural development on the BiH territory; define a framework to ensure conformity of sector strategies and agro-economic policies, specific implementing measures and enforcement procedures required for the coordinated development of the sector of agriculture, food and rural development; define framework objectives of the agriculture and rural development sector and to set up the framework of measures needed for its realisation.

The Law on Environmental Protection of Republika Srpska

The basic goals of this Law are: reduction of use of certain sites or aspects aimed at preventing environment pollution as well as improvement and restoration of damaged environment in damaged natural sites; protection of human health and improvement of environmental conditions for a sustainable and minimum necessary quality of life; conservation and protection of natural resources, rational use of resources and a way by which the economy can ensure restoration of resources or damaged goods; collaboration with other entities engaged in environmental protection; mandatory international cooperation in environmental protection sector; constant encouragement of public participation; concrete coordination of economic and social integration and economic development in accordance with the requirements for

environment protection; establishment and development of new institutions for protection and preservation of the environment.

The Law on Spatial Planning and Construction of Republika Srpska

This Law provides all standards and official requirements aimed to regulate the system of spatial planning and construction standards, preparation and adoption of spatial planning documents, location conditions, land construction rules and requirements (environmental provisions), issuance of building permits, type and content of technical documentation, building construction and relationships between participants in such constructions, use and removal of buildings, legalization of buildings (administrative and technical), measures for the mandatory implementation of the Law, jurisdiction and operation of the Chamber of Engineers, and other issues of importance for spatial planning, construction on land and construction of facilities on the territory of Republika Srpska.

Law on Agricultural Land of Republika Srpska

This Law regulates the planning, protection, development, use and management of all land parcels defined and classified as agricultural land on the territory of Republika Srpska. This Law also prescribes various administrative and concrete technical rules and requirements including the common interest principles, inspection, monitoring issues and additional practices to be implemented in order to obtain safer, more secure and sustainable use of the agricultural land (considered as a natural resource and a major common good).

Master Plan for Afforestation in Republika Srpska

This plan represents important document for the effective and sustainable spatial management within the region. This plan serves as a guiding framework for promoting ecological balance, mitigating environmental risks, and ensuring the long-term viability of forest ecosystems. This plan advocates for increased participation in afforestation, with a particular focus on planting deciduous tree species. This emphasis aligns perfectly with the recommendations of LFM framework, aiming to reduce the risk of landscape fires and enhance landscape resilience against fires. By prioritising the cultivation of deciduous species known for their fire-resistant characteristics, the Master Plan not only ensures the safeguarding of the forested areas but also contributes to the overall sustainability and long-term health of the region's ecosystems.

Spatial Plan of Republika Srpska (2013-2025)

The optimisation of land use represents one of the most crucial segments of the planning system in the country and depends on a large number of natural, economic, and demographic factors. Various planning interests and interdependent goals between agriculture, water management, industry, mining, tourism, transportation, environmental protection, defence, and other interests are closely tied in terms of spatial use with forests and forested areas. These relationships are clearly outlined in the Spatial Plan of Republika Srpska (2013-2025), through strategic priorities in the forestry sector: implementation of the Forestry Development Strategy, increase in forest cover, forest improvement, protected areas, and enhancement of forest management, among others. Additionally, the Spatial Plan defines areas closely related to forest

ecosystems, including the development and protection of biodiversity, regions with characteristic flora and fauna, protection and preservation of protected natural assets, and the protection and regulation of landscapes.

Law on Rescue and Protection in Emergency Situations

This Law establishes a complete national system for the concrete defence and response to various emergency situations on the territory of Republika Srpska. The rules provided by this Law are aimed to offer rescue and protection measures for all sorts of emergency situations caused by human and/or natural disasters and incidents, including the duties and responsibilities of the competent bodies on local and regional level, further defining various monitoring issues and other rules, all necessary for the protection and rescue of human lives, environment and nature.

In this regard, forestry legislation and administrative arrangements of Republika Srpska and Bosnia and Herzegovina must comply with EU Directives and Regulations. Fulfilment of this obligation implies the incorporation of the following contents in domestic laws and regulations: Council Directive 43/92/EEC on the conservation of natural habitats and of wild fauna and flora with the obligation to set up an ecological network Natura 2000; Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds; Council Directive 1999/105/EC of 22 December 1999 on the marketing of forest reproductive material; Council Regulation (EEC) No 2158/92 of 23 July 1992 on protection of the Community's forests against fire; Council Regulation (EEC) No 3528/86 of 17 November 1986 on the protection of the Community's forests against atmospheric pollution; Council Regulation (EEC) No 1615/89 of 29 May 1989 establishing a European Forestry Information and Communication System (Efics).

V History of Landscape Fires for 2000-2021

This chapter delves into the historical analysis of landscape fires in Republika Srpska over the period from 2000 to 2021. Landscape fires, both wildfires and landscape fires, have had a significant impact on the region's ecosystems, communities, and natural resources during this timeframe. By examining the frequency, intensity, and trends of these fire incidents, we aim to gain valuable insights into the patterns of fire occurrence and their implications for fire management and environmental conservation.

The chapter begins with an overview of the historical fire data, including the number of fire incidents and burnt areas. This analysis provides a comprehensive understanding of the geographical extent and the temporal variations of landscape fires during the specified period. Furthermore, we explore the contributing factors and drivers behind the observed fire patterns, including climatic conditions, land-use changes, human activities, and fire management practices. Understanding these underlying causes is essential for developing effective strategies to mitigate fire risks and enhance landscape fire management in the future.

This chapter aims to provide a comprehensive historical perspective on landscape fires in Republika Srpska from 200. to 2021. By analysing past fire data and trends, we aim to inform and guide future fire management policies and practices, fostering a more fire-resilient and sustainable environment for the region.

Fundamentally, wildfire events are accepted to be crucial phenomena within the ecosystem cycles of a variety of biomes on earth (Pausas and Keeley, 2014). Naturally, our home planet holds vital burnable conditions based on its characteristics such as: carbon-rich vegetation, dehydrated seasons, oxygen availability, and lightning etc., which are among factors promoting originally natural wildfire ignition events. Yet, based on the current literature, a large number of wildfire ignition cases are caused by human factors. Especially in the Western Balkan context, a great majority of wildfire burst events are reported to have been caused by human activities being either intentional or accidental.

While the wildfire ignition occurrences rely mainly on human activities and rarely on catastrophic natural events, the spreading phases of wildfire are mostly dependent on a range of physical and environmental properties of the territory. The factors underlying fire ignition such as lightning, uncontrolled burns, arson, negligence, differ from those facilitating fire spread, as are fuel type, meteorological conditions, slope, and capacities for effective fire suppression. Other microclimatic settings such as temperature, precipitation, solar radiation, wind direction and speed, etc., are directly affected by physical properties of the context like altitude, aspect (orientation), latitude, and topographic formation.

Fire occurrence in Republika Srpska is seasonal with maxima in March and secondary peak in August. Both drought periods over the summer and human influence have increased the number of wildland fires in the last decades. For example, rural abandonment contributes to weed expansion, vegetation succession, and conversion of cropland into shrubland, making some areas highly vulnerable to wildland fires.

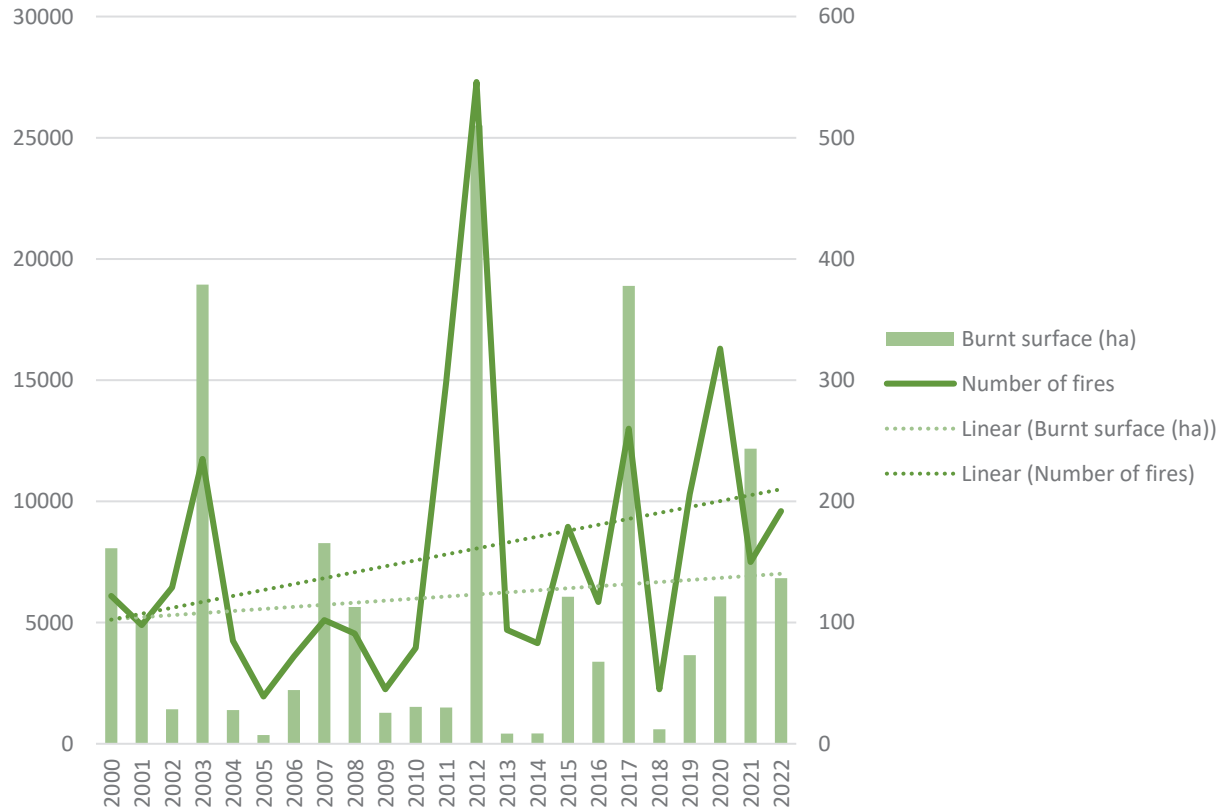
Up until now, precise spatial distribution data regarding forest fires has been lacking due to the historical practice within the state forestry agency. Accurate location information for fires was not recorded in their existing records; only the departmental numbers associated with the fire's location were documented. This approach was predominantly followed by the PEF Šume RS. Consequently, the absence of specific geographical data has posed challenges in comprehensively analysing the patterns and impacts of forest fires in the region. This underscores the need for an enhanced and more precise recording system to gather reliable information about the spatial distribution of forest fires and enable more effective fire management strategies.

Previous records on wildfires were kept in forms prescribed by the Ministry of Agriculture, Forestry and Water Management of Republika Srpska. In most cases, the lowest level of record keeping on wildfire occurrences is kept at the departmental level. This means that the exact geographical location of the wildfire is not determined, but only the micro-area where the fire occurred is indication. In such case, only forestry department or numerous departments are entered in the records, but even then, there is no information of the exact geographical wildfire location. In addition to the listed data on wildfire location, the document/form also contains other groups of data: type of fire and area affected by the fire; type of plants affected and type of burned forest stand; wildfire duration; damage caused per plant type and amount of damage, damage value; causes of fires and key factors in extinguishing fires. (Ljubojevic 2015)

Year	Number of fires	Burnt surface (ha)	Totally destroyed wood mass (m^3)	Direct damage (BAM)	Firefighting costs (BAM)
2000	122	8,064	28,272	1,102,608	-
2001	98	5,066	41,381	1,613,859	-
2002	129	1,426	12,387	483,093	-
2003	235	18,942	97,231	3,792,009	-
2004	85	1,391	42,931	1,674,309	-
2005	39	360	3,479	135,681	-
2006	72	2,214	9,919	386,841	-
2007	102	8,279	52,974	2,065,986	-
2008	91	5,646	28,974	1,129,986	-
2009	45	1,281	5,354	208,806	-
2010	79	1,523	2,802	554,796	32,713
2011	298	1,497	79,268	2,739,504	174,298
2012	546	25,508	83,491	7,084,771	743,485
2013	94	422	741	286,973	48,199
2014	83	428	362	153,267	2,039
2015	179	6,067	21,654	74,189	149,757
2016	117	3,388	17,317	812,573	47,598
2017	260	18,886	254,598	2,694,786	138,833
2018	45	599	3,361	142,844	13,227
2019	206	3,654	13,722	609,132	77,207
2020	326	6,076	25,081	1,818,269	212,079
2021	150	12,173	5,734	1,806,172	159,576
2022	192	6,832	38,263	1,497,579	83,602
Total	**3,593**	**139,722**	**869,296**	**32,868,033**	**1,882,613**
Average	**156.2**	**6,074.9**	**37,795.5**	**1,429,044.9**	**144,816.4**

Table 2. *Overview of the number of forest fires and damage value for the period 2000-2022:* ***Source of data:*** *Republic Statistical Institute of Republika Srpska*

When we analyse the data from Table 2, we notice that massive damages were recorded within the observed period. The total burnt area is 139,722 ha, while the total destroyed wood mass is 869,296 m^3. When observing the economic aspect of recorded forest fires, it can be concluded that total damage amounts to 32,868,033 BAM for the analysed period, which represents significant financial damage. The financial consequences are also reflected through the total firefighting costs which amount to 1,882,613 BAM (only for last 10 years).



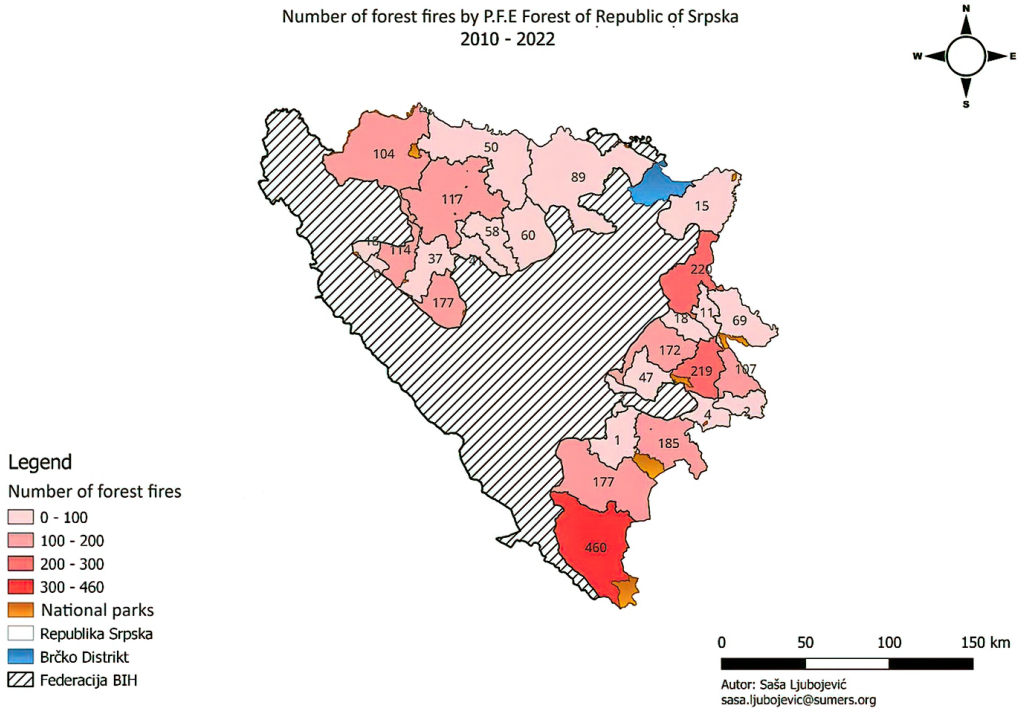
Graph 10. *Ratio of the number of fires to the burnt surface* ***Source of data:*** *Republic Statistical Institute of Republika Srpska*

Based on the previous graph, it is evident that there is a clear upward trend in the number of fires (red line on graph) and an increasing trend in the burnt area over the last 22 years in Republika Srpska. The data presented in the graph highlight a concerning pattern of rising fire incidents and expanding burnt areas, signifying a significant challenge for fire management and environmental preservation in the region.

Year	Crown Fire	Surface Fire	Ground Fire
2010	1	78	0
2011	4	293	1
2012	23	517	6
2013	1	89	4
2014	0	83	0
2015	6	170	3
2016	1	116	0
2017	12	247	1
2018	3	42	0
2019	2	203	1
2020	9	317	0
2021	9	137	4
2022	12	180	0
Total	**83**	**2,472**	**20**

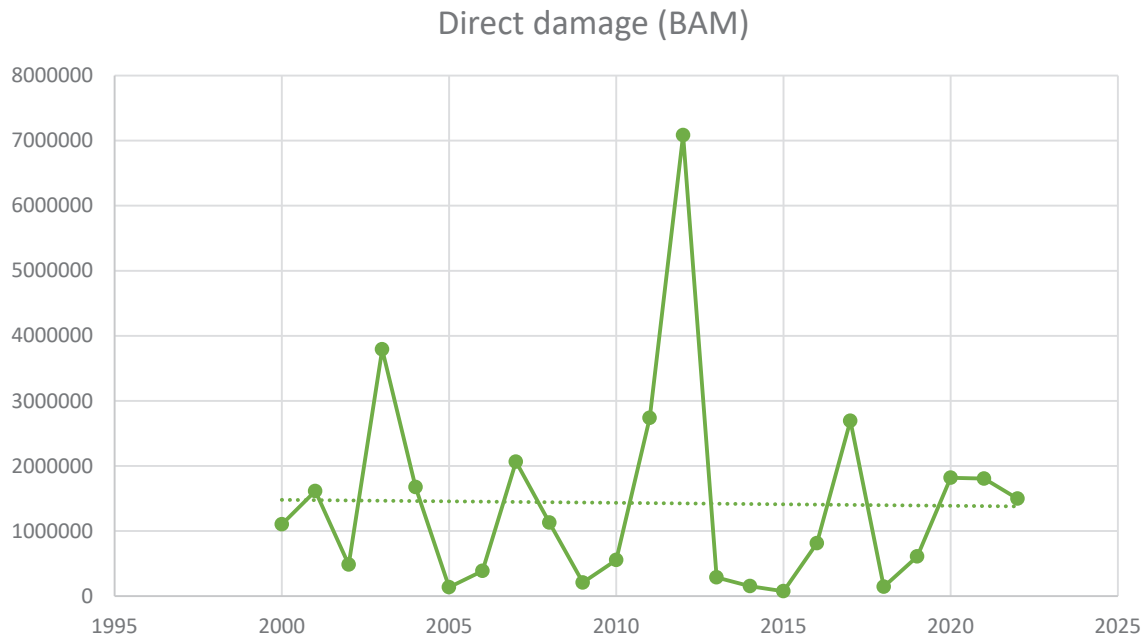
Table 3. *Number of forest fires by forest strata, for the period 2010-2022:* ***Source of data:*** *Šume RS*

Table 3 shows the recorded types of fire during the observed period. Analysing the recorded fires, we can see that the most frequent fire was surface fire type which occurred 2,472 times, while, on the other hand, there was a small incidence of crown fires which occurred 83 times and ground type fire which occurred 20 times.



Map 16: *Overview of the number of forest fires by forest-economic regions for the period 2010-2022 (Author: Ljubojevic 2023)*

Based on the previous map illustrating the distribution of fires across forest-economic regions, it becomes evident that the most frequent occurrences of fires are concentrated within the region of Herzegovina. This observation highlights the higher incidence of forest fires in this area compared to others. The data underscores the significance of focusing fire prevention and management efforts on Herzegovina to effectively mitigate the risks posed by frequent fire events and safeguard the forest ecosystems in this specific region.



Graph 11. *Direct damage from wildfires during the previous period in BAM. Source: Šume Republike Srpske* ***Source of data:*** *Šume RS*

The Ministry of the Interior only has data on Landscape fires in which there were elements of a criminal offense. This ministry keeps no record of the area that was burned, but rather there exist only a division based on who the property belongs to.

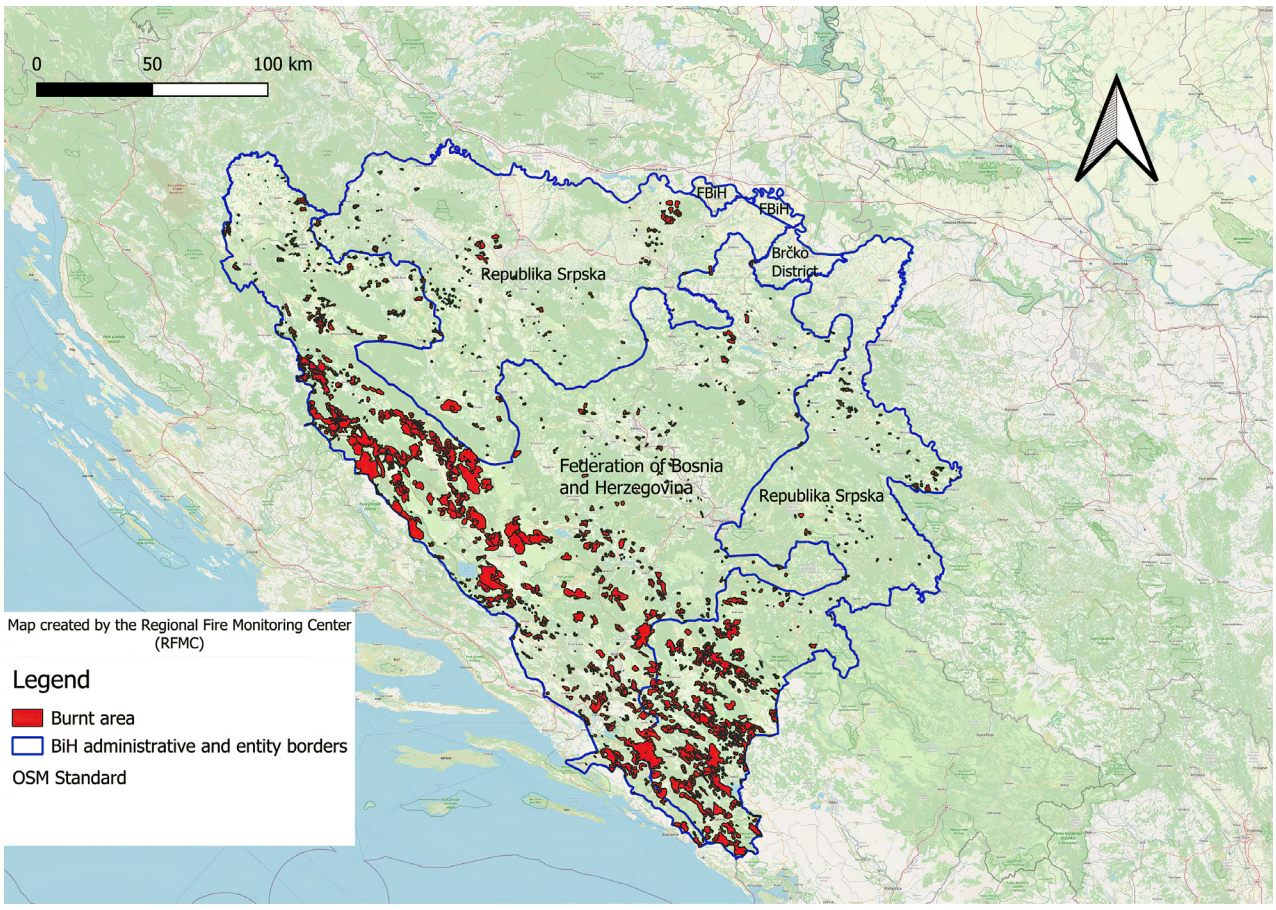
Period	Total	State property	Private property
2014	73	21	52
2015	239	82	157
2016	169	64	105
2017	350	177	173
2018	52	39	13
2019	221	94	127
2020	199	45	154
2021	191	27	164
2022	350	62	288

Table 4. *Numbers of forest fires and fires in the landscape for the period from 2014 to 2022P. Source:* ***Source of data:*** *Ministry of the Interior*



Graph 12. *Number of Forest fires and fires in the landscape for the period from 2014 to 2022 Srpske* ***Source of data:*** *Ministry of the Interior*

Based on the previous graphs and tables, it is evident that there is a clear upward trend in the number of fires and an increasing trend in the burnt area since 2000 in Republika Srpska.



Map 17: *Burnt area from Landscape Fires in Republika Srpska (2008 to 2023)*

This map was created based on data provided by the European Forest Fire Information System – EFFIS (https://effis.jrc.ec.europa.eu) of the EC JRC and prepared by the Regional Fire Monitoring Centre (RFMC) in Skopje. In addition to the image representation of the map above, for the period of 2008 to 2023, the digital/interactive map offers the following information (and more):

- Date and geo-referenced location
- Timeframe: beginning and end of fire
- Comparison of fires in the same location but different time periods
- Total burnt area (per fire or overall) expressed in hectares (ha)
- Structure of the burnt area: land use and vegetation type, expressed in percentage (%) of the total burnt area

Data accuracy concerning fire outbreak time was confirmed based on the available information on significant fires that occurred in the last two years (such as those in Ljubinje and Veliki Stolac - the habitat of Pančić's spruce), and the dates coincided, which confirms the reliability of the data. According to these data, the total burned areas in Republika Srpska from 2001 to 2022 is 244,923.44 hectares (with an annual average of 11,132.88 hectares).

According to the data of PEF Forests of Republika Srpska, in the same period, 139,722 hectares of burned areas were recorded in forests and forests land. The difference between this figure and the total burned area of 244,923 hectares according to EFFIS data probably relates to fires on agricultural land and other categories of landscapes.

The fact that 198,496.96 hectares, or an incredible 81% of the total area, were burned in the territories of seven local self-government units in eastern Herzegovina (Trebinje, Bileća, Ljubinje, Berkovići, Gacko, Nevesinje and East Mostar) is striking.

In the past 20 years, Republika Srpska has faced an average of 156 annual wildfires, significantly impacting the region's natural landscapes and agricultural resources. These devastating fires have collectively ravaged an estimated 6,074 hectares of land each year, posing a substantial threat to the environment, wildlife, and local communities.

Understanding the drivers behind the surge in fire occurrences is crucial for implementing effective fire prevention and management strategies. Demographic shifts, land-use changes, climate variations, and human activities are among the factors that may be influencing this trend. Therefore, it is imperative to conduct further in-depth analyses and studies to comprehend the complex dynamics driving the increase in fires. Moreover, investing in advanced fire detection and monitoring technologies, early warning systems, and well-equipped firefighting teams is critical to ensure rapid and efficient responses to fire incidents. Simultaneously, fostering a culture of fire safety and responsible behaviour among the public is essential in curbing human-induced fire ignitions.

In conclusion, the upward trend in the number of fires and the increasing burnt area in Republika Srpska over the last 22 years demands immediate attention and concerted efforts from all stakeholders. By addressing the root causes of the escalating fire incidents and implementing robust fire management strategies, we can work towards reducing the impact of wildfires and safeguarding the environment, communities, and valuable natural resources for future generations.

VI Landscape Fire Risk Assessment

Fire risk assessment is the assessment of the risks to people and property due to unwanted fires. A simple risk assessment considers the probability for a certain unwanted fire scenario to occur as well as the consequence of such a scenario. A comprehensive risk assessment considers all probable unwanted fire scenarios and their consequences.

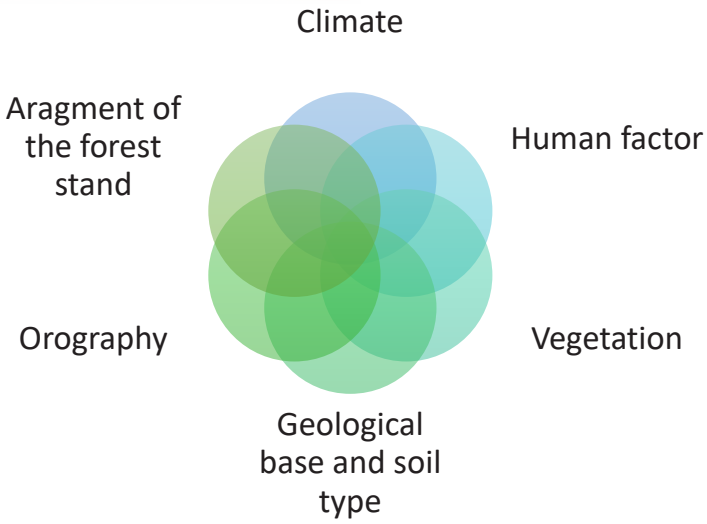
Short term risk refers to fire ignition and fire behaviour as influenced by quickly evolving factors related to climatic conditions or vegetation (fuel) status. Medium term risk refers to fire ignition and propagation as influenced by structural factors with slow change over time.

Short term risk assessments, through efficient operational indices based on weather and fuel characteristics, allow organizing activities for fire pre-suppression, detection, and suppression, and updating decisions (level of alert, management of firefighting on the flaming front) concerning fire risk level changes.

Medium term fire risk includes fire hazard and vulnerability, both influenced by human activities and land use. Its assessment considers: a) the probability of ignition occurrence related to human settlements and socio-economic indicators, and of fire spread; b) potential damage related to fire intensity and vulnerability (incl. the value). Assessment methods are still under development.

The weather can be considered as the most significant component of fire ignition and propagation and assessment of the impact of meteorological factors on daily fire occurrence and behaviour has always been a key point for researchers. Vegetation characteristics are also important to consider. Short-term fire risk is assessed through indices based on daily and even hourly measures of vegetation moisture content and/or of meteorological variables influencing fire behaviour (air temperature, relative humidity, wind, precipitation). These indices consider the risk from the point of view of flammability/ignition ability depending on the fuel conditions (moisture content, temperature) and on the fuel type (continuity, compactness and on whether it is alive or dead fuel). The main purpose of such indices is to provide information, in advance or instantaneously, concerning fire ignition or spread probability. Some indices are based on meteorological data only (in this case, the moisture status of the vegetation is estimated indirectly), others are based on vegetation stress related data, while a third type combines both weather and plant data. A number of these indices have been developed in Europe and requires information about the fire regimes in a determined region, trying to understand the factors that determine the landscape-scale spatial fire patterns. The probability of fire occurrence, considered as an

Fire spread estimations can be accurately obtained with currently existing simulators. However, for a medium-term perspective, the use of regional scales and fire regimes is a more appropriate approach than single event studies. The medium-term analysis of fire spread is based on static variables such as: topography, average weather conditions, living fuel dynamics, and spatial connectivity of fuels including landscape configurations. New satellite images with very high spatial resolution can provide a large amount of spatial explicit information useful for fire behaviour prediction (Birot 2009).

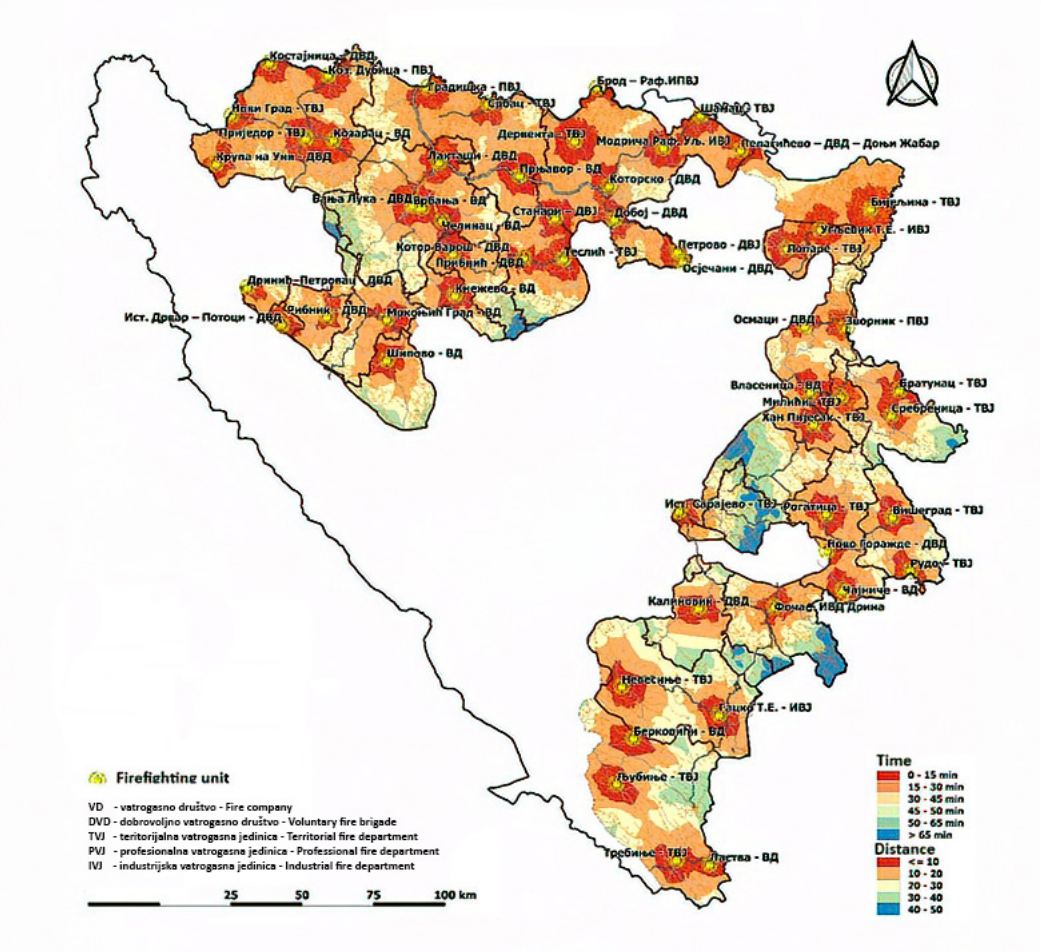


Graph 13. *Criteria for assessing fire hazard* ***Source of data:*** *Rulebook on the content and procedure of creating a forest fire protection plan (Official Gazzete of RS no. 107/09)*

Landscape fires are considered to be natural disasters. Causes of fire are most often directly related to human activities, such as negligence, carelessness, accident, or arson in open areas. Recent research of JRC Technical Reports shows that, due to climate change increasing air temperature and decreasing humidity, could double the area affected by landscape fires in Europe (Ishizaka and Nemery 2013). This fact raises concern and initiates serious analysis of this phenomenon and preventive modelling of landscape fire risk. According to the European Forest Fire Information System's report, BiH is in the fourth place, right behind Algeria, Spain and Portugal, in terms of fire risk (Ishizaka and Nemery 2013).

The aim is production of Landscape fire risk map. Landscape fire risk zones are locations where a fire is highly likely to start, and from where it can easily spread to neighbouring area. Identification of these zones helps us discover areas with increased risk of landscape fire occurrence and its development, which is the basis for emergency intervention planning. This creates favourable conditions for minimizing the number of fires and removing the conditions for their formation. Modern tools and technologies in combination with traditional knowledge could have great importance in prevention and landscape fire control.

The fire response time, which is the sum of all individual times related to the activities included in the time frame for bringing fire extinguishing agents to the spot and the discharge of water. The following map shows that there are areas on the territory of the Republika Srpska which would take firefighters, in the best case scenario, more than 65 minute drive to reach a potential fire from their base.



Map 18: *The coverage of the space and the reaction time of the Republika Srpska fire brigade units (S. Dražić, 2018)*

Currently, there is a lack of a comprehensive fire risk map covering the entire territory of Republika Srpska, Bosnia and Herzegovina. This absence of a detailed wildfire risk assessment poses a significant challenge in effectively managing and mitigating fire-related hazards across the region. To address this critical gap, there is a pressing need to develop and implement a wildfire hazard map for Republika Srpska.

Creating a landscape fire risk map would provide valuable insights into the spatial distribution of fire risks, identifying high-risk areas that require immediate attention and resources. By incorporating various factors such as vegetation types, weather patterns, historical fire data, and human activities, the map could offer a comprehensive understanding of the potential threats posed by wildfires in different regions. Such a map would serve as an essential tool for fire management planning, enabling authorities to allocate firefighting resources strategically and implement targeted preventive measures. Additionally, it would aid in raising public awareness about fire risks, encouraging responsible behaviour, and promoting community engagement in fire prevention efforts.

The collaborative efforts of relevant stakeholders, including government agencies, environmental organizations, and scientific institutions, would be crucial in developing an accurate and reliable wildfire hazard map. By pooling together expertise, data, and resources, a comprehensive assessment can be achieved, ensuring that the map reflects the most up-to-date and relevant information. In conclusion, the absence of a landscape fire risk map for the entire territory of Republika Srpska, Bosnia and Herzegovina presents a significant challenge in effectively managing fire-related risks.

VII Existing Projects

This chapter focuses on presenting a compilation of ongoing projects that address both landscape fire management and mitigation of climate change impacts. The projects highlighted herein aim to tackle the increasing challenges posed by wildfires and their intertwined relationship with climate change. By examining these initiatives, we gain valuable insights into the multifaceted approaches and innovative strategies being deployed to safeguard the environment, communities, and natural resources.

In the context of disaster risk reduction and civil protection the management of landscape fire crises is only one arena in which countries are challenged to develop agreed standards and protocols for enhancing the efficiency and the effectiveness of cooperation. A common landscape fire management terminology, agreed competency-based standards, and agreements that regulate responsibilities and liabilities of cooperating parties are prerequisite for improving governance of major disasters, both for providing and receiving assistance (Goldammer 2000).

The table below gives a comprehensive overview of each project, outlining its objectives, scope, donor, implementer, budget, and duration. The featured projects encompass a diverse range of efforts, including fire prevention and preparedness, community engagement, sustainable land management, and initiatives targeting climate change adaptation and mitigation.

By showcasing these existing projects, we seek to underscore the importance of collaborative endeavours in combating the rising threat of landscape fires and the broader implications of climate change. Each project serves as a testament to the collective determination to address these pressing challenges and foster a more resilient and sustainable future.

No.	Project/ programme/ initiative title	Donor	Implementer	Budget	Duration (from-to)	Website or announcement URL
1	IPA II Cross Border Cooperation (CBC) Programme "Bosnia and Herzegovina – Montenegro"	EU	Directorate for Civil Protection of Republika Srpska	1,530,000.00 €	2015-2020	https://neighbourhood-enlargement.ec.europa.eu/system/files/2016-12/2014_-_2020_ipa_cbc_bosnia_and_herzegovina-montenegro_0.pdf
2	Interlinking Disaster Risks Management	Government of Italy	UNDP	Unknown	01.01-28.12.2019	https://localgovernance.ba/en/project/11/interlinking-disaster-risk-management-in-bosnia-and-herzegovina-idrm
3	UNDP's Fire Risk Management project	Foreign Affairs Ministry of the Czech Republic	UNDP	120,000.00 €	2020 - 2021	https://www.undp.org/bosnia-herzegovina/news/thanks-czech-support-better-fire-resistance-civil-protection-units
4	Disaster Risk Reduction for Sustainable Development in Bosnia and Herzegovina	Joint Programme of the Government of Switzerland and United Nations	UN agencies: UNDP, UNICEF, UNESCO, UNFPA and FAO	8,400,000.00 BAM	2018-2022	https://www.undp.org/bosnia-herzegovina/news/ten-local-self-government-units-selected-within-joint-programme-government-switzerland-and-united-nations-disaster-risk
5.	Joint action to reduce the increased risk of forest fires to nature and people in the context of climate change in Bosnia and Herzegovina	Ministry of Foreign Affairs of the Kingdom of Norway	FEA, Centre for Civil Society Promotion (Centar za promociju civilnog društva - CPCD)	533,458.93 NOK	15/06/2023-15/09/2024	https://www.feasee.org/projects-30/joint-action-to-reduce-the-increased-risk-of-forest-fires-for-nature-and-people-in-the-context-of-climate-change-in-bosnia-and-herzegovina

6.	Protection of nature and environment from forest fires – Forest Eye	EU IPA funds	Entity governments	Unknown	2015 - 2017
7.	Project on Capacity Building for Disaster Risk Reduction through National Forest Fire Information System (NFFIS) and Ecosystem-based Solutions for Disaster Risk Reduction (Eco-DRR)	JICA - Japan International Cooperation Agency	Ministry of Security	Not defined yet.	Since 2023

Table 5. *Existing projects in Republika Srpska*

As we delve into the details of each initiative, we hope to inspire further cooperation, knowledge exchange, and innovation among stakeholders involved in fire management and climate action. These projects exemplify the potential for transformative solutions and hold valuable lessons that can inform and strengthen future endeavours in the pursuit of a safer, healthier, and more environmentally conscious world.

A non-refundable grant from domestic and international organizations represents one of the quality solutions for securing external (co) financing and enhancing human resources and other capacities in the field of landscape fire management. In addition to funds directed towards entrepreneurial development, special attention is given to the role of the forestry sector in fulfilling commitments under the Paris Agreement and the European Energy Community, as well as issues related to rural development, land degradation, and nature protection, increasing resilience to biotic and abiotic factors.

In the current situation, scientific research organizations, civil society organizations, and some local development agencies are focused on attracting grant funds from domestic and international financiers. Potential additional (financial and other) resources for the sector in the new investment period 2021-2027 are found in the EU Horizon programme, IPA funds, and the ERASMUS+ program. In addition to the Swiss Agency for Development and Cooperation, with the help of which the production of this Report was financed, there are ongoing programs from other international development organizations:

- German Corporation for International Cooperation (GIZ)
- U.S. Agency for International Development (USAID)
- Sweden's Government Agency for Development Cooperation (SIDA)
- United Nations Development Programme (UNDP)
- Food and Agricultural Organization (FAO)
- World Bank (WB)

Additionally, other international funds are also significant, such as the Global Environment Facility (GEF), Green for Growth Fund (GGF), Climate Investment Funds (CIF), Green Climate Fund (GCF), Sustainable Development Goals Fund (SDGF), and Special Climate Change Fund (SCCF). These funds can realistically be accessible for activities focused on addressing landscape fire management issues within the framework of green economy, rural development, nature protection, land degradation, environmental protection, and sustainable energy sources.

The banking sector can also provide a significant boost to these activities by creating specialised "green" credit lines (Green Credit Lines, GCL). In this regard, in addition to improving the offerings of commercial banks, the role of the European Investment Bank (EIB) and the European Bank for Reconstruction and Development (EBRD), as well as other international financial institutions, is emphasized within the Economic and Investment Plan of the EU for the Western Balkans.

VIII ANALYSIS OF IDENTIFIED STRENGTHS AND WEAKNESSES (PRO'S/CON'S) OF LFM SYSTEM

The following chapter delves into an in-depth analysis of the strengths and weaknesses, or pros and cons, of the Landscape Fire Management (LFM) system as identified through comprehensive assessment. By scrutinizing the system's advantages and limitations, this exploration aims to provide a balanced understanding of its current state and potential areas for improvement. Through a thorough examination of both the positive aspects and challenges, we aim to derive insights that will inform strategic decisions and guide the enhancement of the LFM system for more effective fire management and resilient landscapes.

Prevention

Preventive fire protection reduces the risks of fire outbreaks, which can reduce total damage from fire to one tenth in relation to the existing state (Stipanicev D., Hrastnik B., 2004). The impact of forest road network density on initial forest fires is large because the higher road network density influences faster fire detection and defence line formation to prevent the spread of terrestrial fires (Larjavaara M., 2005). However, in addition to forest roads and paths, they form lines of defence against forest fires, by which excursions and campers move, which increases the risk of fire (Chuvieco E., Congalton RG, 1989), so there is a significant correlation between the incidence of fire and forest road network density (Arienti CM, et al, 2009).

Forests of Republika Srpska are not passable enough to allow quick access to the location of fire, forest management companies and private owners of forests are not equipped well enough for observation and early detection of fires, or for quick access and putting out fires. Rehabilitation of fire-affected areas is not completed within the foreseen time, which used to be two years as per the former legislation.

In order to prevent damage to landscapes and to society as a whole, it is necessary to build a modern fire protection system that would minimize the harmful effects. This system must provide a forecast of a fire hazard on the basis of which it would be possible to allocate human and material resources necessary for rapid and effective fire extinguishing from areas with lower risk to areas with higher risk. When areas of increased fire hazard are identified in this way, the intensification of the observation would allow for early detection of resulting fires, which would lead to reduction of fire affected areas due to faster firefighting intervention.

Forest roads represent projected and constructed infrastructure objects whose spatial and constructive performance depends on the terrain shape, forest purpose, habitat and occasional opportunities of forest ecosystems, planned works in the forest as well as reduced forests due to forest fires.

The forest path network influences the reduction of large-scale fires occurrence and spread (Lugo A.E. Gucinski H. 2000). The importance of forest roads in fire protection is great because they provide preven-

tive and repressive protection. Preventive protection is not only reflected in the prevention of fire occurrence, but also in eliminating conditions for their occurrence (Ratkinis M. et al, 2006b) as well as through constant monitoring of endangered forest areas, while repressive protection is reflected in the creation of conditions for timely fire extinguishing. Preventive fire protection reduces the risks of fire outbreaks, which can reduce total damage from fire to one tenth relative to the existing state (Stipanicev D., Hrastnik B., 2004). The impact of forest road network density on initial wildfires is large because the higher density of the road network influences the faster fire detection and defence line formation to prevent the spread of terrestrial fires (Larjavaara M., 2005).

a) Prevention - Strengths and Weaknesses

Strengths	Weaknesses
• Well-organized existing systems and legislative framework, providing a foundation for effective fire management. • Existing public awareness campaigns • Existence of statistical data. • Effective implementation of closer-to-nature forest management practices ("preborno gazdovanje"), promoting sustainable and resilient ecosystems. • Favourable climate and vegetation conducive to fire prevention efforts. • Relatively open communication channels, aiding in some aspects of fire prevention coordination. • Abundance of skilled human resources and high levels of expertise in the field. • Non-combustible terrains aiding in reducing fire risks. • Substantial use of deciduous tree seedlings in reforestation efforts. • Active public awareness campaigns regarding fire prevention measures. • Existence of relatively good accessibility through communication infrastructure (highways, regional roads, and forest roads.	• Incomplete application of existing laws • Not well-regulated prevention measures and competences • Improper methodology for data collection • Overlapping responsibilities among institutions leading to inefficiencies in the system. • Excessive participation of coniferous species in afforestation • Weak inter-agency communication hindering effective collaboration. • Inadequate enforcement of sanctions for fire instigators, potentially encouraging negligence. • Lack of learning from past fire incidents, leading to repeated mistakes. • Slow response mechanisms impeding swift and effective fire management. • Financial constraints limiting the implementation of modern technological solutions. • Abundance of neglected and uncultivated land, increasing fire vulnerability. • Depopulation of rural areas due to better employment opportunities in urban areas and average over-aging of the remaining population. • Extensive agricultural activities. • Tendency of abandonment of traditional land uses such as grazing • Overlapping of inspection competencies at subjects of supervision of two levels of inspections • Lack of coordination between inspections on republican and local level • Imposition of more repressive measures relative to preventive measures. • Increasing frequency and intensity of wildfires due to climate change. • Political instability. • Human factors, difficult to control and manage, contributing to fire incidents. • Landmines and other hazardous materials from 90s wars. • Proliferation of illegal waste dumping sites increasing the risk of fire incidents. • Lack of consensus in decision-making processes hampering effective policy implementation. • Investor favouritism influencing regulatory planning decisions. • Continued urban expansion and land development leading to increased interface between urban areas and forests, heightening the risk of fire incidents. • Tendency to increase the use of forests as a raw material producer. • Relatively large areas under conifer monocultures.

Moreover, the longstanding practice of adopting a nature-friendly forest management system, such as the selective logging approach, in Republika Srpska is commendable, as it significantly contributes to reducing the risk of catastrophic forest fires. This traditional method of forest management demonstrates the region's commitment to preserving its natural ecosystems and mitigating the potential impact of wildfires on its valuable forest resources. Furthermore, the vast forested regions in Republika Srpska demand dedicated efforts in forest fire prevention, early detection, and suppression. Implementing sustainable forest management practices, can enhance forest resilience and diminish the susceptibility of forests to catastrophic fires.

To achieve effective landscape fire management, collaboration among government agencies, local communities, and environmental organisations is indispensable. Together, they can devise and implement comprehensive fire prevention and preparedness plans, incorporating community engagement, awareness campaigns, and capacity-building initiatives.

By emphasizing a holistic approach to land use management, one that considers the coexistence of uncultivated land and forests, Republika Srpska can better safeguard its natural heritage and protect its citizens from the adverse effects of landscape fires. Sustainable land management practices and proactive fire management strategies are the cornerstones of building fire-resilient ecosystems and fostering a safer environment for all.

b) Preparedness (Readiness/Pre-suppressive)

In the fire suppression paradigm, there is much work to be done before the actual fire starts. Planning is key for a good development of the fire suppression strategy and some decisions should be taken in advance: acquisition of material, hiring of personnel, and allocation of resources to bases, or even the decisions on where to locate these bases.

All firefighting units in Republika Srpska are professionally and well trained for firefighting in the open, especially those units that regularly have a larger number of fires in their area. In the event of a large-scale wildfire, the fire department, in most cases, would not be able to respond adequately with the available human resources material capacities, so they would be forced to ask for help. Fire vehicles in most fire departments (in more than 70% of cases) are too old, often 20, or even 30 years old. In addition to age, most fire departments face with insufficient number of fire vehicles. In the last 7 years, the fire departments of Banja Luka, Bijeljina, East Sarajevo, Gradiška, Prijedor and Doboj each acquired from one to three fire vehicles and other firefighting equipment, which significantly contributed to the greater efficiency of firefighting units in firefighting and other interventions.

A number of local communities have no established professional firefighting units or voluntary firefighting societies, while a certain number of firefighting units do not have the minimum number of firefighters prescribed by the Law on Fire Protection. Most municipalities do not have a fire protection plan in place.

Preparedness (Readiness/Pre-suppressive) SWOT analysis

Strengths	Weaknesses
• Robust hydrological network supporting firefighting operations. • Abundance of skilled human resources and high levels of expertise in the field. • Presence of dedicated firefighting societies serves • Collaboration with international firefighting agencies for knowledge exchange and resource sharing. • Integration of community-based fire prevention initiatives for improved preparedness and resilience.	• Slow response mechanisms impeding swift and effective fire management. • Financial constraints limiting the implementation of modern technological solutions. • Limited openness of the space due to inadequate road networks can hinder quick and efficient access for firefighting personnel and equipment. • Absence of an early warning and early detection system • Absence of a fire risk map of the Republika Srpska (existing only for forest) • High costs of road construction and maintenance, particularly in challenging terrain. • Insufficient number of meteorological stations

c) Suppression

Strengths	Weaknesses
• Rich experience: The fire services in Republika Srpska have extensive experience in extinguishing outdoor fires, enabling them to respond effectively to emergencies. • Knowledge of the terrain: Firefighters are familiar with the local terrain and specificities, facilitating quicker responses and more efficient management of fire suppression situations. • Involvement of "Šume RS" which actively participates in fire suppression activities, contributing with their resources and expertise in managing forest fires. • The existence of a Helicopter service for rapid response and scouting (RS)	• Outdated equipment: The fire services have outdated equipment, which may be less effective in modern outdoor fire suppression scenarios. • Insufficient number of firefighters: There is a lack of human resources, which can hinder swift and effective responses to emergency situations. • Limited funding: Insufficient financial resources might hinder the implementation of necessary upgrades and training programs, impacting the overall firefighting capabilities in the region.

When fire prevention fails, the firefighting process starts (Çanakçıoğlu, 1993). The first step of this process is to immediately identify the origin of the fire. It depends on noticing the fire in the shortest time possible and extinguishing it before it grows further. Delayed action of identifying the fire ignition location also delays response by the first teams and that may allow the fire to grow bigger and burn large areas (Rodrigues et al., 2019).

The role of fire suppression is to control—and ultimately extinguish—destructive wildfires found by the detection systems (Martell 1982). Decisions on how to extinguish a fire are heavily influenced by how the fire grows and develops, depending on weather conditions, terrain features or fuel type, conditions, and attributes. However, they are also influenced by the available resources, and where those are located. Thus, fire suppression management encompasses decisions not only related to directly acting on the fire once it has ignited, but also to arrange all the available resources prior to the beginning of the wildfire.

Martell (1982) divides the fire suppression process into four stages: resource acquisition and strategic deployment, resource mobilization, initial attack (IA) dispatching, and extended attack (EA) management. The first phase includes all the long-term decisions to make before the fire, which will heavily influence the others. The second, related to resource mobilization, deals with how the acquired resources are distributed between the bases, where the resources will await to be dispatched in an initial attack. This distribution can be performed at the beginning of the fire season, but it may change depending on fire occurrences (Chow et al. 2019).

Initial attack (IA) is an aggressive way of extinguishing the fire with the first resources to arrive. It is focused on arranging the deployed resources, deciding on the strategies to be used and how to implement them to prevent the fire escaping control. If the initial attack fails, an extended attack is needed. Extended attack (EA) comprises two key stages: containment and control. Containment entails the creation of control lines that are expected to hold the fire spread. Control deals with the completion of a control line around the fire, any spot fires, and any other interior areas to be saved as well as the cooling down of any hotspot that may be a threat to the constructed control line. This fire suppression scheme comprehends decisions corresponding to the preparedness stage of a disaster (long-term decisions in acquisition and deployment of resources to bases) and others corresponding to the response stage (resource mobilization, initial attack, and extended attack). The inherent interrelation between these stages makes it almost impossible to develop a specific plan for one of them exclusively. In this regard, operations research can provide integrated tools that help decision-makers determine alternatives. To develop a suitable fire suppression strategy, a significant amount of information is needed. The lack of good quality information could be a major limitation for the development of Operations Research models.

Thompson et al. (2011) review several articles criticizing the lack of robust information regarding fire response and suppression resource performance; they suggest that the first step to improve performance is real-time monitoring and analysis. To anticipate and manage the extinguishment of the fire as fast and efficiently as possible, its behaviour must be predicted, due to its uncertain nature. In this regard, fire growth simulation models are a good forecasting tool.

HELICOPTER SERVICE

The Helicopter service of Republic of Srpska plays important role in the relentless battle against landscape fire, serving as a crucial asset in the swift suppression of initial outbreaks as well as in conducting vital aerial reconnaissance. With its ability to swiftly transport water and fire retardants to inaccessible areas, the helicopter fleet serves as a critical force in the first line of defense against the rapid spread of flames. Moreover, its aerial surveillance capabilities provide invaluable support in identifying potential fire hotspots and determining the most effective strategies for containment, thereby significantly enhancing the efficiency and effectiveness of the firefighting efforts on the ground. On the axis of the Report on the implementation of Helicopter service activities, we see that the total engagement of the Helicopter service of Republic of Srpska, in 2022. amounts to: 77:40 flight hours, 704 water ejections, 704,000 liters of water thrown onto the scene.

d) Post-Fire Management

Post-fire management plays a critical role in the aftermath of landscape fires in Republika Srpska. While fire suppression is essential, the rehabilitation and restoration of fire-affected areas are equally crucial in promoting ecosystem recovery, minimizing erosion, and reducing the risk of future wildfires. This chapter explores the various components of post-fire management in the region, including rehabilitation techniques, monitoring strategies, and community involvement to foster a more resilient and fire-safe environment.

Strengths	Weaknesses
• Presence of a robust capacity for producing planting material in the firefighting system facilitates efficient post-fire rehabilitation, enabling the timely and effective restoration of burnt areas. • Experience in implementing post-fire measures can provide valuable insights for future planning and interventions. • Advancements in vegetation restoration technologies post-fire can contribute to the rapid recovery of ecosystems. • Partnerships with local communities and organisations can provide additional resources and support for the implementation of post-fire measures.	• Lack of learning from past fire incidents, leading to repeated mistakes. • High costs associated with rehabilitation efforts after a fire can strain budgets and resources, impacting the efficiency of restoration activities. • Limited funding and competing priorities in resource allocation may limit the scope and scale of post-fire recovery initiatives, potentially impeding long-term ecosystem rehabilitation.

Post-fire management in Republika Srpska holds immense importance in building resilience against the adverse effects of landscape fires. By adopting a comprehensive approach that includes ecosystem restoration, monitoring, community involvement, and adaptive strategies, the region can better safeguard its landscapes and communities from future wildfire events. The integration of effective post-fire management practices not only aids in ecological recovery but also fosters a proactive fire-safe culture, mitigating

the risk of wildfires in the future. Through collaborative efforts and continued dedication, Republika Srpska can create a more sustainable and fire-resilient environment for generations to come.

LANDSCAPE FIRE MANAGEMENT GUIDELINES

The chapter "Landscape Fire Management Guidelines" aims to provide a comprehensive framework for guiding future actions and strategies in the realm of landscape fire management in Republika Srpska, Bosnia and Herzegovina. By offering essential guidelines and recommendations, our intention is to lay a foundation for effective and informed decision-making in fire prevention, mitigation, and response efforts. These guidelines have been derived from the insights gathered through discussions and suggestions obtained during the workshops held in Banja Luka as part of the LFMWB Programme. Through a proactive and holistic perspective, these guidelines aspire to chart a course towards enhanced preparedness, resilience, and adaptability in the face of fire-related challenges, fostering a collaborative approach that prioritizes the preservation of valuable ecosystems, the protection of communities, and the sustainable use of resources.

Landscape Fire Management plays a role, in protecting forests and landscapes from the consequences of wildfires. However, there are obstacles that impede the effectiveness of fire management programs. This chapter will focus on highlighting the lack of communication between institutions, inadequate integration of fire management in the education system, system inertia, the problem with sparsely populated areas, the expansion of uncultivated and overgrown areas, climate change and other related challenges. We will present a set of proposals aimed at enhancing the fire management system and reducing the risks associated with wildfires.

Promoting Fire Protection Education from Early Age: To cultivate a society that prioritises fire protection, it is vital to introduce the principles of fire management into the curriculum starting at a young age. By incorporating age lessons on fire prevention and preparedness we can raise awareness about the importance of preventing fires and instil in generations a sense of responsibility towards their environment.

Using Media Support for Fire Prevention: Media platforms can serve as powerful tools for disseminating fire prevention messages. Collaboration with media outlets can help in reaching a broader audience and enhancing the impact of fire prevention campaigns.

Creating Awareness about Fire Prevention: Awareness plays a role in mitigating wildfires. Launching a media campaign can effectively educate citizens on methods for preventing fires, responsible land management practices and the importance of reporting potential fire hazards.

Establishing a Comprehensive National Program for Forest and Landscape Fire Protection: It is crucial for the government to develop and implement a program dedicated to safeguarding forests and landscapes from fire incidents. This program should encompass guidelines for land management conducting fire risk assessments and implementing effective emergency response strategies.

Developing an Early Warning and Early Detection System: An effective fire management system requires an early warning and reporting mechanism. Investing in modern technologies and Geographic Information System (GIS) mapping can provide real-time data on fire risk areas, enabling swift response measures.

Establishing an Integrated Forest Fire Statistics System: To ensure efficient data collection and utilization, a seamless system for forest fire statistics should be established. From data collection to analysis and dissemination, every step must be well-coordinated, involving all relevant stakeholders.

Formation of a Land Management Authority: Creating a dedicated body responsible for managing agricultural land can streamline land use planning and minimize the risk of wildfires in rural areas. This authority should focus on promoting responsible land management practices.

Enhancing Inspection and Oversight Processes: To identify potential fire hazards in a timely manner, a more effective inspection and oversight process should be put in place. This includes periodic assessments of fire-prone areas and the implementation of stringent safety measures.

Encouraging Interagency Collaboration: Establishing a collaborative approach to fire management requires experts from different institutions and neighbouring countries to work together. Regular meetings and discussions should be held to pool resources, knowledge, and expertise, ultimately leading to a more robust fire management strategy.

Regular Training for Fire Management Personnel: Continuous training and skill development are vital for firefighters and personnel involved in fire management. By organizing regular training sessions, we can equip them with the latest firefighting techniques and safety protocols.

Data Sharing Agreements: Collaboration among institutions can be enhanced through formal data-sharing agreements. By sharing vital information on fire incidents and management strategies, we can improve response times and minimize damage.

Strengthening Regional Cooperation: In regions prone to wildfires, close cooperation between neighbouring areas is essential. Joint efforts can ensure efficient resource allocation and faster response times during emergencies.

Normative regulation of numerous deficiencies in the existing legislation governing operation and organisation of firefighting units. Absence of sanctions for causing landscape fires significantly contributes to a large number of fires, large material damage, and, in extreme situations, loss of human life. In accordance with neighbouring experiences, it is necessary to consider the adoption of a Law on Fire Fighting, which would completely solve the issues and status of firefighting units at the local level as well as the organisation at the Republic level.

Based on the analysis of the firefighting units organisation and operation area, it is necessary to carry out the procedure of their organisation in accordance with Art. 39, 44 and 49 of the Law on Fire Protection, so that the response to the fire is timely. It was observed that some local communities have no **Fire Protection Plans**, while those which do have such plans in place, do not fully implement them (the problem is with filling in the number of firefighters and the level of technical equipment). With reference to the above, the lack of appropriate legal sanctions has negative consequences for the most responsible persons in local communities, requiring appropriate amendments to the Law.

It is necessary **to ensure consistent execution of jobs and tasks** of all subjects that are obligated to implement and organise fire protection measures in forests and agricultural lands as well as better coordination of firefighting unit members in this area.

In situations of increased fire danger, when the existing fire department unit structure is not sufficient to provide an adequate response due to the large number of interventions as well as areas affected by fire, it is necessary **to implement the measures from the Fire Protection Plan of Republika Srpska**, which refer to the engagement of additional forces with the necessary equipment for firefighting in order to increase the degree of competence of firefighting units, initiate activities for establishment of a Republic Centre for training of firefighters.

Construction and Maintenance of an Extensive Network of Forest Roads: Ensuring the regular upkeep and construction of forest roads to facilitate swift access for firefighting teams and emergency services, thereby enabling rapid response in case of fire outbreaks.

Establishment and maintenance of effective **firebreaks and fuel-brakes**: Constructing new fuel-brakes and firebreaks and maintaining the existing ones is a crucial preventive measure to impede the rapid spread of fires, effectively containing and minimizing their impact on the surrounding environment.

The current **meteorological station** network in Republika Srpska is insufficiently widespread, hindering the comprehensive monitoring of weather patterns. A significant stride forward would involve expanding the existing network by installing new meteorological stations in areas currently lacking coverage. This expansion would greatly enhance the quality of climate data, providing more accurate insights into climate

changes. Given the profound impact of climate on the occurrence of landscape fires, such an initiative becomes particularly crucial. Improved climate data would not only bolster our understanding of environmental changes but also contribute to more effective measures in preventing and managing the growing threat of fires.

Encouraging the Leasing of Uncultivated Land: Incentivizing the leasing of uncultivated land to promote responsible land management practices, reducing the risk of accidental fires caused by unregulated land use and encouraging sustainable land utilization.

Exclude the **introduction** of tree species into habitats that are **not suitable** for them in terms of spatial and altitudinal aspects (avoid introducing white pine (*Pinus sylvestris*) into the hilly belt of deciduous forests) and beyond the boundaries of its natural range because it is susceptible to damage from snow and ice, resulting in the creation of a large amount of fine combustible material. Also, avoid introducing spruce (*Picea abies*) at lower altitudes, especially in the oak and hornbeam belt. It is necessary to **sow and plant beech trees in spruce cultures** on better habitats under the canopy of old trees. Direct specialised funds for forests and natural reproduction towards (among other things) the **care of forest cultures**, which are at a high risk of fire.

Increasing the participation of **broadleaved tree seedlings** during afforestation: Encouraging the planting of a diverse range of tree species, particularly broadleaved trees, to prevent the establishment of monocultures, thus enhancing the ecological resilience of forests and reducing their vulnerability to fire outbreaks. One of the main shortcomings for optimizing spatial use and planning investments in the forestry sector related to silvicultural activities is the lack of reliable data on land use. Forestry planning documents do not fully address the land use, which represents a deficiency in terms of its utilization. Afforestation plans in the forests of the Republic are linked to data on the areas of shrubbery and barren land suitable for afforestation. These data need to be significantly more precise to ensure that planning in the field of seed production and nursery cultivation is based on more realistic assumptions.

Collaboration with neighbouring countries and knowledge exchange: Establishing collaborative partnerships with neighbouring countries to facilitate the exchange of knowledge and experiences in fire suppression techniques, enabling the adoption of successful practices and strategies to bolster the existing fire management system.

Promotion of **voluntary firefighting**: Encouraging and supporting the development of voluntary firefighting programs to augment the current under-resourced firefighting capacity, ensuring a more robust and efficient response to fire incidents.

Resolution of **property-related issues** to facilitate better land management and fire prevention.

Accessing **international funding sources** for enhancing fire management capabilities.

Development of **community-driven initiatives** for fire prevention and management, rising a sense of collective responsibility.

Increased investment in research and development for **advanced fire prevention technologies** and engagement with **research institutions and universities** for the development of innovative fire prevention technologies and strategies.

Ecosystem Restoration and Rehabilitation: After a wildfire incident, the immediate focus lies in restoring the affected ecosystems to their natural state. This involves implementing rehabilitation techniques that encourage natural regeneration of vegetation and prevent the spread of invasive species. Initiatives such as reseeding, soil stabilization, and erosion control play a vital role in jumpstarting the recovery process and safeguarding the ecological balance.

Monitoring and Assessing Post-Fire Impacts: Comprehensive monitoring and assessment efforts are fundamental in understanding the long-term impacts of wildfires on the landscape. Regular monitoring helps gauge the progress of ecosystem recovery, identifies areas of concern, and assists in adapting management strategies accordingly. Utilizing remote sensing technologies, GIS (Geographic Information System) tools, and field surveys enable accurate post-fire impact assessments.

Collaborative Efforts and Community Involvement: Effective post-fire management necessitates collaboration among various stakeholders, including government agencies, local communities, non-governmental organizations, and scientific institutions. Engaging local communities in the restoration process not only empowers them with a sense of ownership but also fosters sustainable practices and fire awareness among residents.

Fire Education and Prevention: Post-fire management initiatives offer a valuable opportunity to enhance fire education and prevention measures. Public awareness campaigns, workshops, and training sessions educate residents about fire-safe practices, responsible land management, and the importance of early reporting of potential fire hazards.

Adaptive Strategies: Implementing adaptive management strategies is vital in responding to the dynamic nature of post-fire environments. Flexibility in resource allocation and the ability to adjust management plans based on new information and emerging challenges ensure a more effective and timely response to fire-induced changes.

In the context of disaster risk reduction and civil protection the management of landscape fire crises is only one arena in which countries are challenged to develop agreed standards and protocols for enhancing the efficiency and the effectiveness of cooperation. A common landscape fire management terminology, agreed competency-based standards, and agreements that regulate responsibilities and liabilities of cooperating parties are prerequisite for improving governance of major disasters, both for providing and receiving assistance (Goldammer 2000).

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Endnotes

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