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Swiss Agency for Development and Cooperation SDC

Republic of North Macedonia
Ministry of agriculture, forestry and water economy

Regional Fire Monitoring Center - RFMC

LANDSCAPE FIRE MANAGEMENT REPORT FOR NORTH MACEDONIA



2023

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The Landscape Fire Management Report in Republic of North Macedonia is prepared within the Landscape Fire Management in the Western Balkans (LFMWB) Programme financed by the Swiss Agency for Development and Cooperation (SDC) and coordinated by Farmahem - Skopje with backstopping support of Helvetas Swiss Intercooperation. The process for preparation of this report was coordinated by the Ministry of Agriculture, Forestry and Water Economy in the Republic of North Macedonia with the support of the Regional Fire Monitoring Center (RFMC) for the Southeast Europe/Caucasus Region as partners of the LFMWB Programme.

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List of Abbreviations

CMC	Crisis Management Centre
DPR	Directorate for Protection and Rescue
DRR	Disaster Risk Reduction
EU	European Union
FAO	Food and Agriculture Organisation
FNC	Fourth National Communication on Climate Change
FMP	Forest Management Plan
FPU	Fire Protection Union
GFMC	Global Fire Monitoring Centre
GHG	Greenhouse gas
GIS	Geographic Information System
ITTO	International Tropical Timber Organisation
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
IUCN	International Union for Conservation of Nature
LFM	Landscape Fire Management
LULUCF	Land Use, Land Use Change and Forestry
LFMWB	Landscape Fire Management in the Western Balkan
MAFWE	Ministry of Agriculture, Forestry and Water Economy
MoEPP	Ministry of Environment and Physical Planning
MKFFIS	Macedonian Forest Fire Information System
NFI	National Forest Inventory
NAPFO	National Association of Private Forest Owners
NGO	Non-governmental organisation
NDCs	National Determined Contributions
PENF	Public Enterprise National Forests
PE	Public enterprise
RFMC	Regional Fire Monitoring Centre
SSO	State Statistical Office
TFPU	Territorial Fire Protection Unit
TNC	Third National Communication on Climate Change
UN	United Nations
UXO	Unexploded ordnance

Introduction

The countries of the Western Balkan (WB) region have gone through a period of societal, economic, and social transformation in the last three decades. 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 The Republic of North Macedonia (MKD) 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 the country sounding board, the members of the National LFM Network were actively involved in a dynamic feedback process of preparation of the first Landscape Fire Management Report for North Macedonia, 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 Economy 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 members of the National LFM Network in North Macedonia 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 North Macedonia, 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 Contributions, analysis of the existing fire system on landscape level, recording fires, landscape fire risk assessment, and existing initiatives. Additionally, this report includes findings of the LFM Network members in North Macedonia 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 North Macedonia. These Guidelines offer essential recommendations, laying a solid foundation for implementing the landscape fire management approach in all of its phases,

especially through stressing prevention and preparedness measures, all in one cohesive fire protection system.

The validation process of the Landscape Fire Management Report was ensured through continuous communication among the LFMWB Country Project Staff in Skopje seconded by MAFWE as a drafting person of the report as well as the members of the National LFM Network members of North Macedonia 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 the forests and landscapes of North Macedonia fire-resilient.

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

LAND USE

Land use data is essential for understanding how land is being utilised and how it can be managed sustainably. By gathering information on different types of land use, such as agriculture or forest, policymakers, researchers, and other stakeholders can make informed decisions about land management, environmental conservation, and rural development. The data in the analysis is collected through statistical surveys that rely on various sources, including accounting and administrative records, as well as expert assessment. Collected data is used to monitor changes in land use over time, identify trends and inform policy decisions. Overall, land use data is crucial for ensuring the sustainable use of land and natural resources.

A. AGRICULTURE AND AGRICULTURAL LAND USE

Indicators in the subchapter provide a detailed breakdown of agricultural land types and their respective areas according to their usage. It provides information on the land used for agricultural production, including both cultivable areas and pastures. Cultivable areas refer to land that is used for the cultivation of crops while pastures are areas generally used for grazing livestock (Map 1).

In recent times, the agricultural sector has undergone significant changes due to structural and legal reforms that aim to align national legislation with European standards. The Republic of North Macedonia has a total of 1,259, 996 ha of agricultural land, which include 516,733 ha of cultivable land. This cultivable land consists of different categories of land, such as arable land and gardens occupy 416,714 ha, while orchards, vineyards, meadows, and pastures cover 16,942 ha, 23,776 ha, 59,301 ha and 742,760 ha, respectively (Table 1).

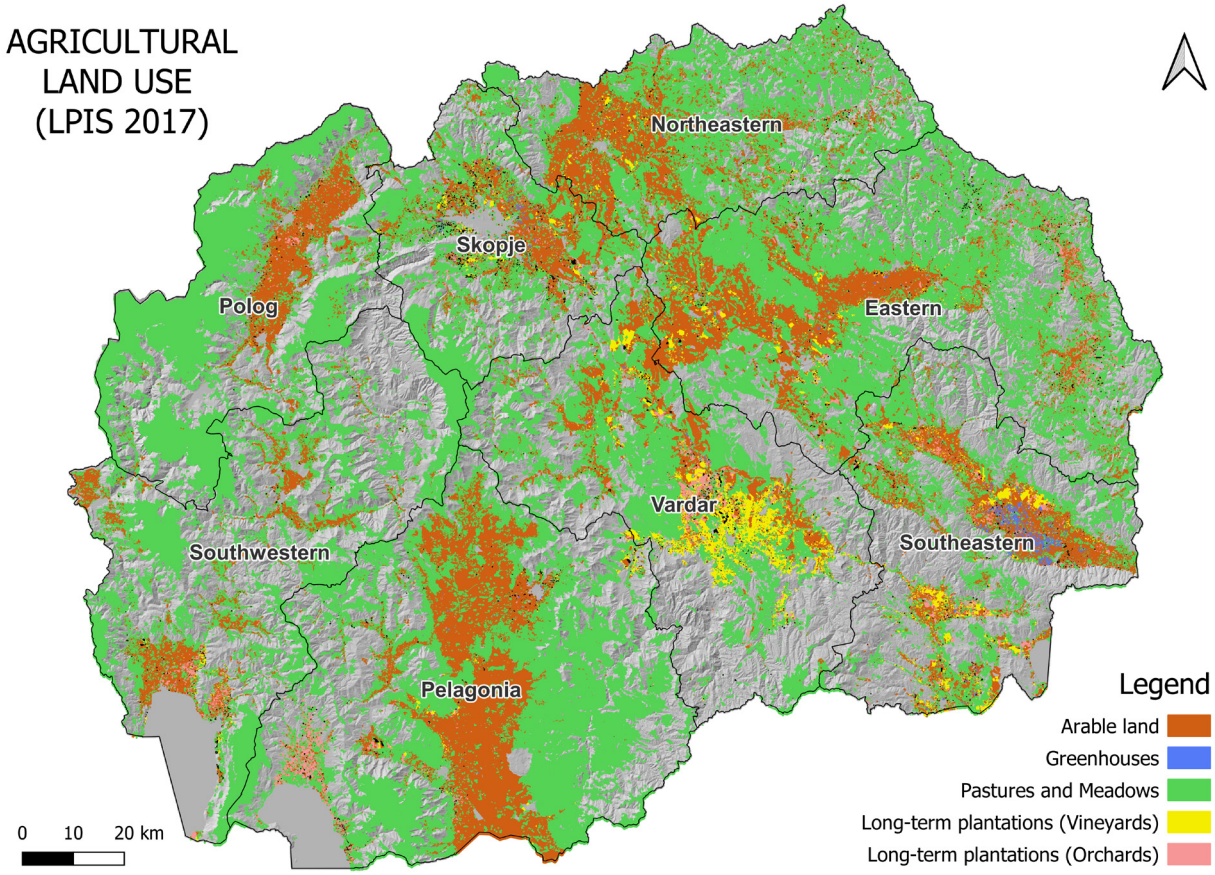
Table 1. *Agricultural land use by category:* ***Source of data:*** *North Macedonia in numbers; 2022; State Statistical office*

LAND USE BY CATEGORY	TOTAL AREA (HA)
Total agricultural land	1,259,996
Cultivable area of which:	516,733
▪ Arable land and gardeners	416,714
▪ Orchards	16,942
▪ Vineyards	23,776
▪ Meadows	59,301
Pastures	742,760

** The difference in the agricultural area and the sum of the arable area and pastures represents the area under reed ponds and fishponds.*

According to the World Bank, arable land in North Macedonia decreased from 606,000 ha in 1992 to 417,000 ha in 2021 year. Agricultural land is fragmented and unproductive. More than 40% of the total area of arable land (approximately 240,000 ha) and 80% of the pastureland (approximately 570,000 ha) in North Macedonia is owned by the State. Nearly one third of the total arable land is either abandoned or not utilised for agricultural production (Forth National Climate Change Communication, Skopje 2023).

Over the past decade, the analysis of agricultural land use changes has become increasingly critical in understanding the evolving dynamics of rural and environmental landscapes. Accordingly, the State statistical office data period 2005 – 2013 has witnessed significant shifts in agricultural practices, driven by factors such as economic imperatives, and environmental concerns. The shifts in agricultural practices, including abandonment of agricultural land, especially arable land, influences the successive increase of landscape fire risk.



Map 1: *Representation of agricultural cultivated land use map of North Macedonia by regions:* ***Source of data:*** *LPIS, MAFWE*

NUMBER OF LIVESTOCK BY SPECIES

In a period of 20 years, all species have faced significant decrease. According to the numbers from the State Statistical Office in North Macedonia, horse population faced a decrease of around 75% (Table 2); sheep numbers decreased almost 50%, while the decrease of poultry is around 60% etc. Goat population numbers are interesting as they are facing an increase according to the numbers from 2000.

Table 2. *Types of livestock by species for the period 2000 to 2021:* ***Source of data:*** *North Macedonia in numbers; 2022; State Statistical office*

	HORSES	CATTLES	PIGS	SHEEP	GOATS	POULTRY	BEE-FAMILIES
2000	56,486	264,968	204,135	1,250,686	78,913	3.713,369	75,481
2005	39,651	248,185	155,753	1,244,000	62,190	2.617,012	66,738
2010	26,661	259,887	190,552	778,404	75,708	1.994,852	76,052
2015	18,784	253,442	195,443	733,510	88,064	1.761,145	73,960
2020	9,154	222,202	164,074	630,634	95,008	1.643,462	99,558

Chart 1 shows a numerical representation of livestock categorised by species in North Macedonia from 2000 to 2021. Notably, the predominant contributors to the region's livestock meat are poultry farming and production as well as sheep farming. However, it is evident that both categories have experienced a substantial decline in population over the past two decades.

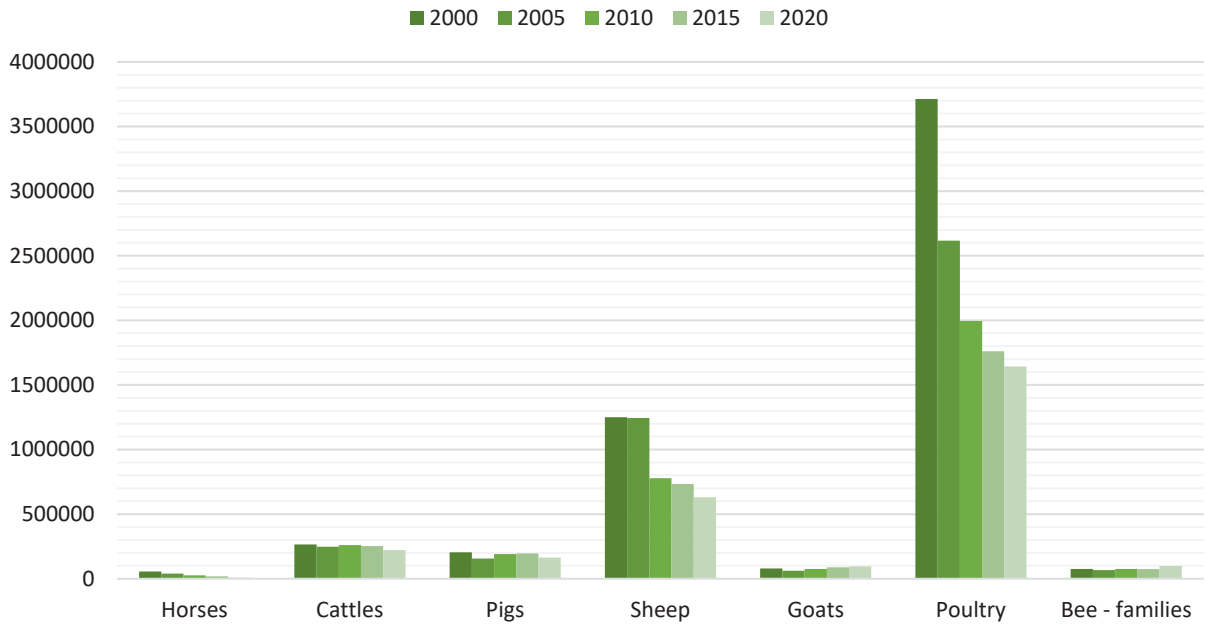


Chart 1. *Stacked bar-chart with the number of Livestock by species for the period 2000 - 2021.*

The livestock sector is characterised by a large number of small, subsistence-oriented farms, and commercially oriented family farms. Pastureland is the dominant category of agricultural land use, covering an area of more than 748,413 ha under pastures in 2017, more than 77.69% are managed by agricultural enterprises and cooperatives, while only 22.31% are managed by farm holdings. There is no organised management of pastureland in terms of clearance of bushes and tree species and increase of passive areas, improvement of degraded natural grasslands. This leads to a gradual decrease in their productivity and territory. (Fourth National Climate Change Communication, Skopje 2023). In summary, as livestock

populations decrease in rural areas, there is a higher risk of forest fires due to increased fuel load, reduced vegetation management, and a potentially diminished capacity to respond to and prevent fires.

B. FOREST AND SEMI – NATURAL AREAS

OVERVIEW OF FORESTS IN NORTH MACEDONIA

Forests and forest lands of North Macedonia cover a total area of 1,159,926 ha, out of which the area under forest is 1,049,300 ha. According to the State Statistical Office (04.02.2023), out of 1,049,300 ha, 907,255 ha or 86,5% are under state ownership while the remaining 142,045 ha or 13,5% are privately owned. There are approximately 220,000 privately owned forest parcels in the country, which are owned by 65,000 families. These forests are typically small and do not produce a significant amount of wood. The average area per property is 0.6 ha (Trendafilov, A. et al 2008).

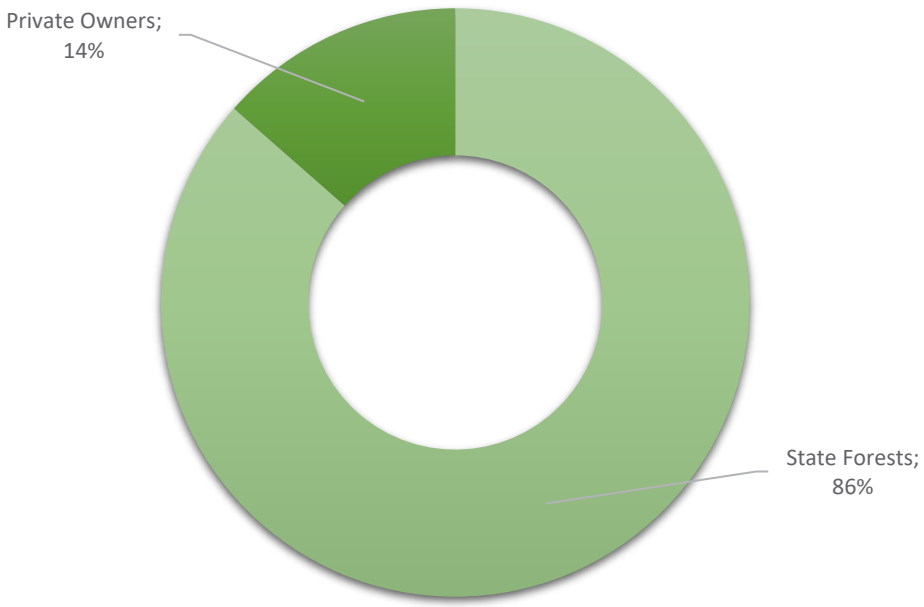


Chart 2. *Pie chart of Forests ownership in North Macedonia:* ***Source of data:*** *State Statistical Office 2023*

For economic use, the state-owned forests are managed by the Public Enterprise National Forests (PENF) while state-owned protected forests are organised and managed by the state established National Parks (Table 5) or other public enterprises. Private forests are managed by private owners, and others, through the associations of private forest owners.

Despite the challenges of deforestation, illegal logging and natural disturbances, the forest cover in North Macedonia has grown in recent years by nearly 5% between 2010 and 2018, dominated by native beach and oak species. The forests are made up of various tree species, including deciduous trees with area covering around 620,874 ha, coniferous cover area of 69,327, mixed forest area of 315,758 ha and degraded forest with area of 43,341 ha (Table 3).

Table 3. *Representation of forest types within 8 regions in North Macedonia (numbers in ha)*

	REGIONS								
	Vardar	East	Southwest	Southeast	Pelagonia	Polosh	Northeast	Skopje	**Total**
Deciduous	51,928	83,378	139,369	94,578	108,051	48,416	49,981	45,173	**620,874**
Coniferous	7,214	13,618	10,267	10,126	11,671	1,832	9,353	5,246	**69,327**
Mixed	59,963	49,361	34,990	31,817	53,700	37,149	23,507	25,271	**315,758**
Degraded	10,019	3,135	11,578	5,996	1,795	6,501	117	4,200	**43,341**
Total	**129,124**	**149,492**	**196,204**	**142,517**	**175,217**	**93,898**	**82,958**	**79,890**	**1,049,300**

** Source: State Statistical Office 04.02.2023*

Forests are covered mostly by Deciduous broad-leaved species with 59% of the total area, coniferous cover of around 7%, mixed forest occupies 30% and degraded forest covers around 4% of the total forest area (Chart 3). The richest forest cover region is the Southwest region in North Macedonia, with around 196,000 ha, and the poorest in terms of forest cover is the Skopje region with around 80,000 ha.

However, the most dominant species are beech (*Fagus moesiaca*) and oak species (*Quercus spp.*), which together make up to 85% of all native forest species.

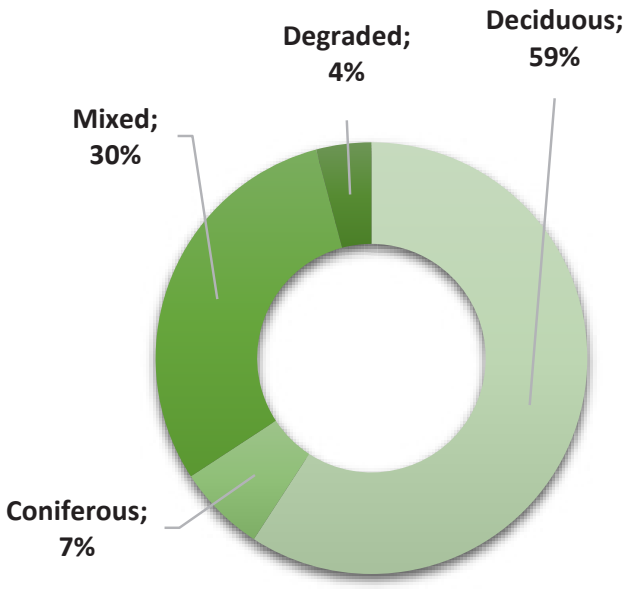
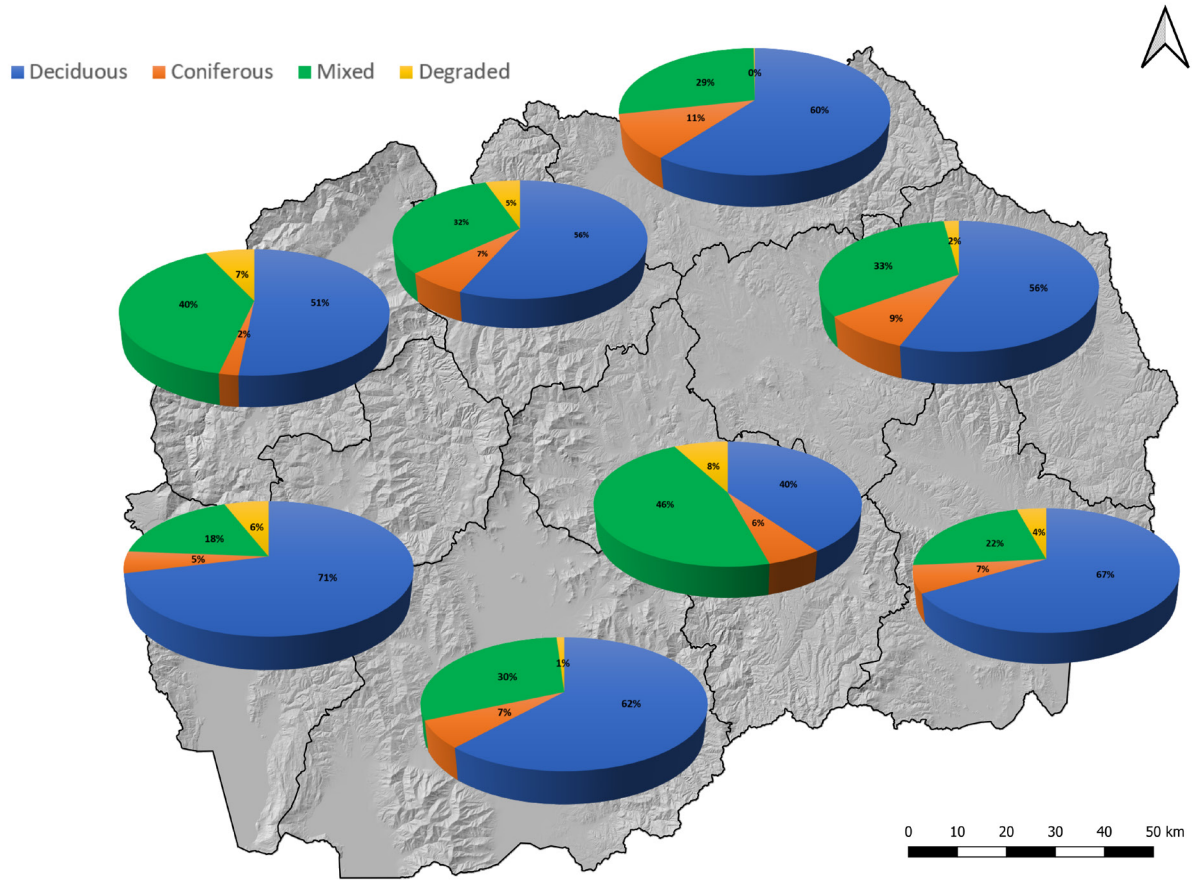


Chart 3. *Pie chart of Forest cover type (%) in North Macedonia represented in pie chart*

Beech forests cover 44.4% of the total forested area while oak forests cover 40%. Beech forests also account for 58.7% of the total wood mass while oak forests contribute 24,5%. Around 550,000 ha or 71% are categorised as low-quality coppice forests, and around 390,000 ha or 29% are categorised as high forest stands. Coppice forest stands have a wood mass of 51,542,609 m^3, accounting for 39.6% of the total wood

mass in the country. The average wood mass per hectare for coppice forest stands is about 96.4 m^3. Out of the remaining, around 140,000 ha are plantations artificially planted mostly with coniferous tree species such as *Pinus nigra, Cupressus sempervirens* and other (Forest Fire Country Study, 2015 RFMC). Distribution of forest types is uneven in terms of quantity and quality. For instance, low quality coppice forests are located mostly in the central part of the country. This low wood mass level indicates general low quality of the forest in North Macedonia, which is due to historical, social, and economic factors.



Map 2: *Forest cover types in North Macedonia by economic/planning regions (pie chart values in %):* ***Source of data:*** *State Statistical office 2023*

The total wood mass in state owned forests is 87,493,788 m^3, while the total annual growth is about 1,646,455 m^3 with average annual growth of 2.02 m^3/ha. (source: PENF, http://www.mkdsumi.com.mk/zasumite_en.php?s=1&page=3). The average annual growth in high forests is 4.2 m^3/ha while in coppice and degraded forests, it is only from 1 to 1.5 m^3/ha. The planned annual available cut (planned and allowable rate of timber harvest from a specified area of land in accordance with the forestry management plans) in North Macedonia in the last 10 years is about 1,300,000 m^3 out of which around 70-75% is used. The principal share of the amount mentioned is mostly related to state forests while a very small part is related to protective and protected areas in the country. Of the produced forest products, around 85% are firewood products used by households.

GROSS TIMBER CUT

In terms of gross forest timber cut, in accordance with the State Statistical office 2023 (Chart 4), from 2000 there is constant decrease in the harvesting intensity within the deciduous and coniferous forest stands. For instance, gross timber cut in 2000 was 1,148,000 m^3, in 2005, it was 821,000 m^3 while in 2010, gross timber cut was 871,000 m^3.

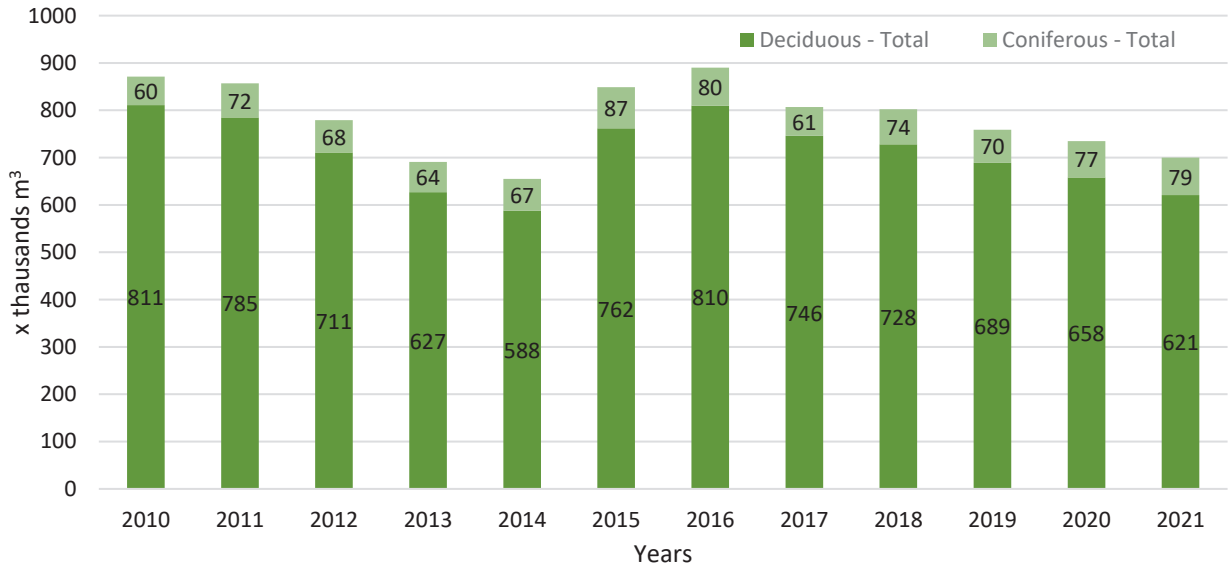


Chart 4. *Annual timber cut in the deciduous and coniferous forest stands in North Macedonia (x thousands):* ***Source of data:*** *State Statistical Office: data 26.08.2023*

AFFORESTATION

Afforestation in North Macedonia, like in many countries, is a critical component of environmental conservation and sustainable land management. Afforestation refers to the deliberate planting of trees on land that was previously not forested or had experienced significant deforestation during past land activities. The government has recognised the importance of afforestation in its environmental policies and through the Ministry of Agriculture, Forestry and Water Economy (MAFWE) has implemented various programmes and initiatives aimed at afforestation (Chart 5).

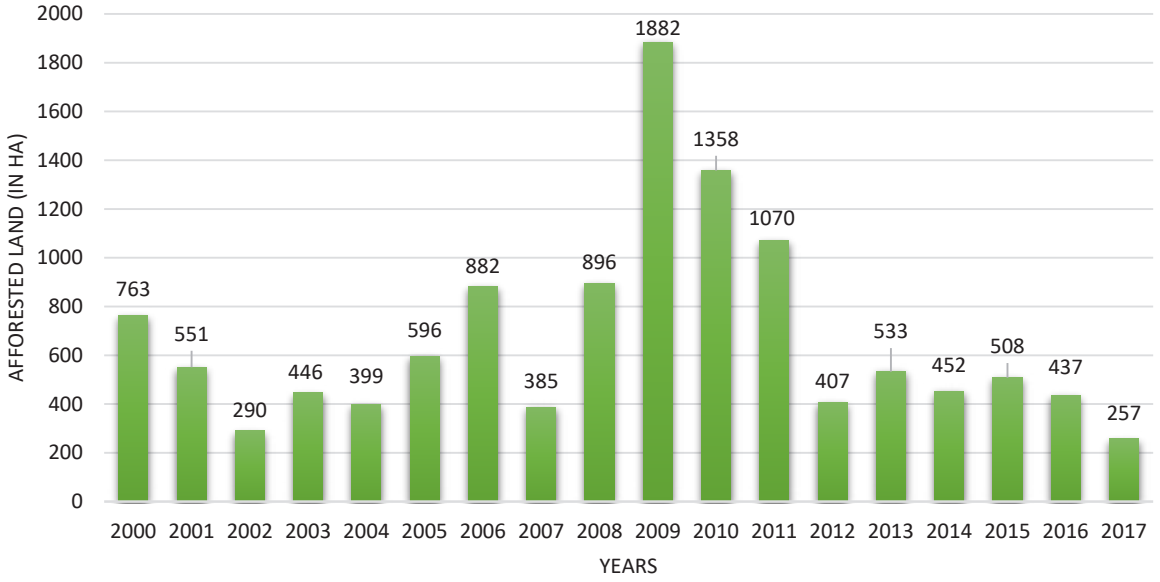


Chart 5. *Afforestation (in ha) by each year in the period 2000 – 2017, outside of forests, mostly in rocky and bare ground, eroded ground, agricultural and other types of ground:* ***Source of data:*** *State Statistical Office Publications*

REFORESTATION

Reforestation in North Macedonia is integral to environmental restoration, climate change mitigation, and sustainable land management (Chart 6). As the country continues to work towards EU integration and environmental sustainability, reforestation will remain a critical tool in achieving these goals. Reforestation involves the deliberate planting of trees and restoring forested areas that have been previously deforested or degraded.

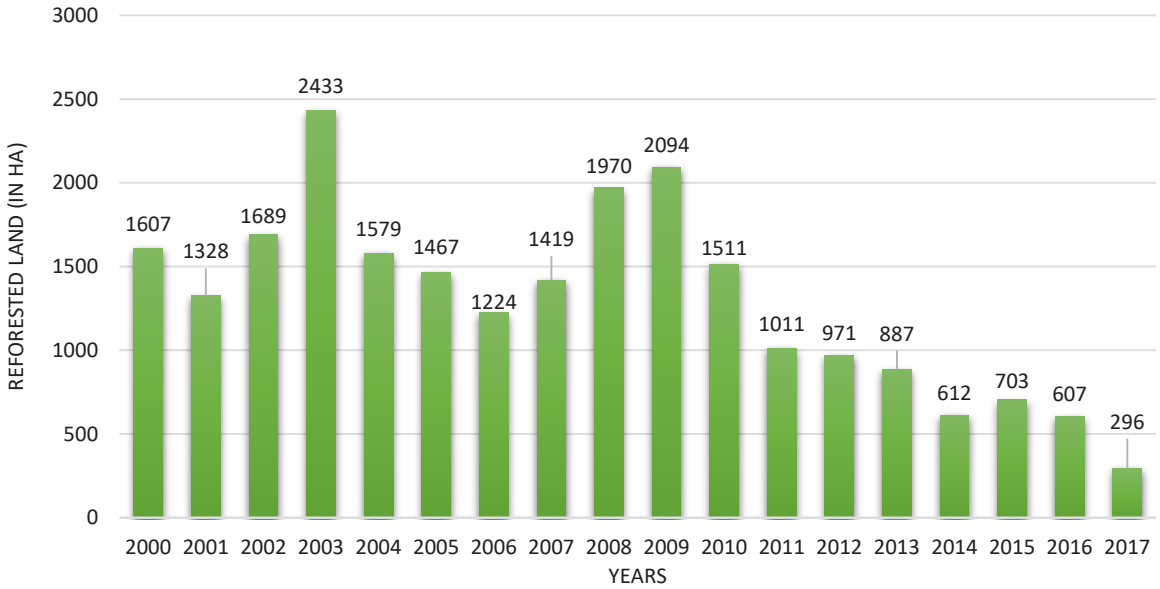


Chart 6. *Reforestation by each year in the period 2000 – 2017, within forest land, mostly in bare ground and cleared areas:* ***Source of data:*** *State Statistical Office Publications*

PROTECTED AREAS IN NORTH MACEDONIA

The Sector for Nature within the Ministry of Environment and Spatial Planning (MoEPP) is responsible for nature protection through protection of biological diversity and protection of natural heritage. This involves preserving both the variety of living organisms and ecosystems on a local and broader scale, conserving natural landmarks within and outside protected zones, and upholding the integrity of unique natural elements.

In accordance with the Law on Nature Protection, the framework for protected areas is established with the aim of conserving the diversity of life forms within natural habitats, natural processes. By declaring an area as protected, it attains the status of natural heritage. Under the Law on Nature Protection, six (6) classification categories (Table 5) of protected areas are recognised in accordance with the classification of the International Union for Conservation of Nature - (IUCN).

Table 4. *Categories of protected areas*

CATEGORIES OF PROTECTED AREAS	
CATEGORY I – Ia – Ib	 Strict nature reserve Wilderness areas
CATEGORY II	Natural parks
CATEGORY III	Natural monuments
CATEGORY IV	Park nature
CATEGORY V	Protected areas
CATEGORY VI	Multi-purpose areas

National parks are the most representative part of the national natural heritage. Four (4) National Parks are present in North Macedonia (Table 6): National Park Mavrovo with area of 731 km^2, National Park Galichica with area of 227 km^2, National Park Pelister with area of 125 km^2 and National Park Shar Mountain with area of 627 km^2.

Table 5. *National Parks in the Republic of North Macedonia:* ***Source of data:*** *4th National Communication on Climate Change*

NATIONAL PARKS	
NAME	**AREA**
National Park MAVROVO	731 km^2
National Park SHAR MOUNTAIN	627 km^2
National Park GALICHICA	227 km^2
National Park PELISTER	125 km^2
TOTAL:	**1,776 km^2**

The framework of protection areas encompasses 82 zones, which cover a total expanse of 357,778.05 ha or approximately 13.92% of the land within the confines of the Republic of North Macedonia (Table 7).

National parks cover about 6.91% of the country's territory or 1,776 km^2, followed by nature monuments with 3.0%, while all other categories of protected areas cover about 4.01% of the country's territory.

Table 6. *Number and area under protection by category*

CATEGORY OF PROTECTION	NUMBER OF AREAS	AREAS (HA)	AREA % OF THE TERRITORY OF NORTH MACEDONIA
Strict nature reserve	2	10,583	0.41%
Wilderness areas	-	-	-
Natural parks	4	177,575	6.91%
Natural monuments	60	77,015	3.0%
Park nature	12	3,040	0.12%
Protected areas	3	64,261	2.5%
Multi-purpose areas	1	25,305	0.98%
Total	**82**	**357,778**	**13.92%**

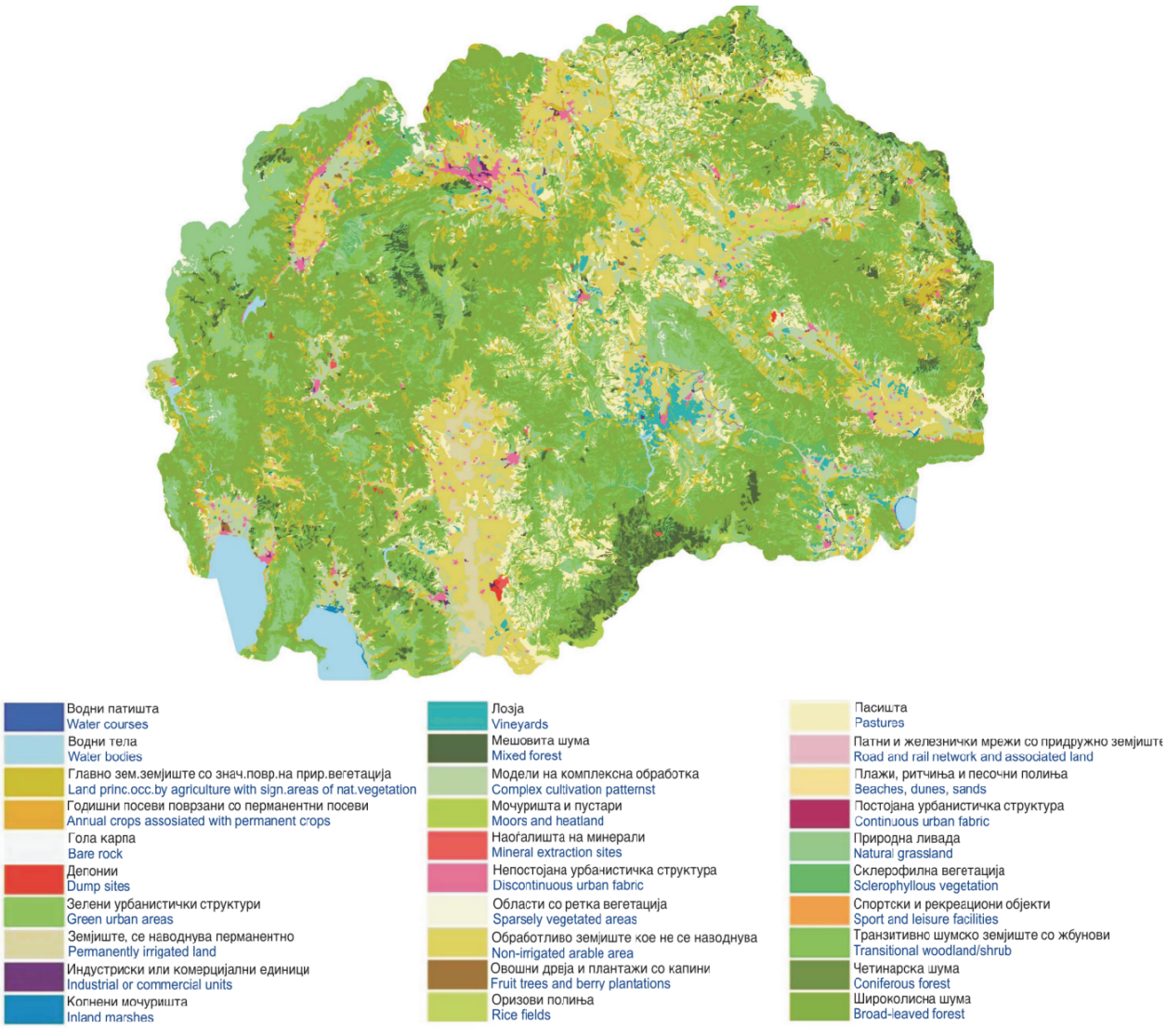
C. TRANSFORMATION OF LAND USE

The transformation of land use is a pivotal factor in the realm of landscape fires management. This chapter endeavours to amalgamate data concerning land use changes within a specific timeframe. The significance of comprehending these shifts in land use cannot be overstated, as they exert profound effects on fire risk, fire behaviour, and the efficacy of fire management strategies. This chapter seeks to shed light on the evolution of land use, as this understanding directly shapes the distribution of fuels, human exposure to fire risks, and the overall resilience of ecosystems in the face of landscape fires. This sub-chapter delves into the intricate interplay between land use changes and landscape fire management, recognising the critical role it plays in protection of our ecosystems and communities from the devastating impact of forest fires.

Table 7. *CORINE level 1 category land – total transformation changes (in ha)*

PERIOD		ARTIFICIAL LAND	AGRICULTURAL LAND	FOREST AND SEMI – NATURAL AREAS	WETLANDS	WATER BODIES
2000 - 2006	<	910	4907	4744	60	124
	>	3539	1249	1262	84	4410
Σ (in ha)		**2629**	**-3658**	**-3482**	**24**	**4286**
2006 - 2012	<	649	3765	22292	54	58
	>	1178	528	367	73	192
Σ (in ha)		**529**	**-3237**	**-21925**	**19**	**134**
2012 - 2020	<	364	3967	24521	0	134
	>	2666	1971	24207	32	110
Σ (in ha)		**2302**	**-1996**	**-314**	**32**	**-24**

Based on data sourced from the Ministry of Environmental and Physical Planning, this chapter delves into an analysis of land areas within North Macedonia using the CORINE Land Cover Nomenclature spanning the period from 2000 to 2018 (Table 8). Within this comprehensive framework, a total of 44 potential classifications are available for assessment, of which 33 have been identified within the country (as depicted in Map 3). At the highest level of the nomenclature, the preeminent portion of land is revealed to be enveloped by forests and semi-natural areas, constituting a substantial 61.3% of the total surface area. Agricultural zones encompass 36% of the overall land area while water bodies claim 2.2%, artificial surfaces occupy 1.8%, and swamps represent 0.1%. This data serves as a foundational insight into the intricate mosaic of land use patterns in North Macedonia, setting the stage for a comprehensive examination of the implications of these land use changes in the context of landscape fire management.



Map 3: *Land Cover Map of North Macedonia:* ***Source of data:*** *Ministry of Environment and Physical Planning 2018*

Significant changes in land use in North Macedonia are analysed in the 2006 to 2018 period occupying an area of approximately 1.13% of the total national territory, or around 28,985 ha. Major changes between

the period of 2006 to 2018 are noted in artificial areas, increasing 2,302 ha, and a decrease in agricultural land by 1,996 ha. Other changes are minor, for instance, decrease in water bodies by 24 ha, increased swamps by 32 ha, and decrease of total forest and semi natural areas by 288 ha.

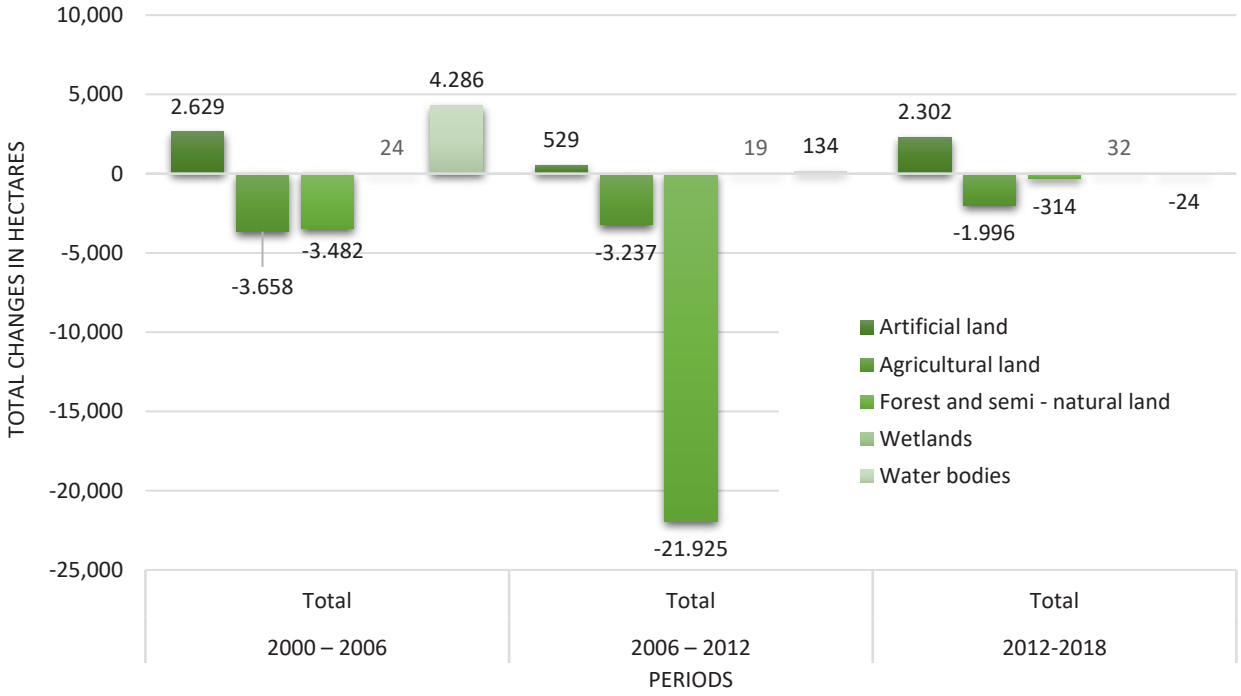


Chart 7. *CORINE Level 1 category land, total transformation changes into urban area (in ha):* ***Source of data:*** *Ministry of Environment and Physical Planning*

There are several factors to be considered:

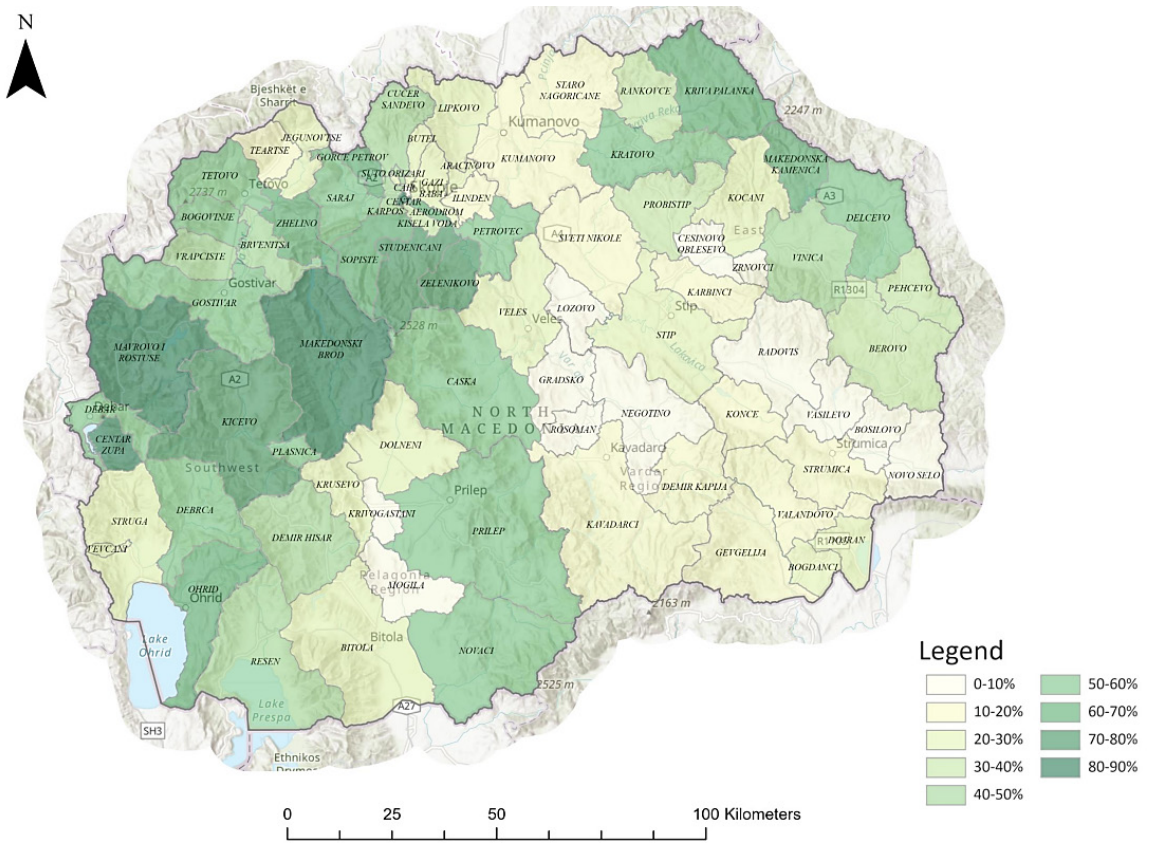
- Agricultural lands are mainly near urban areas, and this is why they are also the most vulnerable when fires spread.
- Due to the transformation of agricultural lands from large factories to smaller private holdings, some of the lands, primarily due to uncultivable nature, are transformed into forest land.
- The reduction of forest land is largely due to strategic infrastructure facilities, primarily state roads, so in these situations, measures are taken to reduce the impact on the environment.

Land use and land use changes in the Republic of North Macedonia are crucial aspects that require careful consideration and effective strategies. The country's land use practices, coupled with its diverse landscapes, make it susceptible to fire incidents and necessitate appropriate management approaches.

North Macedonia's land use patterns encompass a range of activities, including agriculture, forestry, urbanisation, and protected areas. These various land uses can contribute (inappropriate land use) to the occurrence and spread of landscape fires. For instance, agricultural practices, such as slash-and-burn farming, can lead to unintentional fires that can rapidly escalate. Additionally, urban expansion into natural areas increases the risk of fire incidents through factors like human activity and the proximity of flammable structures to wildland areas. The large area covered by coniferous afforestation, degraded forest and coppice accompanied with improper management in terms of fire protection are preconditions for forest fires appearance, too.

LAND ABANDONMENT

The analysis (FAO, 2023) reveals that both privately and state-owned agricultural land in the country is on average 32% abandoned. Abandoned lands are more present in the western part (Skopje, Polog, Southwest and Pelagonia regions) of the country with more mountainous areas, while other lands with higher agricultural potential are with lower abandonment rates (Map 4).



Map 4: *Represented land abandonment in % by municipalities in North Macedonia:* ***Source of data:*** *FAO. 2023. Analysis of land abandonment and development of agricultural land markets in the Republic of North Macedonia – Conclusion and policy recommendations. Budapest.*

Land abandonment in North Macedonia is a complex issue driven by a variety of interconnected factors (Photo 1). This phenomenon results in land being left unused, which can have several consequences, including an increased risk of forest fires.

The dominance of very small farms (Inefficient farm structure) can make it challenging to sustain agricultural activities profitably. These small-scale operations may struggle to compete in the market effectively. Further, excessive land fragmentation or when land parcels are divided into numerous smaller plots, it becomes difficult to manage and utilise them efficiently. This fragmentation can hinder productive agricultural practices. Furthermore, agricultural value chains or issues in the supply chain, including transportation and marketing, can impact the profitability of agricultural activities. A crucial issue that the rural areas face in North Macedonia is the internal migration (particularly young people) to urban areas which leads to a shrinking workforce and reduced agricultural activities.

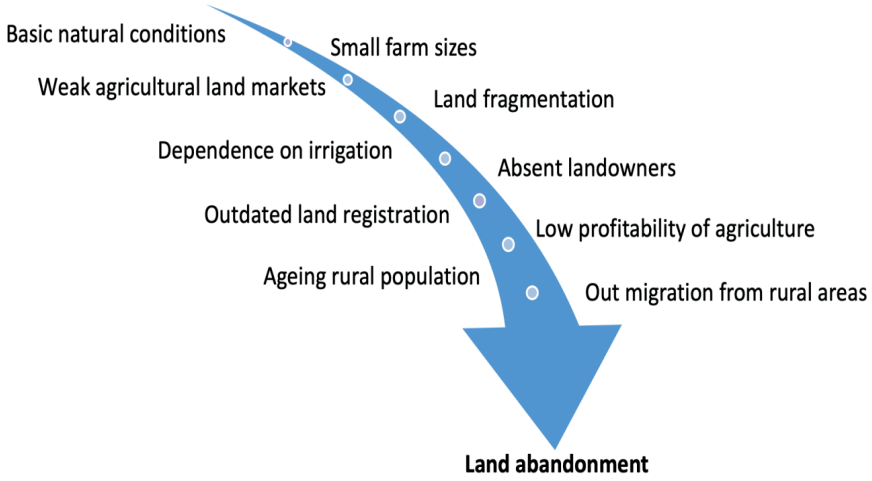


Photo 1: *Factors driving land abandonment in North Macedonia:* ***Source of data:*** *FAO. 2023. Analysis of land abandonment and development of agricultural land markets in the Republic of North Macedonia – Conclusion and policy recommendations. Budapest*

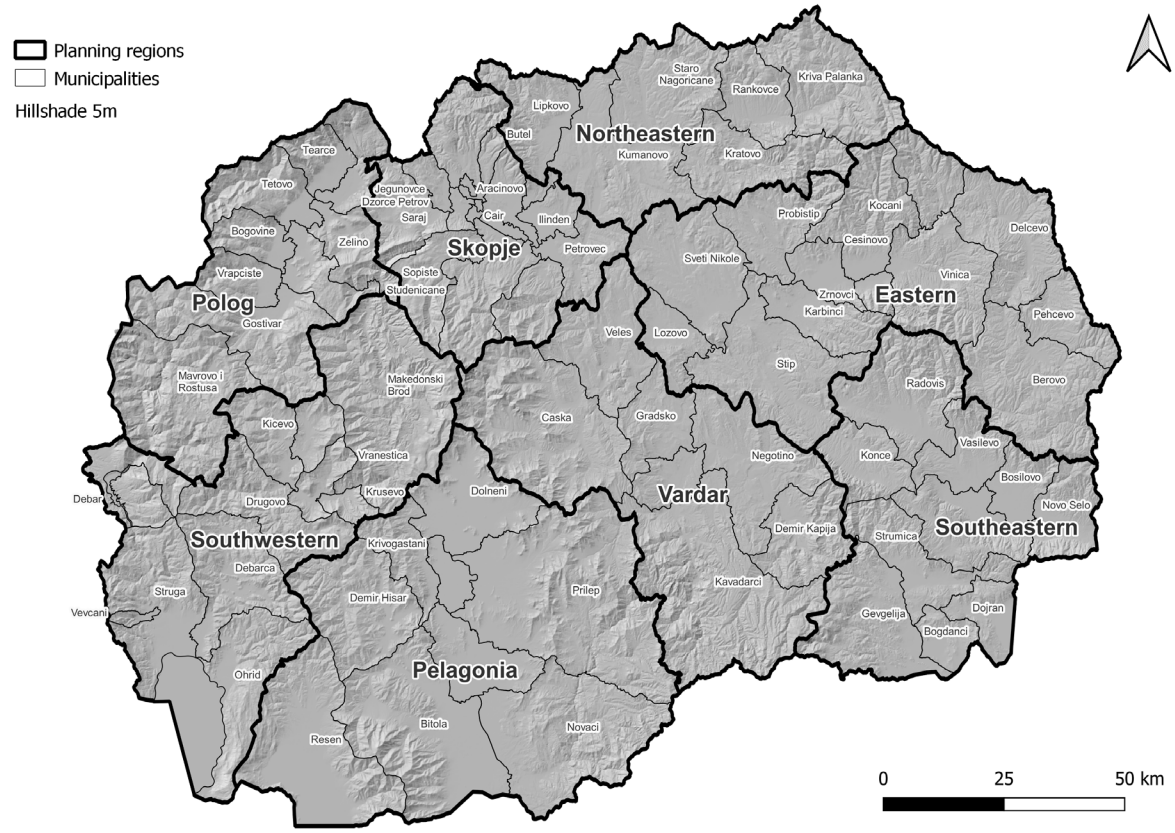
The connection to the risk of landscape fires lies in the fact that abandoned land often becomes overgrown with vegetation. When this vegetation becomes dry and combustible, it can serve as fuel for forest fires, especially during hot and dry summer seasons. Additionally, the absence of active land management, such as controlled burns or clearing of vegetation, grazing and others can exacerbate the risk of uncontrolled forest fires.

II. DEMOGRAPHICS

A. ADMINISTRATIVE DIVSION

The division of North Macedonia into municipalities and planning regions constitutes a fundamental aspect of the country's administrative framework. Initiated in 2007, the process of defining planning regions, as depicted in Map 5, was a strategic decision by the Macedonian government. This comprehensive restructuring aimed to serve statistical, economic, and administrative objectives, with a primary focus on promoting regional development and governance.

Officially, North Macedonia is organised into eight planning regions, each meticulously delineated based on a nuanced understanding of factors such as geographical proximity, economic commonalities, and shared social characteristics. This chapter delves into the significance of this administrative restructuring, exploring its implications for the effective management and coordination of regional initiatives, particularly in the context of forest fire prevention and response strategies. Understanding the rationale behind this division is crucial for comprehending the localised dynamics and challenges associated with forest fire management in North Macedonia.



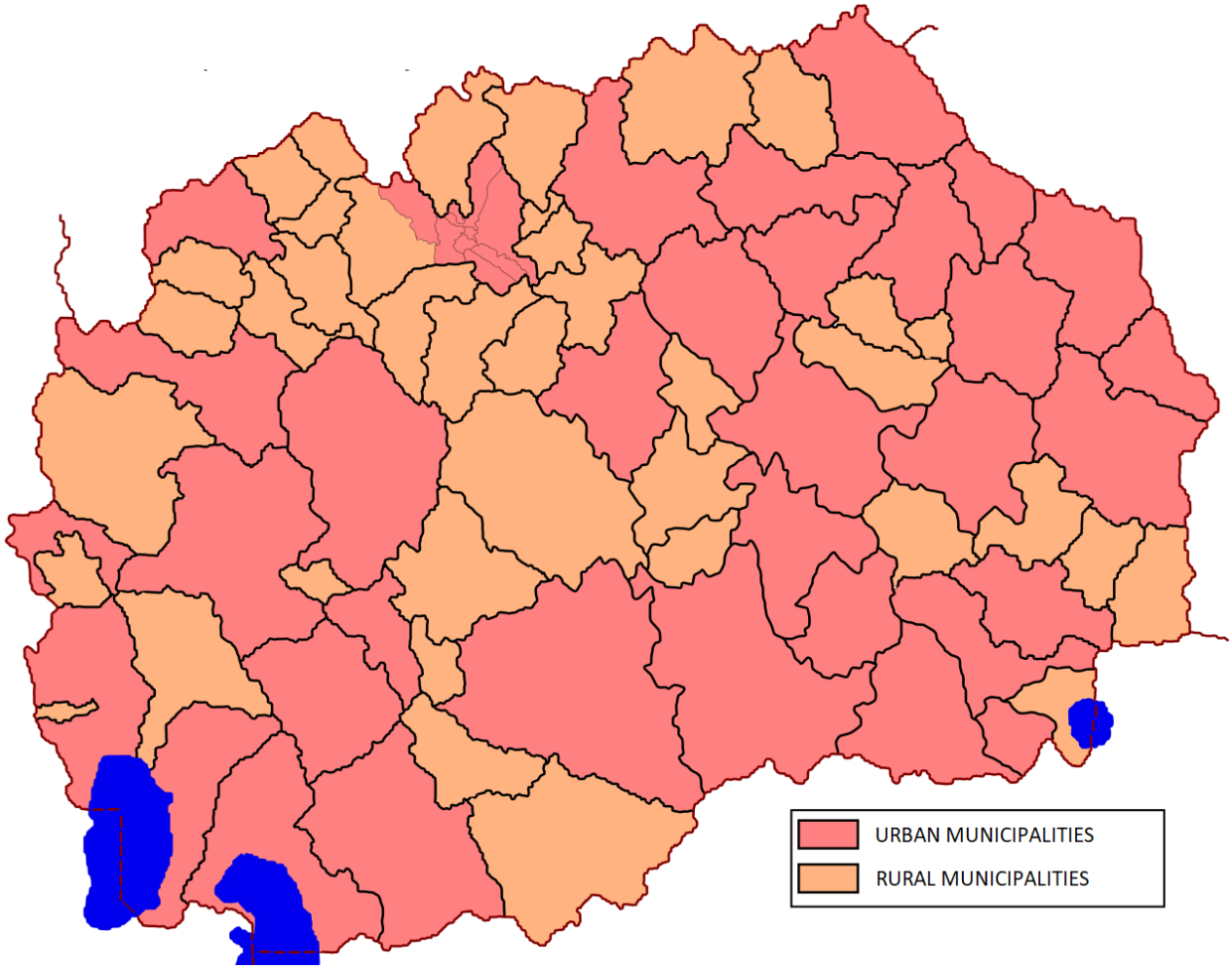
Map 5: *Map of municipalities associated with the planning regions in North Macedonia; Skopje as a capital and plan region is organised with 10 municipalities:* ***Source of data:*** *Agency for Real Estate Cadastre, 2023*

The planning regions serve multiple purposes, for instance: Statistical – they provide a framework for collecting and analysing data related to different regions, helping in policy formulation, resource allocation, and planning; Economic – the regions help in identifying economic strengths and weaknesses, which aids in targeted development initiatives and investment strategies; Administrative – the regions play a role in the decentralised governance structure of North Macedonia (Table 9). Local governments in each region have some degree of authority over regional affairs. Regional Disparities and Development - the division into planning regions can be valuable in addressing regional disparities and promoting balanced development across the country. By identifying areas with specific needs and potential, authorities can implement region-specific policies to uplift disadvantaged regions and support growth in others.

Table 8. *Planning regions in North Macedonia associated with population, area, and no. of municipalities:* ***Source of data:*** *Ministry of Local self-government; State Statistical office – population by region data census 2021*

REGIONS	POPULATION	AREA IN KM²	NO OF MUNICIPALITIES
Pelagonia	209,844	4,717	9
Vardar	138,376	4,042	9
Southeastern	148,096	2,739	10
Eastern	149,741	3,537	11
Northeastern	152,656	2,310	6
Skopje	606,611	1,812	17
Polog	251,574	2,416	9
Southwestern	177,187	3,340	13

In addition to the planning regions, North Macedonia is further divided into municipalities, which constitute the first-level administrative division. These municipalities have more localised administrative responsibilities and are responsible for delivering various public services to the citizens. It is a single-tier local self-government with 84 municipalities, and the city of Skopje together with 43 other cities serving as units of local self-government. However, the city of Skopje, being the capital, has a slightly different system with a combination of 10 municipalities and the city itself having wider responsibilities and acting as a separate Local Government Unit. Municipalities in North Macedonia have autonomy in carrying out their constitutionally and legally defined competences and their work is supervised by the central government.



Map 6: *Map of urban and rural municipalities distributed within the country.*

B. DEMOGRAPHIC STATUS

Since the last census in 2021, there has been an estimated population of 1,836,713 people, which is a slight decrease compared to the 2002 census where population was 2.022,547 people (Chart 8). However, the rate of population growth has been decreasing in recent years due to factors such as emigration and aging population. Emigration has been a significant issue in North Macedonia, with many young people leaving in search of better job opportunities and higher standards of living. This trend has had a considerable impact on the country's demographic makeup, and it has become a challenge for the government to retain its young workforce.

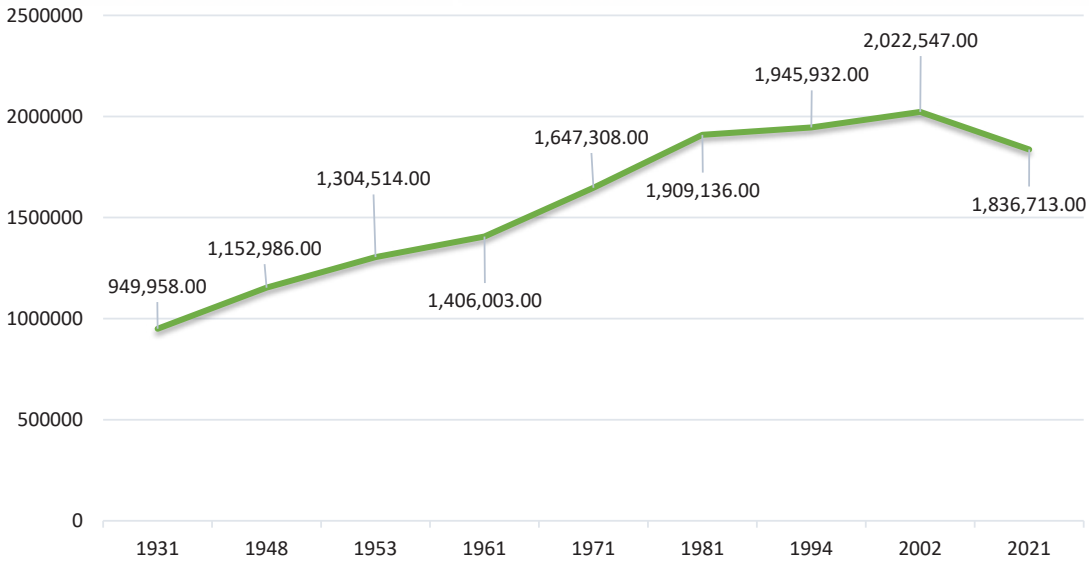
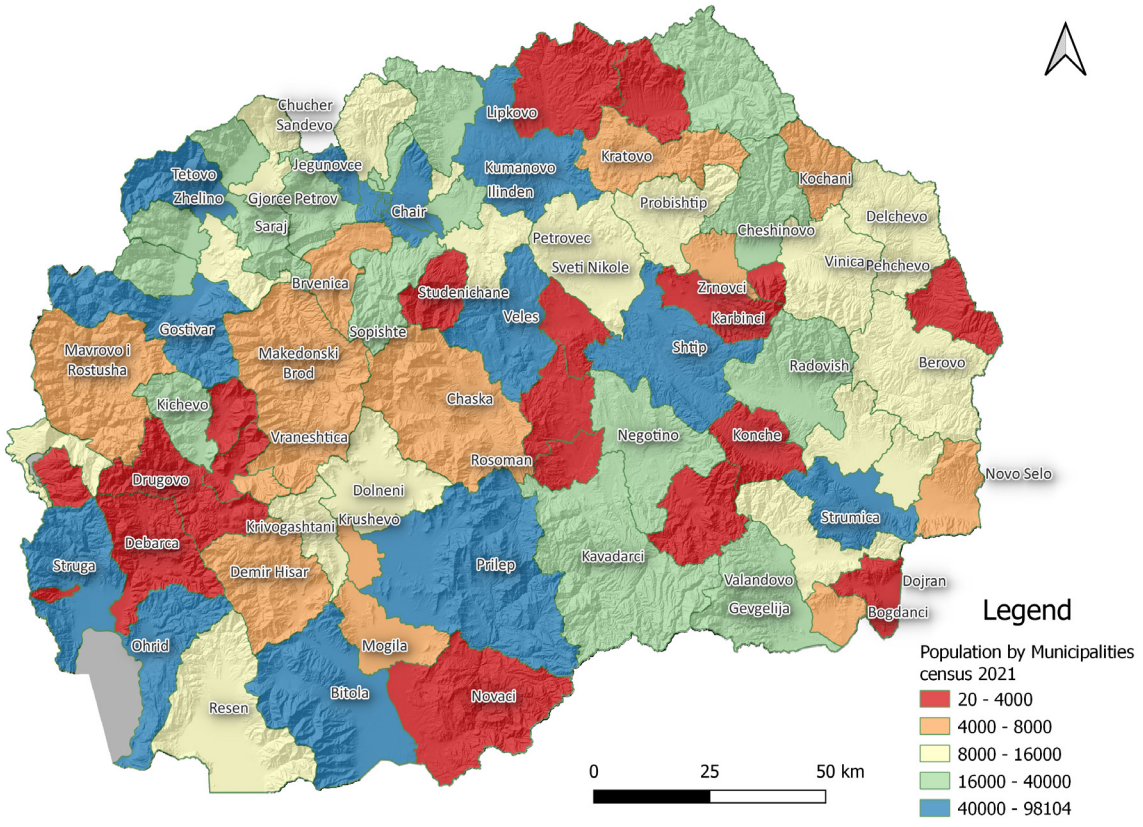


Chart 8. *Population according to censuses conducted after WWII in North Macedonia:* ***Source of data:*** *State Statistical Office*

Among the cities within the municipalities, about 70% of the population lives in urban areas, which places it in the middle among European countries (Map 6). However, a significant issue is the concentration of the population or distribution disparity in a few large cities, with approximately 30% of the country's population living in Skopje. This is one of the major demographic challenges (Strategy for RDRNM 21-31).



Map 7: *Map of the total resident population in the Republic of North Macedonia, by municipality, Census 2021*

In accordance with the "Strategy for Balanced Development 2020-2030 Report," rural areas are currently experiencing intensive and dynamic migration processes in various directions. Between 2014 and 2019, internal migrations were distributed as follows:

- 35.1% of migrations were from villages to cities.
- 21.6% of migrations occurred from cities to villages.
- Migrations between villages accounted for 34.7%.
- Intercity migrations constituted only 8.6% of the total.

The Skopje planning region again, experienced the most substantial proportion of migration, comprising 43.7% of the overall internal migration flow within the country. Regarding the gender structure, women played a prominent role in internal migration, constituting over 70% of the total migration across all regions.

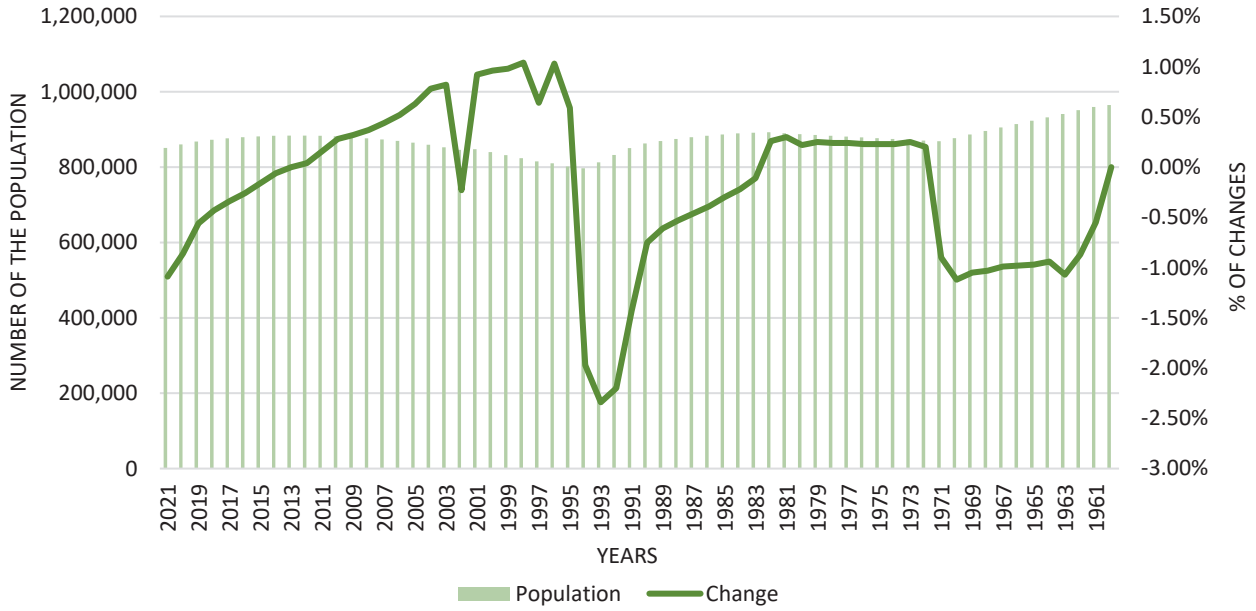


Chart 9. *Rural population an historical review:* ***Source of data:*** *World Bank, 2023*

Chart 9 provides a comprehensive overview of the rural population dynamics in North Macedonia spanning the years from 1960 to 2021, encompassing the percentage of rural population relative to the total population and the annual percentage change. In 1960, the rural population stood at 964,870, constituting approximately 65.98% of the total population. Subsequently, over the ensuing years, a gradual decline in the rural population percentage was observed. From 1960 to 1971, the rural population continued its descent, culminating in a count of 868,956 by the close of 1971, accompanied by an average annual decrease of around 0.97%. However, a brief deviation occurred in 1972 and 1973, with a slight upturn in the rural population, reaching 870,708 and 872,845, respectively, with relatively modest percentage changes during these years. Post-1973, the rural population resumed its decline trajectory, reaching 860,473 by the conclusion of 2020, signifying a significant drop from previous years. Throughout this period, the annual percentage change fluctuated between -0.85% and -1.09%, underscoring a persistent reduction in the rural population.

Vice versa, Chart 10 shows the historical movement of the urban population of North Macedonia from 1960 to 2021. Percentage has been steadily increasing over the years, indicating a significant shift of people from rural to urban areas. This trend is commonly observed globally and can be attributed to several factors such as industrialisation and urbanisation. The period after the industrial revolution in the late 1950s witnessed rapid urbanisation worldwide. The growth of industries and job opportunities in urban areas attracted people from rural areas seeking better employment prospects and improved living standards. North Macedonia likely experienced a similar phenomenon during this time, leading to an influx of people into urban centres.

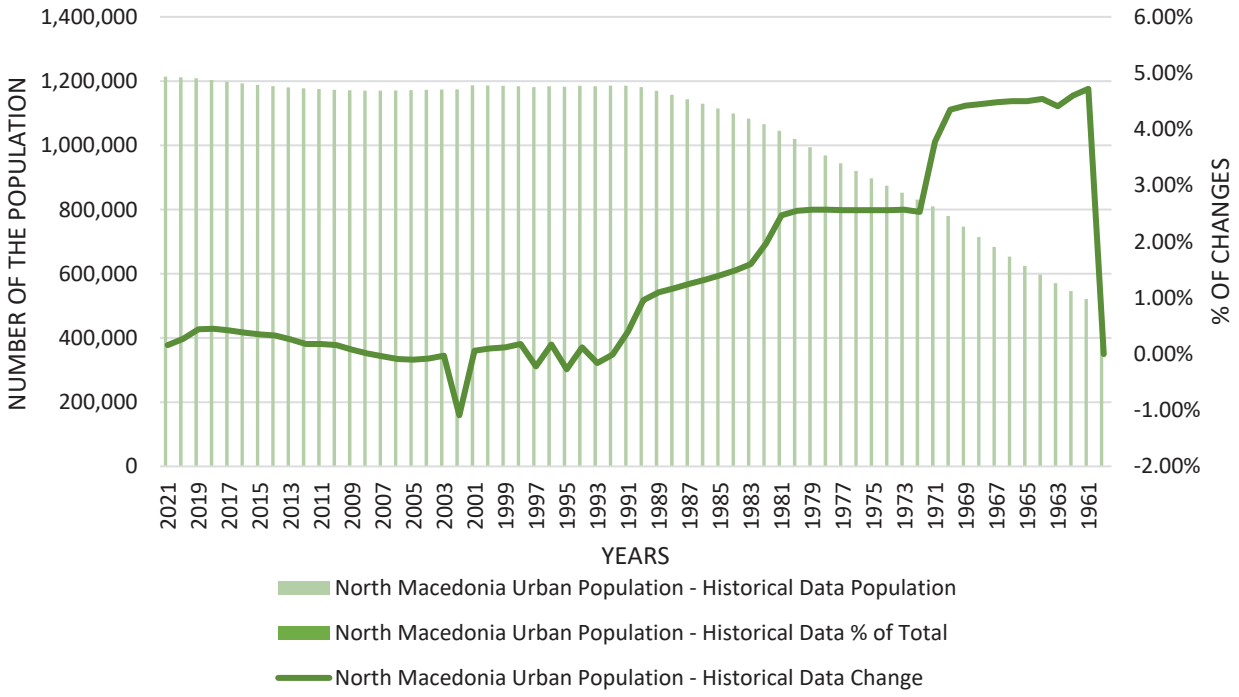


Chart 10. *Urban population an historical review:* ***Source of data:*** *World Bank, 2023*

Looking at the period immediately after the World War II till 2008, the percentage of rural population in Macedonia dropped from 72.4% in 1948 to 31% in 2008. More specifically, the agrarian population dropped from 71.52% in 1948 to 11.79 in 1994. That means that large areas of arable land and pastures have been abandoned in the last 6-7 decades and they have become grasslands, shrublands or even forest (G. Xanthopoulos and N. Nikolov, 2019).

Overall, the historical review of data suggests a gradual decrease in the rural population and significant increase in the urban population of North Macedonia over the past six decades. This trend aligns with the global pattern of urbanisation, where people are moving from rural areas to urban centres in search of better economic opportunities, education, and healthcare.

C. GENDER STRUCTURE

The gender structure of North Macedonia is relatively balanced (Chart 11, 12), with almost equal participation of both genders in the population. According to the 2021 census, the number of women is 925,626 or 50,4% of the population, while man account for 911,087 or 49.6%. This indicates that there is no significant gender imbalance in the country's population, which is a positive sign for gender equality.

The trend of a decreasingly aging population in North Macedonia is expected to continue in the future. According to the projections by the United Nations, the percentage of the population aged 45 – 60 and over 60 will continue to increase.

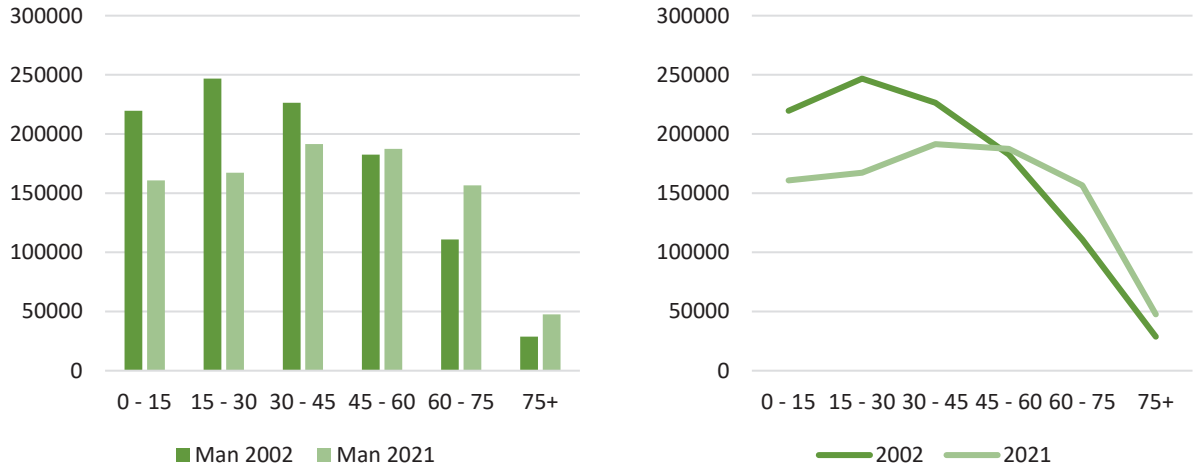


Chart 11. *Male structure representation within 6 age categories, data for 2002 and 2021:* ***Source of data:*** *State Statistical Office*

At the same time the percentage of the population aged 0 – 15, 15 – 30 and 30 – 45 is projected to continue decreasing by 2050. The population of North Macedonia is also characterised by a significant level of emigration, particularly among the younger population. This has led to concerns about a potential brain drain, as well as the long-term impact on the country's demographic and economic situation.

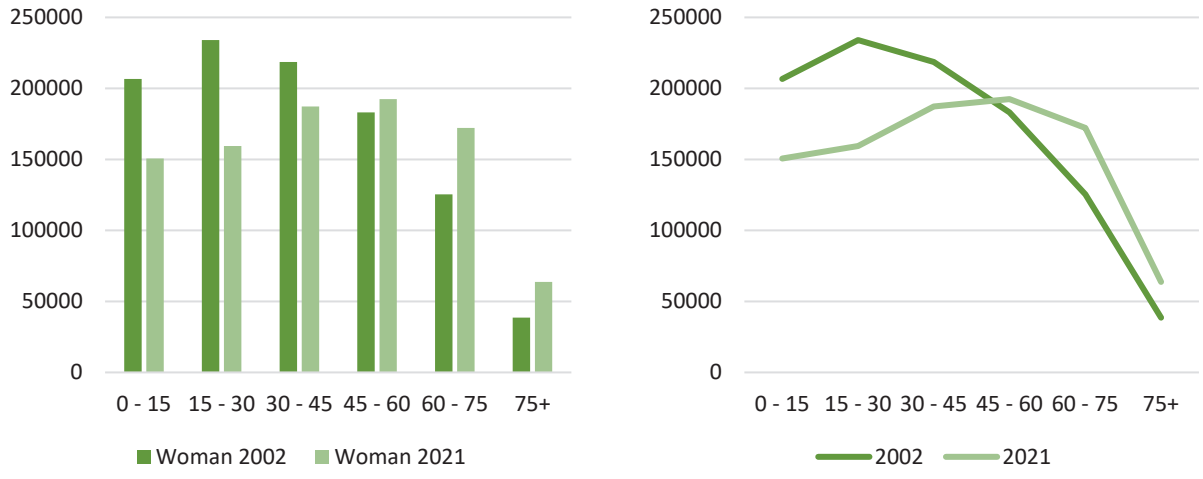
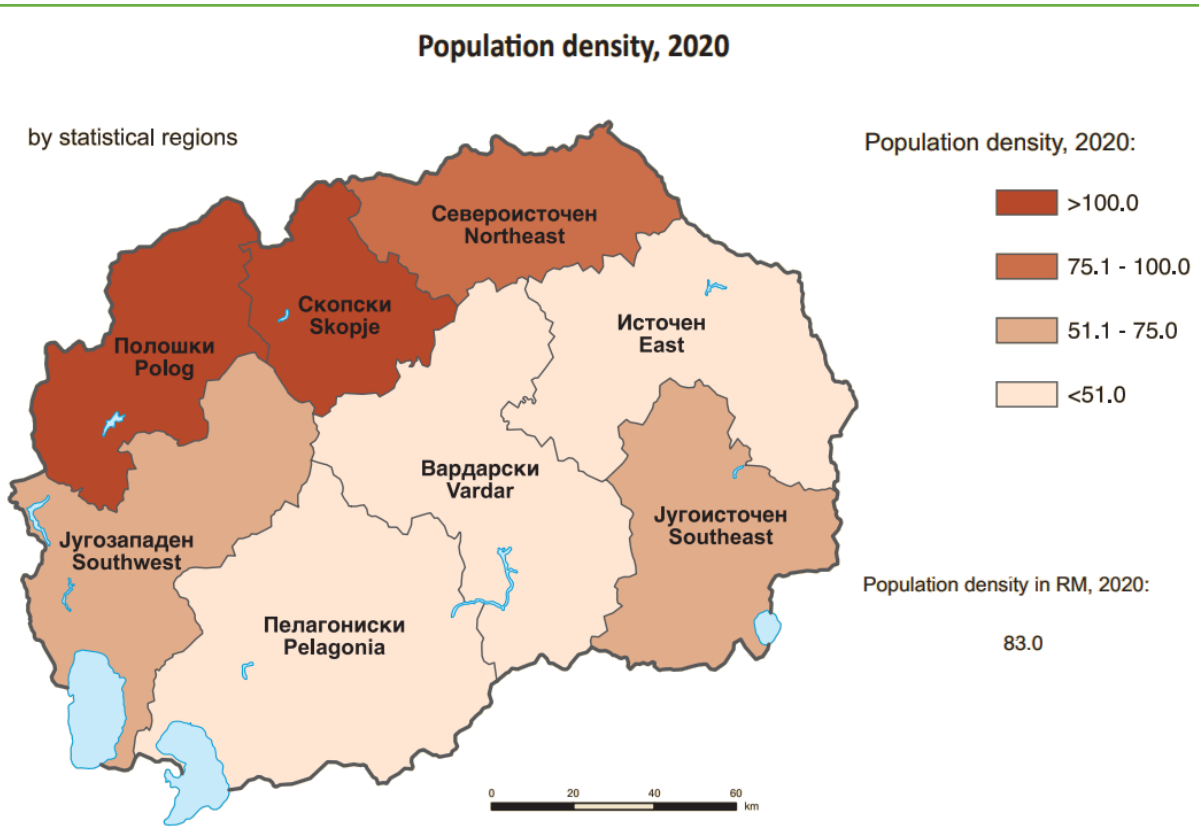


Chart 12. *Female structure represented within 6 age categories:* ***Source of data:*** *State statistical office*

The Skopje region has the highest percentage of young people aged 0 – 15 years among all regions in North Macedonia. This is likely due to the fact that Skopje as a capital is the economic and cultural centre of the country, attracting young families and people seeking job opportunities and a better quality of life. In contrast, the East Region, which covers a more rural area, has the lowest share of young people. The East Region has the highest proportion of elderly people aged 65 and above, while the Polog Region has the lowest percentage of elderly people. This is mostly because the East Region is less developed with limited job opportunities and resources, leading the younger generations to migrate to big cities like Skopje or other countries in search of better opportunities.

Migration from rural to urban space can have both positive and negative impacts. One the one hand, it can help reduce the aging population in rural areas and contribute to the development of urban areas. On the other hand, it can also create significant social and economic disparities between rural and urban areas and put pressure on urban infrastructure and resources. Therefore, it is one of the elements causing the increase of abandoned land (increase of combustible material) which, in further stage of the natural succession, would play significant role in the risks of landscape fires.



Map 8: *Population density by statistical regions in North Macedonia estimated in 2020:* ***Source of data:*** *Environmental statistics 2021*

The average population density in North Macedonia is 83,4 inhabitants per square kilometre. However, there are significant differences in population density at different territorial levels, largely due to intensive migrations. At the regional level, Skopje Region is the most densely populated while the Vardar Region is the least densely populated. Within municipalities, those that include urban settlements tend to have higher population density while purely rural municipalities are much less populated (Figure 8).

As people migrate from rural areas to cities, rural landscapes may become less populated and experience a decline in human activities, including traditional land management practices such as agriculture and

grazing. This decrease in human presence and land use can lead to changes in vegetation dynamics and fuel buildup, making these areas more susceptible to landscape fires. Without regular maintenance and management, such as controlled burns or clearing of flammable materials, the risk of fire ignition and spread increases. Simultaneously, the influx of people into urban areas can result in urban expansion and the encroachment of human settlements into nearby wildland areas.

This wildland-urban interface (WUI) creates a higher likelihood of landscape fires due to human activities, such as careless disposal of flammable materials or increased use of fire-prone infrastructure like power lines. Additionally, the close proximity of urban areas to natural landscapes can lead to more frequent and severe fires as fire can easily spread from wildland areas to populated regions. The demographic effect of rural-urban migration also influences fire management practices. As rural populations decrease, there may be a decline in local knowledge and traditional fire management techniques, reducing the capacity to prevent and control landscape fires effectively in the initial phase. Conversely, the increased demand for resources and infrastructure in urban areas can redirect funding and attention away from rural fire management efforts, exacerbating the wildfire risk.

In summary, the migration of the population from rural areas to cities has demographic effects and contributes to increased landscape fires. The depopulation of rural landscapes and changes in land use patterns increase the vulnerability of these areas to fires. Simultaneously, urban expansion into wildland areas creates an wildland-urban interface that heightens the risk of fire ignition and spread. Effective landscape fire management strategies that consider the unique challenges of rural-urban migration, including public awareness, land-use planning, and collaboration between communities, are crucial to mitigate the increased landscape fire risk and protect both human settlements and natural environments.

III. CLIMATE CHARACTERISTICS, CLIMATE CHANGE SCENARIOS AND NATIONALLY DETERMINED CONTRIBUTIONS (NDCS)

A. CLIMATE CHARACTERISTICS

Despite the small territory of Republic of North Macedonia, its climate varies significantly depending on the location. Mean summer temperature ranges from 20.6 °C to 24.3 °C while winter temperature varies from 0.9 °C to 4.9 °C. However, temperature can reach extreme highs of over 45 °C and lows of -30 °C during winter. The western part of the country is more favourable for precipitation, with an average annual rainfall amount of 733 mm and range of 400 mm to above 1,000mm.

North Macedonia has eight distinct climate zones (Filipovski Gj. et al 1996). Due to the different composite river valleys, variation in the size of the valley areas and lakes and differences in altitudes and different climate conditions following various thermo-climatic regions, sub-regions, and forest associations are present within the borders of North Macedonia.

Sub-Mediterranean Climate Region

The sub-Mediterranean climate zone is located at elevations between 50 and 500 meters above sea level. This area has mild winter and hot summers, with an average annual temperature of around 14 – 16°C. The region is characterised by dry summers and relatively wet winters, with the *Querco-Carpinetum orientalis* forest association (**Oberdemend Ht.**) present in the region, typical for the area around Gevgelija and Valandovo.

Moderate-Continental-Sub-Mediterranean Climate Region

The moderate-continental-sub-Mediterranean climate zone covers elevation up to 600 meters. This zone has slightly cooler temperatures than the sub-Mediterranean, with average annual temperature of around 12 – 14 °C. The area is also relatively dry in summers and has more rainfall in winter with the *Querco-Carpinetum orientalis macedonicum* forest association (Rudski apud Ht.) present in the region.

Warm Continental Climate Region

The warm continental climate zone is situated between 600 and 900 meters. This zone has hot summers and cold winters, with an average annual temperature of around 9 – 11 °C. The region receives moderate rainfall throughout the year with the *Quercetum frainetto-cerris macedonicum* forest association (Oberd Emend Ht.) present in the region.

Cold Continental Climate Region

The cold continental climate zone is located at an elevation between 900 and 1,100 meters. This zone has cold winters and mild summers, with an average annual temperature of around 6 – 8 °C. The region also has moderate to high levels of precipitation throughout the year with the *Orno-Quercetum petraeae* forest association (Em.) present in the region.

Sub-Forest-Continental-Mountainous Climate Region

The mountainous continental climate zone covers elevations between 1,100 and 1,300 meters. This zone has relatively mild summers and cold winters, with an average annual temperature of around 4 – 6 °C. The region is also characterised by high levels of precipitation, particularly in the form of snow with the *Festuco heterophyilla-Fagetum* forest association (Em.) present in the region.

Forest-Continental-Mountainous Climate Region

This climate zone is situated at an elevation between 1,300 and 1,650 meters. This zone has cold, snowy winters and cool summers, with an average annual temperature of around 2 – 4 °C. The region receives a high level of precipitation, and forests are dominated by coniferous trees with the *Calamintha grandiflo-ra-Fagetum* forest association (Em.) present in the region.

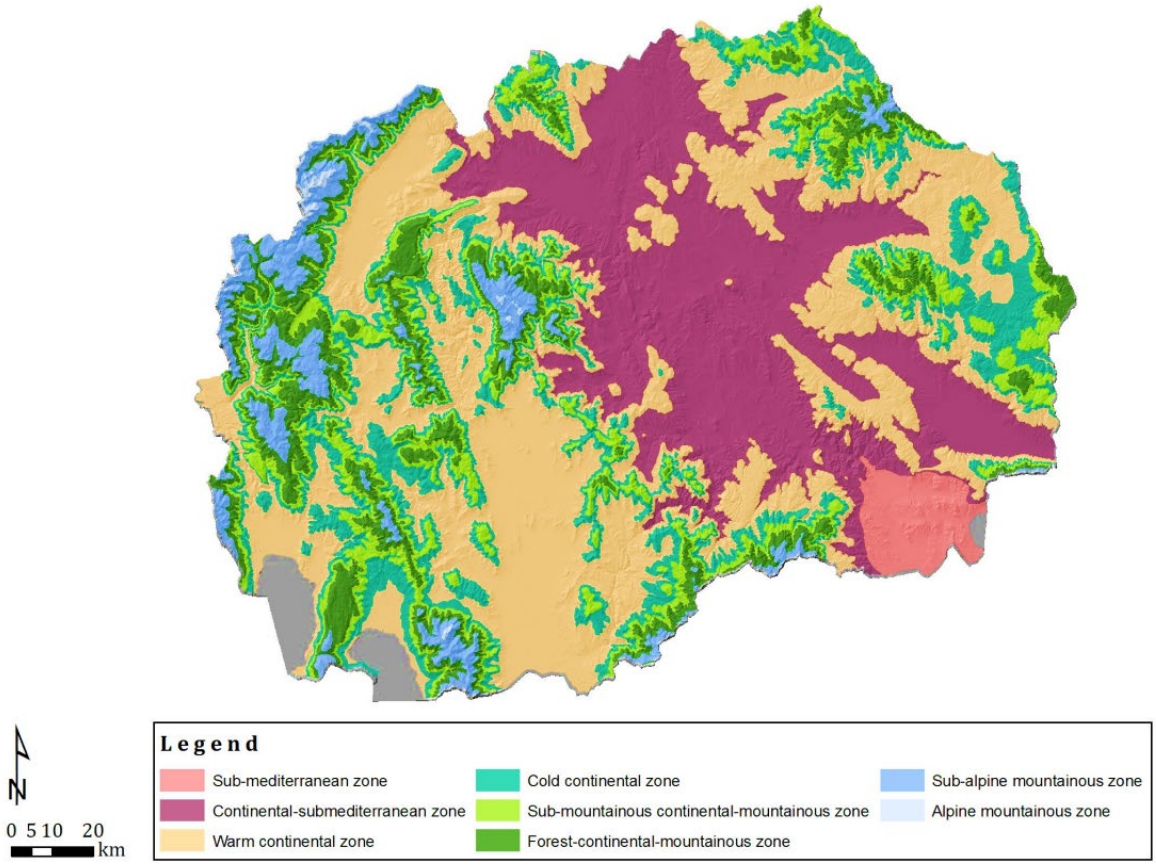
Sub-Alpine-Mountainous Climate Region

The subalpine mountain climate zone covers elevations between 1,650 and 2,250 meters. This zone has a harsh alpine climate with long, snowy winters and short, cool summers, with an average annual tempera-ture of around -1 to 1 °C. The region receives a high level of precipitation in the form of snow with the *Fage-tum subalpinum scardo pindicum* (Em.), *Picetum subalpinum scardicum* (Em.), *Myrtillo-Pinetum pencis subass. Subaplinum* (Em.), *Pinetum mudhi macedonicum* (Em.) and *Junipero-Bruckentalium* (Em.) forest associations present in the region.

Alpine-Mountainous Climate Region

The alpine and sub-alpine mountain climate zones, located at elevation higher than 2,250 meters, have a severe alpine climate with very cold, snowy winters and short, cool summers with an average annual

temperature below 0 °C. The region receives heavy snowfall throughout the year and only a few hardy plant species can survive in this zone followed with mostly grass forest/vegetation associations (Filipovski G., et al 1996).



Map 9: *Characteristic climate zones in Republic of North Macedonia (Trendafilov B., et al 2010)*

Boundaries between the climate zones are not fixed and can vary depending on several factors such as altitude, topography, and regional weather patterns. However, the Vardar valley region in the central part of the country experiences the strongest Mediterranean influence, with hot, dry summers and mild and wet winters (Map 9). As one moves towards the southeast, west, and north, the climate becomes increasingly continental, characterised by hot summers and cold winters with occasional snowfall.

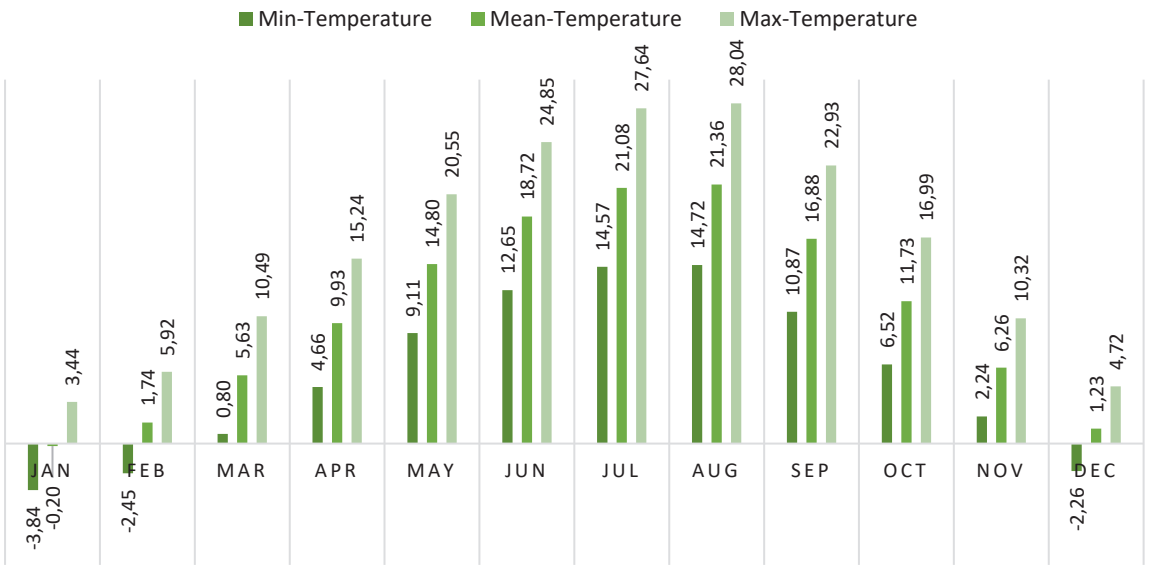
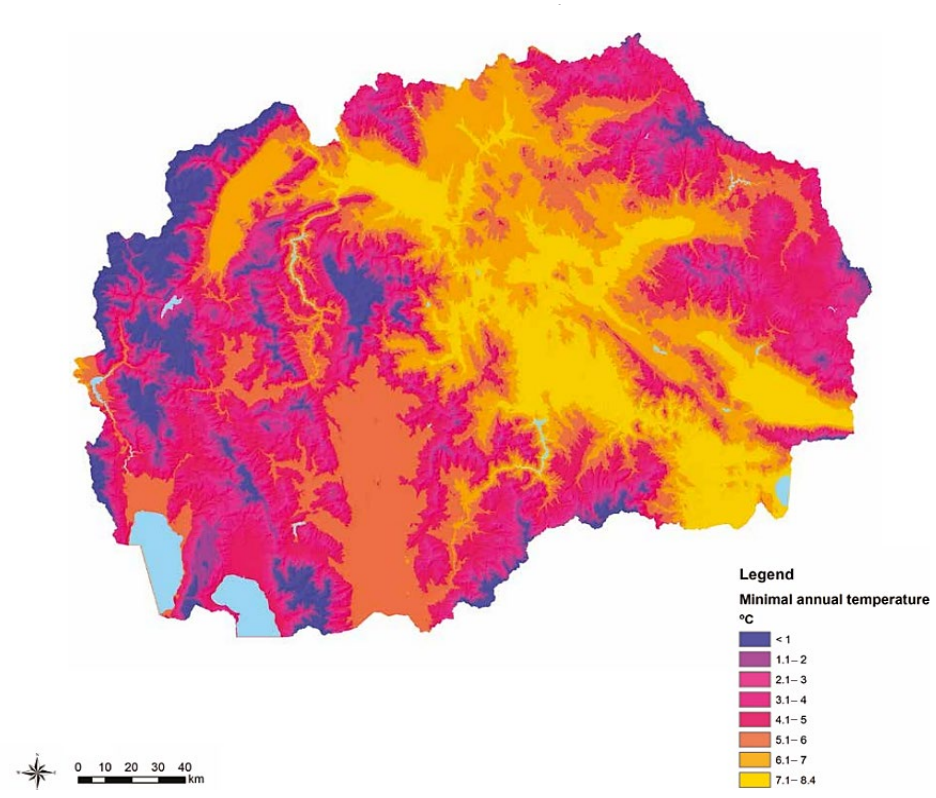


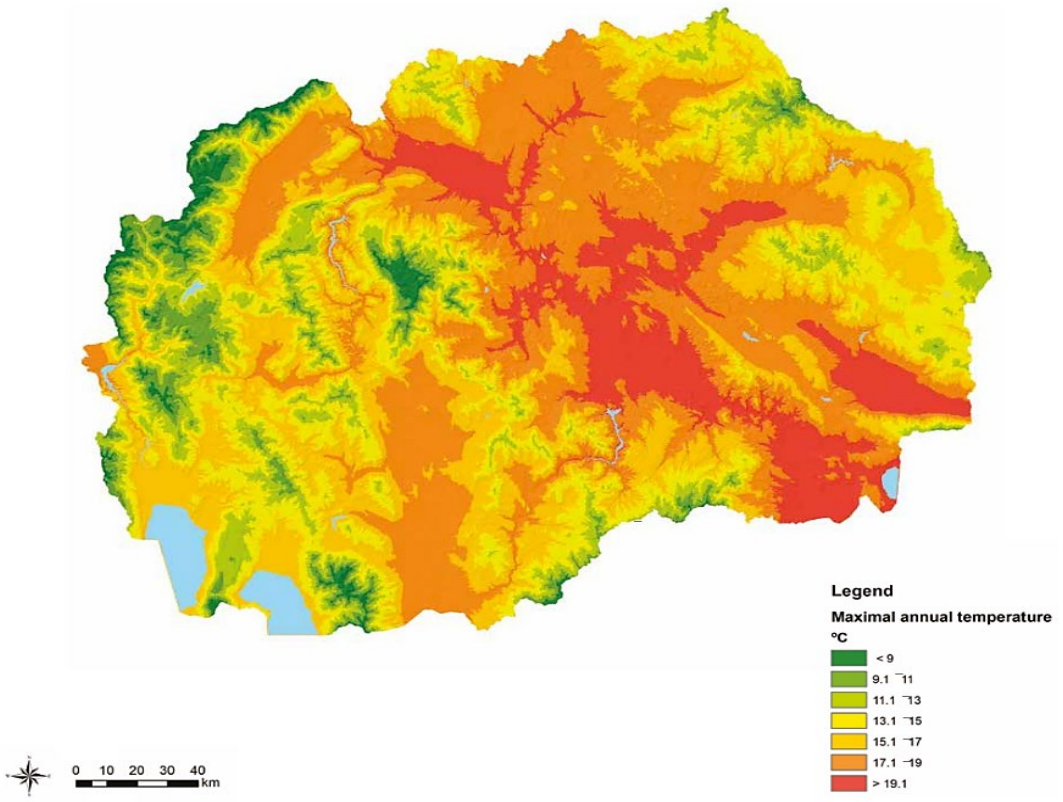
Chart 13. *Monthly data of Average Min-Temperature, Average-Temperature and Average Max-Temperature for period 1991 – 2020:* ***Source of data:*** *World Bank, 2023*

Winter in North Macedonia is generally cold, although the temperature varies with altitude. The average temperature in January is slightly above 0 °C at the lowest altitudes. The winter weather is not always stable. There are calm periods, when cold air clings to the soil, alternating with mild days, when warm air masses from the Mediterranean manage to penetrate the country, but also periods of intense cold due to outbreaks of air masses, which are able to lower the temperature to around -20 °C.



Map 10: *Map of minimal annual mean temperature in North Macedonia:* ***Source of data:*** *FAO, February 2019*

Summer is hot in the valleys located at lower altitudes, e.g., in Skopje where average maximum temperatures are around 29 °C. The temperature range is wide, and moisture is not high, so nights are usually cool, but the days can be scorching, with peaks of 40°C and above. Sunshine is frequent, and the rains are relatively rare, occurring in the form of thunderstorms in the afternoon. Overall, climate in North Macedonia is influenced by its location in the Balkan peninsula, its proximately to the Mediterranean Sea, and its varied topography.



Map 11: *Map of maximum annual mean temperature in North Macedonia:* ***Source of data:*** *FAO, February 2019*

In the long-term annual mean temperature analysis (Map 11), clear evidence suggests that annual mean air temperature in Republic of North Macedonia has risen its maximum annual mean temperature of 12 degrees (11,98 C°) in 2019. According to data from Climate Change Knowledge Portal, minimum annual mean temperature of 9 (8.83 C°) was measured in 1940.

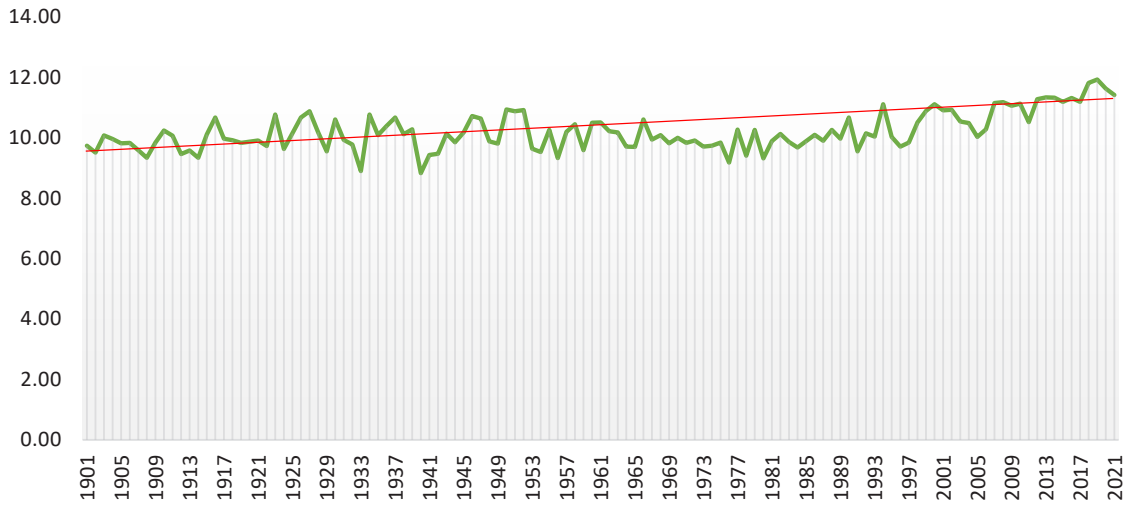
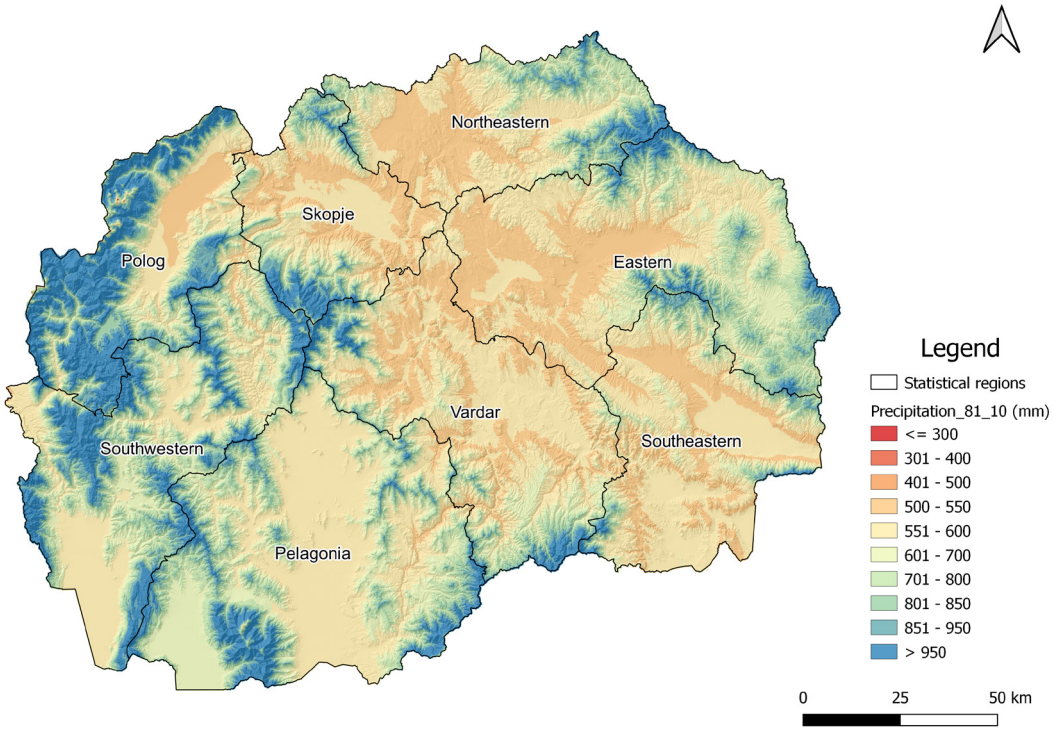


Chart 14. *Observed Annual Mean Temperature of North Macedonia for the period 1901 to 2021 :* ***Source of data:*** *Climate Change Knowledge Portal provided by the Climatic Research Unit CRU*

Precipitation in North Macedonia is not abundant in the valleys (Map 12), where the amount is about 650 mm per year. However, it becomes a bit more abundant with increasing altitude. In general, the two rainiest seasons are late spring and autumn, while winter and summers are relatively dry. During the late spring, which is typically May and June, the rainfall is mainly due to the passage of low-pressure systems, which brings occasional thunderstorms and sometimes heavy downpours. That is the period when it is naturally expected lightning as a possible cause of landscape fires.



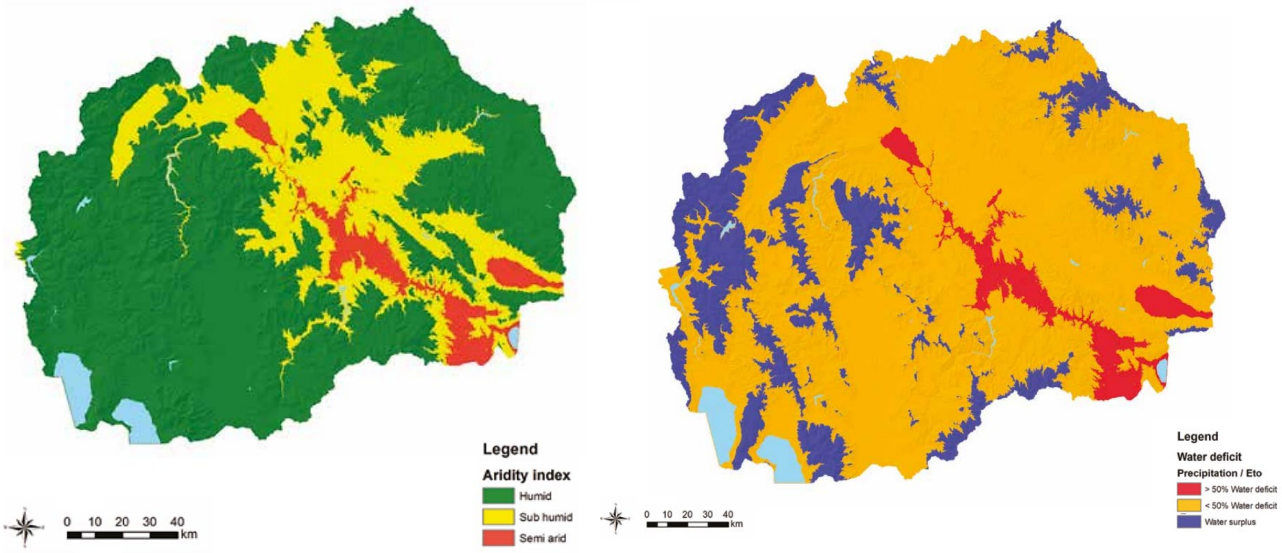
Map 12: *Average precipitation map period 1981 - 2010 (mm):* ***Source of data:*** *Hydrometeorological service of North Macedonia; Agency for Real Estate Cadastre of North Macedonia*

In autumn, October and November are also characterised by rainfall as the Mediterranean brings moist and warm air masses that can lead to persistent precipitation, particularly in the western regions of the country. In contrast, winter and summer are relatively dry in North Macedonia. During winter, the air is usually too cold and stable to allow for significant precipitation, except for occasional snowfall at higher altitudes. In the summer months of July and August, the region experiences a period of stable and very dry weather, with sunny days and clear skies (Table 10). This is due to the influence of high-pressure air system over the Balkan region which suppresses cloud formation and precipitation.

Table 9. *Monthly total precipitation C o in North Macedonia for the period 1901 – 2021 (State Statistical Office and Climate Change Knowledge Portal provided by the Climatic Research Unit CRU)*

	AVARAGE PRECIPITATION FOR THE PERIOD 1901 - 2020				
	1901-1930	**1931-1960**	**1961-1990**	**1991-2020**	**Average**
	Precipitation	Precipitation	Precipitation	Precipitation	Precipitation
Jan	54.67	64.48	52.47	52.88	56.13
Feb	46.11	48.14	49.69	46.00	47.49
Mar	51.51	47.70	54.58	52.39	51.55
Apr	55.05	55.91	53.98	52.93	54.47
May	76.89	72.37	69.70	68.06	71.76
Jun	64.57	59.46	57.18	59.35	60.14
Jul	44.35	36.45	45.37	45.37	42.89
Aug	39.39	33.45	40.96	39.30	38.28
Sep	45.34	46.31	43.66	57.28	48.15
Oct	67.44	70.27	55.57	60.78	63.52
Nov	74.64	81.50	76.70	64.83	74.42
Dec	67.99	72.66	67.35	65.65	68.41

Aridity zones in Republic of North Macedonia are typically classified based on the aridity index map (Map 13), providing information about the dryness or moisture of a particular region. According to the Global Agro-Ecological Zones dataset report (2012), the aridity index for North Macedonia is calculated by taking the ratio between the annual precipitation and reference evapotranspiration which is determined using Penman method. Classification of aridity zones is important for natural resource management, including water resources, forest, grazing land, and agriculture.



Map 13: *Map of Aridity index (left) and Water deficit (right) in North Macedonia:* ***Source of data:*** *Ivan Mincev (FAO), Map conforms to UN world map, February 2019. Dashed lines on maps represents approximate border lines for which there may not yet be full agreement at www.fao.org/3/t0122e/t0122e03.htm*

The climate characteristics of the North Macedonia mentioned previously, play a crucial role in shaping landscape fire management strategies. For instance, Fire season timing is strongly influenced by climate. With hot, dry summers as in North Macedonia, the fire season is typically longer and more severe. Fuel moisture level (moisture content of the vegetation) is directly influenced by the climate. In zones like the sub-mediterranean climate zone as well in the continental zone with hot and dry summers, vegetation becomes dry and more flammable. The historical and real time data from the Hydrometeorological service of North Macedonia, and in the MAKFFIS platform are important to adjust right strategies at the right time of the fire season.

Aridity index (FAO 2019) associated with the water deficit index in North Macedonia clearly indicates the regions following Vardar River are more prone (higher aridity index values) to drought conditions, which leads to dry vegetation susceptible to ignition and rapid fire spread. Combination of low moisture in the soil and vegetation along with the high temperature create conditions conducive to landscape fires.

These two indexes are crucial in long term planning for fire risk mitigation and flexible to be adapted to changes of climate conditions which influence aridity and water availability. Finally, aridity index and water deficit are important tools in landscape fire management for assessing fire risk, understanding the moisture conditions of vegetation, and planning proactive measures to reduce the likelihood and impact of forest fires in dry and arid regions.

B. CLIMATE CHANGE AND NATIONAL DETERMINED CONTRIBUTIONS (NDCs)

Amidst humanity's high level of technological development, life, progress, and society's survival heavily rely on the state of the atmosphere, particularly weather and climate. Sectors like agriculture, transportation, energy, and tourism are highly sensitive to weather and climate changes. Therefore, extensive climate forecasting is conducted so as to adapt to climate change efficiently, mitigate potential consequences, and optimise natural resource utilisation. This report includes analysis of the 3rd and 4th National Communications on Climate Change (TNC and FNC) and National Determined Contributions (NDC) for Republic of North Macedonia reports addressing climate change, mitigation and adaptation actions.



Photo 2: *3rd and 4th NCCC and NDCs reports for Republic of North Macedonia*

Projections suggest that climate change in Republic of North Macedonia will lead to increased risks and extreme events of forest fires, river floods, droughts, biodiversity loss, and threats to human health as well as the economy (sectors to energy, forestry, agriculture, and tourism). Further, the southern part of the country will experience higher temperatures and reduced water access, exacerbating vulnerability to droughts, forest fires, and heatwaves. The northwestern low coastal areas face rising river levels. Easy access to oil and gas reserves and reduced ice cover will add environmental pressure. Mountain regions will deal with reduced snow cover, impacting winter tourism and causing species extinction. Permafrost degradation may endanger infrastructure.

The forestry sector will face higher tree mortality, insect and fungi infestation, large number of heavy rain days and more forest fires. In terms of forest fires, trends have changed, that is, the likelihood of two severe fires to take place with a shorter period between them has increased and fire season has extended. In the summer period of 2019, many of the water springs into the forest area dried up. This was accompanied by strong fungi and insect infestations. In the summer of 2021, forest fires devastated forests, fertile land, crops, and property of the rural and urban population (Photo 3). On august 4th, the government of the of Republic of North Macedonia declared a state of crisis for the whole territory.



Photo 3: *Wildfire events, summer 2021 North Macedonia:* ***Source of data:*** *Red Cross of the Republic of North Macedonia*

Forests and generally the forestry sector are the major contributors to GHG sinks in North Macedonia. Currently the sink of the GHG or its removals from the forests are relatively stable in comparison to the years when there were severe forest fires. Forestlands in most cases are significant sinks of GHG, for instance in some years of the reported period 2005 (-2,230 Gg Co_2-eg), 2014 (-3,382 Gg CO_2eg) and 2018 (-2,255 Gg CO_2-eg) removals are notable. At the same time, the presence of severe forest fires comprised of significant number of fires was followed by large, burned area of forest effectively contributing to increase of the GHG emissions in the atmosphere, for instance, 2000 had a record of 9,843 Gg, 2017 with 1,133 Gg and 2019 with 1,060 Gg. The Emissions of CO_2 in the atmosphere in the forestry sector are mainly from two sources, that is, firewood and forest fires. Constant producers of CO_2 emissions are households which use firewood as a source for heating. In accordance with FNC report, 85% of the annual actual logging volume is used for households mainly for the domestic industry and for firewood heating purposes.

VULNERABILITY AND CLIMATE CHANGE IMPACT ON FORESTRY

Vulnerability of forest growth to temperature changes generally derive from the increase in temperature, sensitivity of tree dynamics to temperature, and the changes of ecosystem composition following changes in tree dynamics. This analysis on forestry focuses on coupled sectoral-ecological system defined as integrated and complex system in which ecosystems and sectors interact. Vulnerability assessments should consider the link between these two systems, in our case forest and forestry.

Projection on future vulnerability of such complex system, as is the forest and forestry sector, is difficult. Parameters that must be taken into consideration are mostly related to human activities, optimal

conditions for a species, ecosystem type, and forest management. For instance, Forest fires represent a good example of the complexity of the system where doe to droughts, there is increases of the risk of forest fires.

The vulnerability of a forest will depend on the amount of dead wood (biomass/fuel accumulation) which in turn depends on:

- Forest management,
- Number of dead trees due to previous drought and/or pests, diseases,
- Spatial organisation of the forest (e.g., the presence of buffer strips and fire breaks)

Finally, vulnerability will depend on the means of planning, prevention and monitoring fires as well as addressing them at an initial early stage.

CLIMATE CHANGE SCENARIOS FOR NORTH MACEDONIA

Climate Change Scenarios and projections are essential tools used to understand and anticipate the potential impacts of climate change on a specific region, such as the Republic of North Macedonia. These scenarios provide valuable insights into how various climatic factors may evolve in the future and key climate impacts, to help policymakers and stakeholders make informed decisions for adaptation and mitigation strategies.

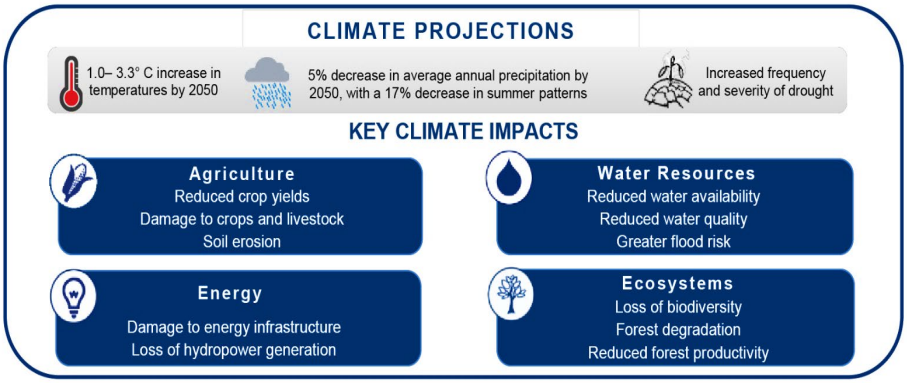


Photo 4: *Climate Projections for North Macedonia with the key climate impact on agriculture, water, energy and ecosystems:* ***Source of data:*** *Climate Risk Profile North Macedonia USAID 2018.*

To develop comprehensive climate change scenarios for the Republic of North Macedonia, different sources and methodology of climate change projections can be utilised:

- Intergovernmental Panel on Climate Change (IPCC):

The IPCC (IPCC — Intergovernmental Panel on Climate Change) is a renowned international body that assesses scientific knowledge on climate change. This body produces periodic assessment reports, which compile and analyse climate data from around the world. These reports present various scenarios based on different levels of greenhouse gas emissions, known as Representative Concentration Pathways (RCPs). These RCPs represent different future trajectories of atmospheric CO2 concentrations and are used as inputs for climate models to project potential climate outcomes.

Future GHG emission scenarios and climate change projections for North Macedonia using RCP2.6, RCP4.5, RCP6, and RCP8.6 scenarios from the IPCC are based on the reports by Vladimir Djordjevic, (2020) for the climate extremes, and Aleksandar Karanfilovski, (2012).

GHG EMISSIONS SCENARIOS

GHG emission scenarios covers the period from 2016 to 2100, divided into three twenty-year intervals: 2016-2035, 2046-2065, and 2081-2100. The reference period is 1986-2005, consistent with the Fifth IPCC report. RCP2.6 and RCP4.5 scenarios assume that greenhouse gas concentrations will stabilise in the future (Chart 15). On the other hand, RCP8.5 and RCP6.0 scenarios suggest that greenhouse gas concentrations will continue to rise or follow past trends in North Macedonia (Figure 30). RCP2.6 anticipates a decline in greenhouse gas concentrations in the latter half of this century, necessitating net-zero anthropogenic emissions at some point.

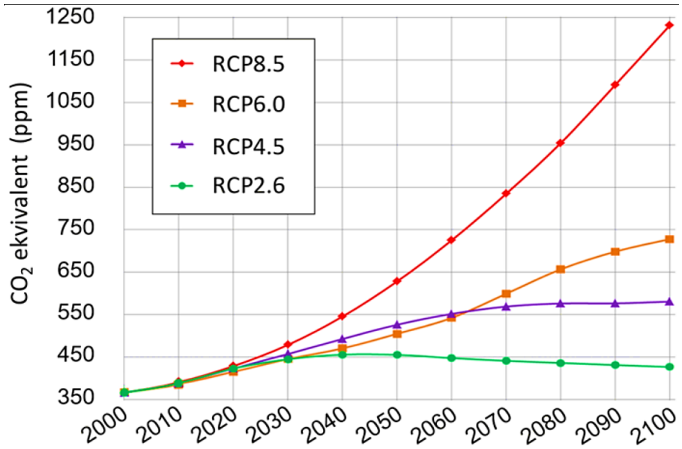


Chart 15. *Future concentrations of greenhouse gases for 4 different scenarios (RCP8.5, RCP6, RCP4.5, RCP2.6 for the Republic of North Macedonia. Vladimir Djordjevic, (2020)*

A MAGICC/SCENGEN software package is used in forecasting climate changes in North Macedonia while adhering to the IPCC's fundamental recommendations and the latest Fourth Assessment Report. Additionally, climate sensitivity values of 2.0, 3.0, and 4.5 °C are used, representing optimal and limit values. Analysis of the temperature and precipitation changes is made in comparison with the 1961 - 1990, which is taken as reference period (A., Karanfilovski, 2012). The analyses are made for four characteristic periods:

- 2025, central year for 2011 – 2040,
- 2050, central year for 2036 – 2065,
- 2075, central year for 2061 – 2090
- 2100, represents the period 2086 – 2100.

The predictions clearly indicate a positive trend, with air temperatures expected to increase from 2025 to the year 2100. The changes in temperature are as follows: the value before the middle bracket represents the mean change, while the values in parentheses represent the maximum (absolute largest) and minimum (absolute smallest) change.

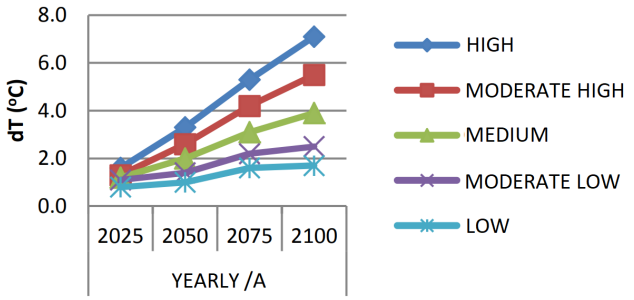
ANNUAL LEVEL: MEAN TEMPERATURE

The data indicates an increase in temperature throughout the period 2025 – 2100 years. These changes are greatest in the summer period. Changes marked with "High" and "Moderate-High" gradient of increase over time (from 2025 to 2100- ta) are the most common. Changes marked "Low" take place more moderately (Table 11).

Table 10. *Annual Mean Temperature (A., Karanfilovski 2012)*

2025 period – changes	1.2 [0.8 – 1.6] ^{0}C
2050 period – changes	2.0 [1.0 – 3.3] ^{0}C
2075 period – changes	3.1 [1.6 – 5.3] ^{0}C
2100 period – changes	3.9 [1.7 – 7.1] ^{0}C

Graph. Annual mean air temperature projection changes



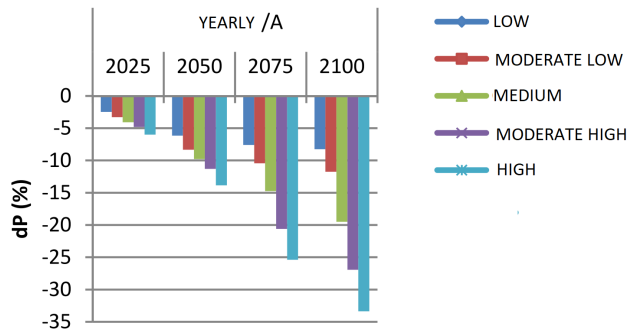
ANNUAL LEVEL: MEAN PRECIPITATION

In all seasons and throughout the year, there is a decline in precipitation levels, with the highest decrease occurring during the summer season. For all selected years (Table 12), there is a consistent pattern of negative changes in precipitation. This means there is an overall reduction in the total amount of precipitation.

Table 11. *Annual Mean Precipitation (A., Karanfilovski 2012)*

2025 period – changes	-4 [-2 / -6] %
2050 period – changes	-10 [-6 / -14] %
2075 period – changes	-15 [-8 / -25] %
2100 period – changes	-19 [-8 / -33] %

Graph. Annual mean PRECIPITATION projection changes



- REGIONAL CLIMATE MODELS (RCMs)

RCMs are numerical models that provide more detailed and localised projections compared to global climate models. They consider the topography and regional characteristics of North Macedonia and help downscale global climate projections to a more local scale. For diverse scenarios of future greenhouse gas concentrations, climate models that utilise these concentrations as input variables can provide suitable climate projections. Climate Models offer considerably higher horizontal resolution compared to Global Climate Models, typically around 11 km. Using their findings, it becomes feasible to assess the regional spatial alterations of the chosen factors.

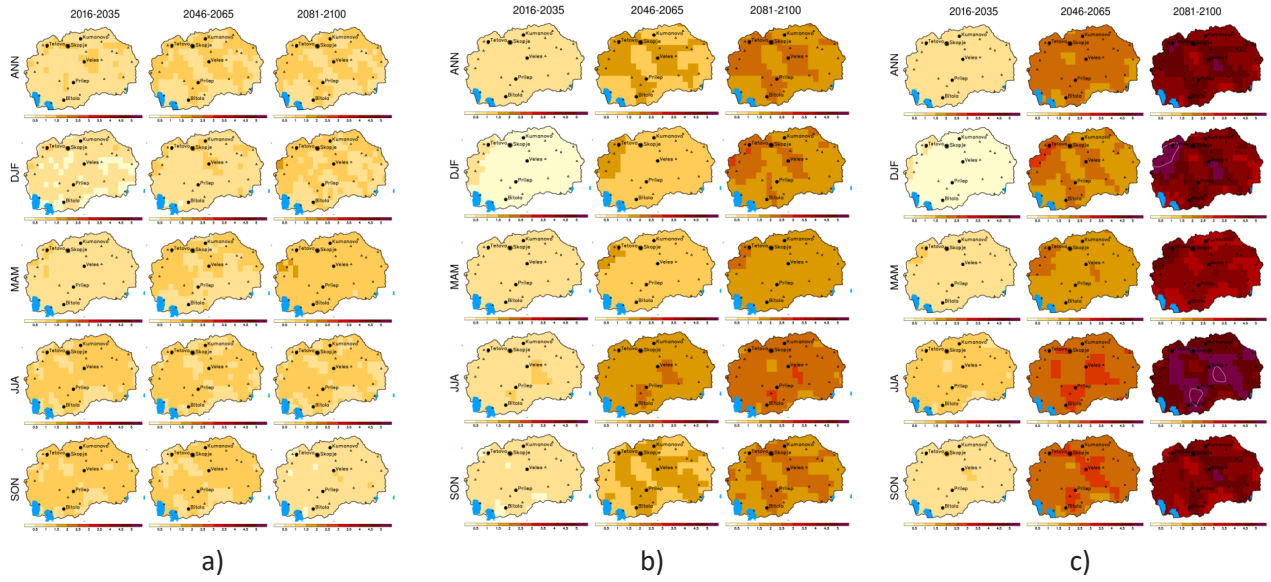


Photo 5: *Future daily minimum temperature change, for three future periods, 2016-2035, 2046-2065 and 2081-2100 with respect to the period 1986-2005, on annual level and for winter (DJF), spring (MAM), summer (JJA) and autumn (SON), for the RCP2.6 scenario (a) and RCP4.5 scenario (b) and 8.5 scenario (c)*

Annual and seasonal changes in the minimum, mean and maximum daily temperature for three different climate change scenarios (RCP2.6, RCP4.5, and RCP8.5) in the Republic of North Macedonia are analysed (V. Djordjevic (2020). In the RCP2.6 and RCP4.5 scenarios (Photo 5), temperatures are projected to increase steadily from approximately 1 °C soon to about 1.5 °C (RCP2.6), reaching to around 2.5 °C (RCP4.5) by the end of the century, with the highest warming anticipated in the summer season. The RCP8.5 scenario indicates the most significant temperature increase, ranging from about 1 °C soon to over 5 °C by the end of the century, with summer again experiencing the highest warming. ANNEX A, MAP A2 demonstrate the changes in annual and seasonal mean daily temperatures for the same climate scenarios. RCP2.6 scenario and RCP4.5 scenario, very similar to previous analysis, project a continuous rise in minimum daily temperatures, reaching over 2.5 °C by the end of the century. RCP8.5 scenario projects a continuous increase in minimum daily temperatures from about 1 °C soon to over 5 °C by the end of the century, with summer, again, experiencing the most substantial warming.

Lastly, ANNEX A, MAP A3 depicts the changes in annual and seasonal maximum daily temperatures for the three climate scenarios. The trends mirror those of mean daily and minimum daily temperatures, with an amplitude of change somewhat higher for maximum daily temperatures (V., Djordjevic 2020). However, there are variations in precipitation changes among the scenarios. RCP2.6 shows a slight increase in

precipitation while RCP4.5 and RCP8.5 (ANNEX A, MAP A4) predict a decrease, particularly pronounced in summer. The choice of greenhouse gas concentrations in these scenarios significantly influences the future pattern of precipitation change in the country.



Photo 6: *Agriculture land, crop production vulnerable to climate change:* ***Source of data:*** *https://balkangreenenergynews.com September 20,2017*

Analysis of various climate indices reveals that meteorological and climatological extremes are expected to change in the future. Cold extremes such as frost days, Ice days and cold waves will decrease, with more pronounced differences among scenarios by the end of the century (ANNEX B, MAP B1 and B2). Frost days will decrease by around -20 to -30 days per year soon, and up to -60 days for high scenarios by the end of the century. Hot extremes such as summer days, tropical nights, extreme heat waves (ANNEX B, MAP B2-3), on the other hand, will increase, with more summer days and tropical nights projected. Regarding precipitation extremes, there is no uniform signal between scenarios due to high spatial and temporal variability. However, both daily maximum precipitation and the number of days with precipitation above 40 mm/day are expected to increase in the future, indicating a higher chance of extreme precipitation events and induced flash floods (ANNEX B, MAP B4-5).

Consecutive dry days will increase, signifying a higher risk of drought, especially in the near future and for high scenarios. Growing season length will extend due to rising temperatures, with an increase of approximately 5 to 20 days soon and up to 50 more days (around 2 months) by the end of the century, benefiting agricultural activities (V., Djordjevic 2020). By combining information from different sources, stakeholders in the Republic of North Macedonia can develop more robust and localised climate change scenarios. These scenarios can be used to assess the potential impacts of climate change on various sectors like agriculture, forestry, water resources, infrastructure, and public health. They can also serve as a foundation for developing climate action plans to build resilience landscapes and ensure sustainable development in the face of a changing climate.

MITIGATION AND ADAPTATION ACTIONS TO CLIMATE CHANGE

The 3rd and 4th National Communication on Climate Change Report emphasizes the importance of mitigation and adaptation actions to the climate change. Forestry's adaptation to climate change is a crucial aspect of sustainable forest management that involves preparing for and addressing the anticipated impacts of climate change on forest ecosystems over the next century. The forestry sector recognises the need to assess the long-term effects of climate change on forests and develop strategies to respond effectively to this threat. By focusing on climate change adaptation, they aim to ensure the continued health and productivity of forests in the face of changing environmental conditions.

Mitigation actions in the 4th National Communication on Climate change report, related to forestry sector are aiming to achieve GHG emission reduction of 657,5 Gg CO_2-e.g., by 2030 and keeping same impact by 2050. The mitigation actions are planned to be implemented in the short, medium, and long term for the period 2030-2040. Among other, the mitigation actions related to LFM include:

- **PAM 38: ESTABLISHING INTEGRATED MANAGEMENT OF FOREST FIRES**

Main objective: Reduction of the average annual burned area to **6000ha.**

Description: Forest fires are already detected as a very significant problem of forest loss and source of GHG emissions. In the period from 1999 to 2019, the average annual number of forest fires was 299, an average annual area of 10.985 ha, followed by average annual damage estimated at 6.9 million EUR. Total burned forest area for the same period was around 219,163 ha with a total damage of around 138 million EUR. This is one of the key measures which includes the protection of the forest area by preventing forest fires and the damage resulting from forest fires.

Time frame for this mitigation action is 2030 to 2050. The action involves legal and regulatory acts as well relevant planning documents such as Law on Forest, Special rule book for forest fire protection, Strategy for development of the forest fire protection, diseases, and insects with action plan for realisation of the projects and procurement for the needs of PE "National Forests". Target assumptions are up to **3000ha** burned annually on average. Among the steps taken, there are steps envisaged in two phases:

Table 12. *Envisaged steps in two Phases, phase 1 and phase 2 for Establishing Integrated Management of Forest Fires*

PHASE 1	PHASE 2
Procurement of vehicles for initial attack, tools, and personal protective equipment (PPE). Duration of this phase is 1 year with followed steps: – Vehicles procurement: 25 specialised vehicles for initial attack (25 vehicles x 40,000 EUR = 1,000,000 EUR. – 50 sets of hand tools and PPE for 50 crews of five fire fighters (two per vehicle) (1 set of hand tools and PPE = 4,000 EUR; 50 sets x 5,000 EUR = 250,000 EUR.	Specialised training for fire fighters (Six days) – 50 craws x 5 persons = 250 fire fighters – 250 fire fighters x 800 EUR = 200,000 EUR.

Finance is organised in budget of 1.45 million EUR with a source of finance from PE "National Forests" and other forest enterprises. Implementation and monitoring entities are Ministry of Agriculture, Forestry and Water Economy through PE "National Forests".

Another Mitigation action closely related to Landscape fires is Afforestation (4th NCC):

- **PAM 39: AFFORESTATION**

Main objective: Afforestation of 5000 ha of barren land with Oak (*Quercus spp).*

Description: Afforestation and reforestation may change landscapes and may have an impact on the provision of landscape related goods and services. The supply of goods and services benefiting people and societies and the conservation of traditional cultural landscapes, as well as landscape ecology, need to be considered. According to the many strategic documents there are about 1,500,000 ha barren land aimed for afforestation or reforestation.

Time frame for this mitigation action is 2030 to 2050. The action involves legal and regulatory acts as well relevant planning documents such as Law on Forest. Target assumptions are up to 5000ha afforested barren land with Oak species. Among the steps taken, such as already existent nurseries for production of more than 8,000,000 seedlings annually, there are steps envisaged in three phases. Before all, the area for afforestation should be carefully chosen, then, around 7,500,000 Oak seedlings should be produced and finally afforestation should be done with proper care in the next 5 years.

Table 13. *Envisaged steps in two phases, phase 1 and phase 2 for Afforestation of 5000ha of baren land with Oak*

PHASE 1	PHASE 2	PHASE 3
Seedlings production (Duration 3 years) – Number of seedlings: 2,500 seedlings/ha x 5,000 ha = 12,500,000 seedlings *Cost of seedlings production: 12,500,000 seedlings x 20 MKD = 250,000,000 = 4,100,000 EUR	**Soil preparation and afforestation** (Duration 10 months) – Soil preparation: Duration of 4 months *Cost of preparation: 5,000 ha x 15,000 MKD = 75,000,000 den = **1,250,000 EUR** – Afforestation: Duration of 6 months *Cost of afforestation: 5,000 ha x 20,000 MKD = 100,000,000 MKD = **1,650,000 EUR**	**Maintenance and protection** (Duration 5 years) – Maintenance and protection *Cost of this action: 5,000 ha x 10,000 MKD = 50,000,000 MKD = **800,000 EUR**

Finance is organised in budget of 7.8 million EUR with a source of finance from PE "National Forests" and other forest enterprises. Implementation and monitoring entities are the Ministry of Agriculture, Forestry and Water Economy (4th NCC).

By maintaining genetic diversity and resilience within forest ecosystems, the ability of forests to withstand and recover from disturbances such as forest fires, pests, and diseases can be enhanced. While adapting to climate change, it is also crucial for forestry to strike a balance between environmental sustainability and economic viability. Forestry should continue to provide essential products and services from the forest while generating sufficient finances to support ongoing management efforts and conservation initiatives.

Another Climate change projections for the Republic of North Macedonia are based on global scenarios developed by the IPCC (Koppen-Geiger; World Bank Group). Future climate predictions have a reference period defined as 100 years from 2000 to 2100. It states that all scenarios show an increase in annual

average temperature, with the largest deviation in July and August (Chart 16 and 17). The number of days with maximum temperature above 35 °C is also expected to increase, particularly in August.

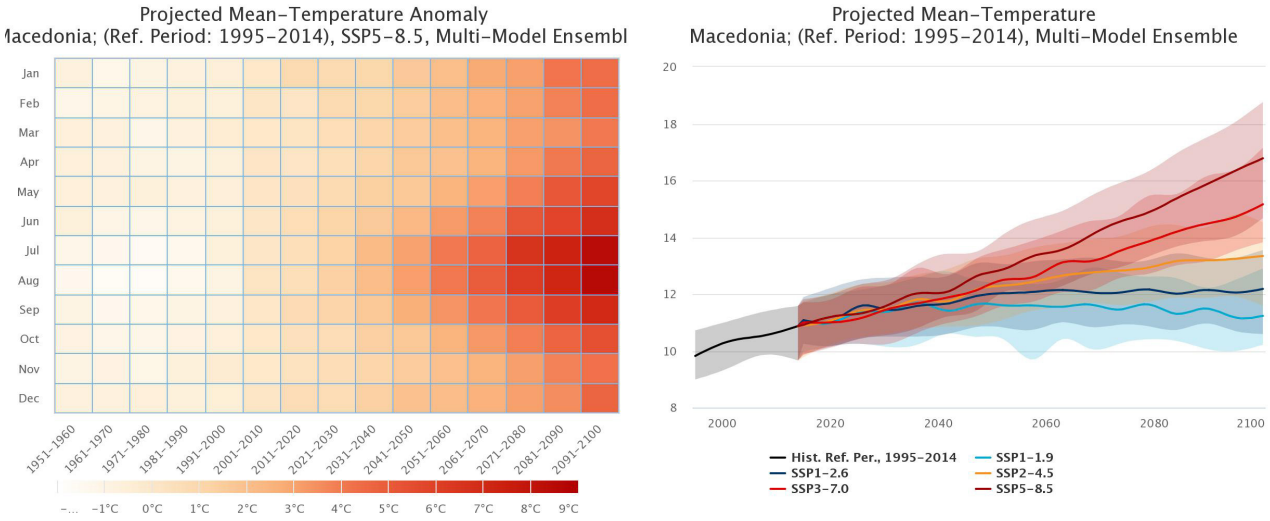


Chart 16. *Projected mean-temperature for the reference period 1995 - 2014 and projected mean temperature for the period 2000 to 2100:* ***Source of data:*** *World Bank Group; Climate Change Knowledge Portal*

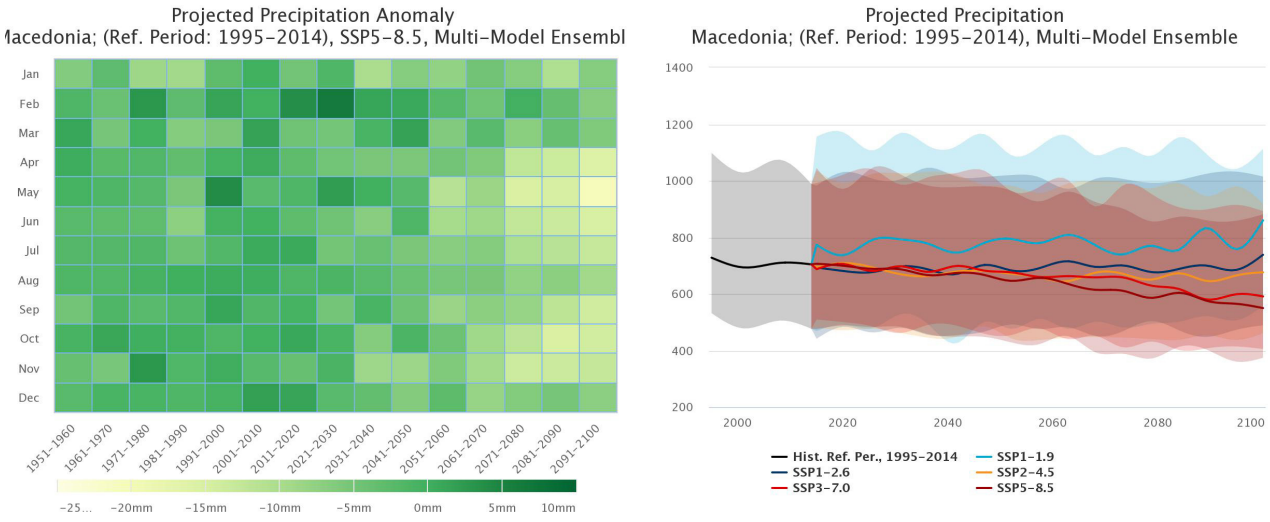


Chart 17. *Projected changes in precipitation; reference period 1995 - 2014 for projected mean precipitation for the period 2000 to 2100:* ***Source of data:*** *World Bank Group; Climate Change Knowledge Portal*

The change in precipitation is more uncertain, but models predict less precipitation between May and September and more precipitation between February and April. The combination of less rainfall and more intense heat waves during summer will lead to larger water deficit, increase risk of forest fires which will have negative effect on all sectors and civil society.

In accordance with the 3rd National Communication on Climate Change, forestry is a sector particularly vulnerable to the effects of climate change. As temperatures rise, vegetation becomes drier and more prone to catching fire, while decreased precipitation can reduce the moisture content of forests and

exacerbate the problem. Additionally, changes in seasonal patterns can alter the timing and duration of the fire season, potentially leading to longer and more severe periods of fire risk.

The major sources of exposure for forests in the country are as follows:

- Increasing temperature: Temporal changes, such as an increasing working season and longer periods of vegetation, as well as increasing frequency of extreme events such as floods and droughts, pose threats to infrastructure, life, inhabitants, and socio-economic factors.
- Increasing frequency of forest fires: Changes in this area include the threat to infrastructure, reduction in wood supply, increased greenhouse gas (GHG) emissions, decreased GHG absorption, and increasing frequency of insects and disease outbreaks. Impacts include reduction of wood supply and decreased growth and yields.
- Changes in forest productivity: Impacts in this area include wood supply and carbon sequestration changes, changes in species composition, and impacts related to the market and recreational values.

The most significant impact on forest management during this entire period have been forest fires. Their impact was felt not only at the time they occurred, but also in subsequent periods due to necessary post-fire management activities.

NATIONAL DETERMINED CONTRIBUTION (NDC)

The Republic of North Macedonia has announced its Enhanced National Determined Contribution (NDC) for reduction greenhouse gas emissions in line with the decisions made at the COP meeting in Paris and Katowice. The government's 65th session held on April 13th, 2021, has announced the first NDC document. NDCs are typically communicated as a set of quantifiable targets, actions, and policy measures that countries intend to implement over a specified timeframe (often up to 2030). They play a crucial role in shaping the global response to climate change and serve as a foundation for international cooperation and collective efforts in combating climate change and working towards a more sustainable and climate-resilient future.

Table 14. *National Determined Contribution base year emission and target year emission level for North Macedonia*

	Year	Emission level:
Reference year (base year)	1990	12,478 Gg CO2-eq.
Target year emission level	2030	6,058 Gg CO2-eq.

With the NDC, the country aims to achieve a 51% reduction in greenhouse gas emissions by 2030 compared to 1990 base levels. This reduction is expressed in net emissions and amount of 82% reduction compared to 1990 levels. The NDC primarily focuses on the mitigation area, with plans to include an adaptation component in subsequent submissions once national strategic and planning documents are prepared and adopted. The main components of the NDC enhancement include mitigation ambition, implementation, and communication (Table 16).

If the initial round of NDCs is fully executed, it would result in a temperature increase of 2.9 °C to 3.4 °C by the end of the century. To attain the Paris Agreement's objective of limiting global warming to well below 2 °C, or ideally 1.5 °C, more ambitious mitigation efforts are crucial. The Agreement established a mechanism to bolster climate action over time, mandating each nation to develop and communicate updated NDCs every five years, reflecting their utmost aspiration for climate action. Target and mitigation ambitions for Republic of North Macedonia are presented below.

Table 15. *Target and mitigation ambition from North Macedonian NDC 2021*

ENHANCEMENT COMPONENTS	ENHANCED NDC (2021)
	MITIGATION AMBITION
Target relative to the reference indicator	In 2030, 51% reduction in GHG emissions compared to 1990 levels (black line on the graph below). Disaggregated by sector (2030 vs.1990) ▪ Energy: 66% reduction (mainly through decommissioning of coal-fired power plants Oslomej in 2021 and Bitola up to 2027) ▪ IPPU: 45% increase ▪ Agriculture: 29% reduction ▪ LULUCF: 95% removals increase. ▪ Waste: 21% reduction

In the energy sector, the country aims to achieve a 66% reduction in GHG emissions by decommissioning coal-fired power plants Oslomej in 2021 and Bitola up to 2027. This is a significant step towards transitioning to cleaner energy sources and reducing the country's dependence on fossil fuels.

The IPPU (Industrial Processes and Product Use) sector, on the other hand, is expected to experience a 45% increase in GHG emissions, indicating the need for greater efforts to mitigate emissions in this sector. The agriculture sector aims to achieve a 29% reduction in emissions, which could involve measures such as promoting sustainable agriculture practices, reducing fertiliser and pesticide use and improving livestock management.

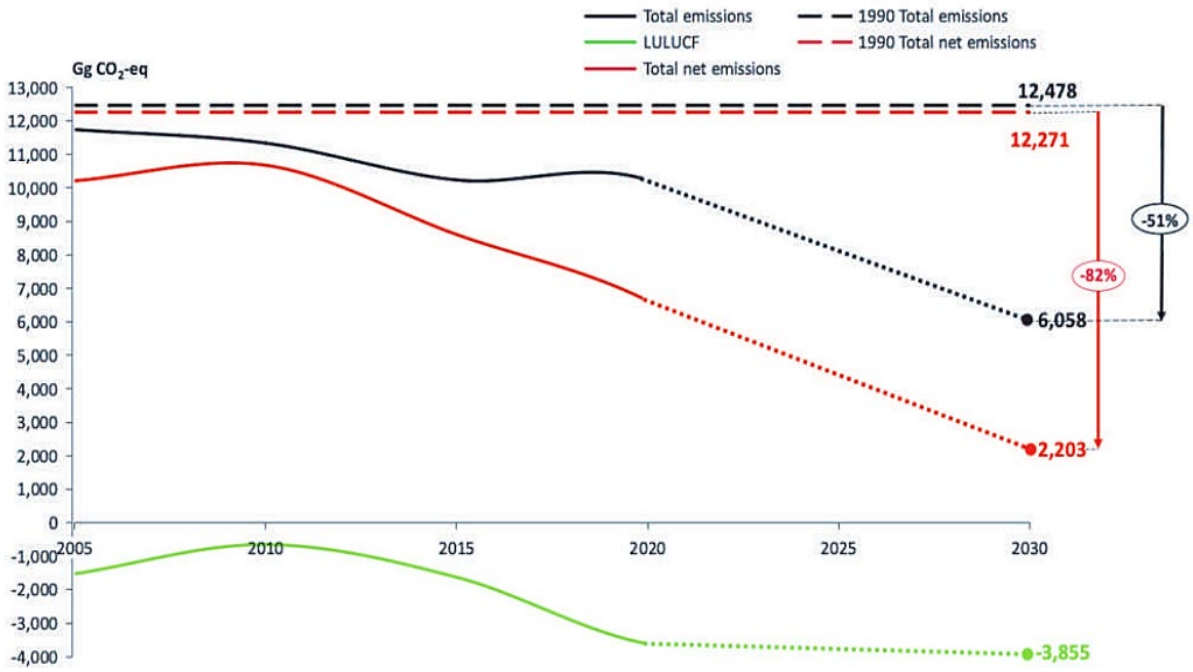


Chart 18. *Enhanced NDC Scenario for the Republic of North Macedonia:* ***Source of data:*** *Enhanced Nationally Determined Contribution Submission by the Republic of North Macedonia April 2021; Ministry of Environment and Physical Planning*

The LULUCF (Land Use, Land Use Change and Forestry) sector aims to increase removals by 95% which means more efforts to reduce deforestation and promote reforestation and afforestation activities. Finally, the waste sector aims to achieve a 21% reduction in emissions, which could involve measures such as promoting waste reduction, recycling, and energy recovery from waste.

Overall, the Republic of North Macedonia's NDC sets an ambitious target (Chart 18) for GHG emissions reductions, with a focus on the energy sector and transitioning to cleaner energy sources. However, the target for the IPPU sector indicates a need for greater efforts to reduce emissions in this sector and the country will need to implement a range of measures across sectors to achieve its mitigation goals.

IV. EXISTING LANDSCAPE FIRE MANAGEMENT SYSTEM

North Macedonian LFM system is a multifaceted approach that encompasses various strategies, agencies, and technologies. It has evolved over decades of experience and adaptation, driven by the nation's need to protect lives, property, and its precious natural heritage. This system reflects a commitment to proactive fire management, scientific research, and community engagement, all designed to mitigate the impact of forest fires. Within this chapter will delve deeper into the key elements of North Macedonian LFM system, its major stakeholders, their responsibility and contribution and interconnection to the LFM system.

A. MAJOR STAKEHOLDERS WITHIN THE EXISTING SYSTEM

The main stakeholders in the North Macedonian LFM system encompass a wide spectrum of individuals, ministries, organisations, public enterprises, associations, NGOs, and agencies. They include government bodies, fire and emergency services, scientific institutions, non-governmental organisations, indigenous communities, landowners, and the public through some organisations. Each of these stakeholders brings unique perspectives, capabilities, and responsibilities to the table, working in concert to prevent, prepare for, respond to, and recover from forest fires.

This subchapter delves into the roles, contributions, and interactions of these key stakeholders within the LFM framework. It explores the vital functions they perform and the collaborative efforts that underpin effective forest fire mitigation and response. Understanding the dynamics and interplay among these stakeholders is fundamental to the development of resilient and adaptive LFM system equipped to navigate the evolving challenges of future climate changes.

MINISTRY OF AGRICULTURE, FORESTRY AND WATER ECONOMY (MAFWE)

The Ministry of Agriculture, Forestry, and Water Economy (MAFWE) was established by the Law on the Organisation and Operation of the Organs of the State Administration (Official Gazette of FYRM No. 58/2000 of July 21, 2000), and its competences are described in Article 21 of the same law. MAFWE is responsible for promoting sustainable agriculture, improving food production and support rural development. In terms of forestry, the ministry is managing and protecting forest resources, promoting sustainable forest management practices, and addressing issues related to deforestation and forest degradation. Water resources are addressed through overseeing the management of water resources, including rivers and lakes and implementing measures to ensure water quality and availability.

MAFWE ACTIVITIES
– Agriculture, forestry, and water economy – Utilisation of agricultural land, forests, and other natural resources and – Inspection in the domain of its competences
SECTORS RELATED TO FORESTRY AND THEIR ACTIVITIES:
▪ **SECTOR FOR FORESTRY AND HUNTING**
– Department for Afforestation and Silviculture – Department for Forest Protection from Biotic and Abiotic Factors – Department for Hunting, Arrangement of Hunting Grounds and Providing Game – Department for Planning of Management Activities and Utilisation of Forests
▪ **SECTOR FOR FOREST POLICE**
The task of the sector is defined by Article 81 of the Law on Forests:
"The guarding of state and privately-owned forests is organised by the Forest Police." According to Article 82 of the same act, besides guarding the forests, the Forest Police has a mandate to monitor and report on the situation in forests regarding illegal logging and forest crimes, forest fires, diseases, pests, and other negative impacts; to inform the authorities about the illegal appropriation of forests and forest land; and to initiate procedures within the appropriate legal institutions against law breakers.

The Ministry of Agriculture, Forestry, and Water Management plays a crucial role in wildfire control and management through various measures and strategies. Here are some ways in which the ministry contributes to wildfire control:

- **PREVENTION AND AWARENESS CAMPAIGNS**

  The Ministry initiates public awareness campaigns to educate communities about fire prevention measures, safe practices in fire-prone areas, and the importance of reporting potential fire hazards.

- **FIREBREAKS AND FUEL MANAGEMENT**

  The Ministry initiates with relevant agencies and PE and local communities to establish firebreaks, which are areas cleared of vegetation to create barriers that can help control the spread of forest fires. Additionally, the Ministry can implement fuel management strategies to reduce fuel loads and prevent more severe forest fires.

- **EARLY DETECTION AND MONITORING**

  The Ministry invests in advanced monitoring systems like remote sensing, satellite imagery, and weather monitoring to detect forest fires at an early-stage, e.g., MKFFIS. This enables faster response times and better coordination in combating the fires.

- **FIREFIGHTING RESOURCES**

  The Ministry allocates resources and funds to enhance firefighting capabilities. This may include the purchase and maintenance of firefighting equipment, training of personnel, and coordination with PENF and other agencies involved in wildfire suppression.

- **RESEARCH AND INNOVATION**

  The Ministry support research initiatives to better understand wildfire behaviour, develop improved firefighting techniques, and promote the use of innovative technologies in wildfire management.

- **COOPERATION WITH OTHER AGENCIES**

  Effective wildfire control often requires collaboration among various government agencies, including emergency services, local authorities, and forestry departments. The Ministry can facilitate inter-agency coordination to ensure a cohesive and efficient response to forest fires.

- **REHABILITATION AND REFORESTATION**

  After a wildfire has been contained, the Ministry leads efforts to rehabilitate affected areas, including reforestation and restoration of ecosystems to reduce the risk of future forest fires. E.g., Annual Programme for extended reproduction.

- **COMMUNITY ENGAGEMENT:**

  The Ministry works closely with local communities, landowners, and stakeholders to involve them in wildfire prevention and management efforts. Community participation is essential in fostering a sense of responsibility and ownership in safeguarding the environment.

By adopting these measures and working in conjunction with other relevant stakeholders, the Ministry of Agriculture, Forestry, and Water Economy in North Macedonia can significantly contribute to wildfire control and reduce the devastating impacts of forest fires on both the environment and communities.

STATE INSPECTORATE FOR FORESTRY AND HUNTING

The State Inspectorate for Forestry and Hunting in North Macedonia is typically responsible for overseeing and enforcing regulations related to forestry, hunting, and wildlife conservation. Its specific roles and responsibilities can vary depending on the country's laws and regulations.

The main purpose of the State Inspectorate for Forestry and Hunting is to secure the management of forests in accordance with Article 7 of the Law on Forests: "silviculture, protection and forest utilisation through the restoration, nurture, protection, afforestation and utilisation of forests and forest land, and other activities for the maintenance and improvement of the forest's functions". The State Inspectorate for Forestry and Hunting carries out inspections of 1,002,809 ha of forests and forest land in State and private ownership, of which 861,243 ha are forested and 141,566 ha are un-forested, which areas are arranged in 176 separate forest management plans, as well as 249 established hunting grounds, arranged with special hunting grounds that are given by way of a concession for the use, breeding and protection of game.

When it comes to forest fires, the State Inspectorate for Forestry and Hunting is involved in several ways:

- **FIRE MANAGEMENT**

  The Inspectorate collaborates with other agencies, such as the MAFWE, PENF, local forestry departments, and fire services, to implement fire prevention measures. These can include enforcing regulations on activities that could lead to forest fires such as implementation of firebreaks, such as controlling burning, campfires, or unauthorised land clearing.

- **FIRE MONITORING**

  The Inspectorate participate in fire monitoring efforts, using patrols or surveillance to detect potential forest fires and report them to the appropriate authorities promptly. As State Inspectorate for Forestry and Hunting, bylaws oblige it to monitor the implementation of the MKFFIS system in the part of fire reporting. Only with the approve of the Inspectorate, the report is accepted as valid.

- **INVESTIGATING FOREST FIRES**

  When a wildfire occurs, the Inspectorate is involved in conducting investigations to determine the cause of the fire, damages, burned area and other measures. This is essential in identifying whether the fire resulted from natural causes or human activities, including illegal actions like arson.

- **ENFORCEMENT OF FIRE REGULATIONS**

  In areas where burning is regulated or prohibited during fire seasons, the Inspectorate is responsible for ensuring compliance with these regulations and taking appropriate actions against violators.

- **FIRE SUPPRESSION**

  During active forest fires, the Inspectorate collaborates with firefighting agencies and other relevant authorities to coordinate efforts in containing and extinguishing the fire.

- **POST-FIRE ASSESSMENT**

  After a wildfire, the Inspectorate is involved in assessing the impact on forests and wildlife, damages, and contributes to planning for post-fire rehabilitation and reforestation efforts.

PUBLIC ENTERPRISE "NATIONAL FORESTS" (PENF)

The public enterprise for management of state forests "National Forests" was founded by the Decree of the Government of the Republic of Macedonia in 1997, and it started working in 1998. Of the total area under forest in North Macedonia, the enterprise manages 90%, and only 10% is under private ownership. The duties and obligations of the entities that manage the forests relate to preventive, preparatory and decisive measures for protection, keeping, planning, security, renewal, uses, records of the forests and other things. PENF is organieed into a Directorate and 30 subsidiaries. The operation of the Directorate is carried out through 9 sectors. The total number of employees is 1649.

The Public Enterprise "National Forests" in North Macedonia is closely related to managing and responding to forest fires that occur within the forested areas under their jurisdiction. Here's how the enterprise is related to wildfire management:

- **WILDFIRE PREVENTION AND AWARENESS**

  The enterprise plays a role in wildfire prevention by implementing measures to reduce the risk of fires in forested areas. This includes fire prevention measures through the FMPs, conducting fire prevention campaigns, educating the public and visitors about fire safety in forests, and implementing regulations to minimise human activities that could cause forest fires.

- **EARLY DETECTION AND REPORTING**

  The Public Enterprise "National Forests" through the MKFFIS monitoring systems is in place to detect forest fires as early as possible. With the team for forest protection, one of the tasks is to patrol and monitor the forest visually and in presence with the guards and together in coordination with forest police. They ensure that their staff and relevant authorities are promptly informed when a wildfire is detected to initiate a rapid response.

- **FIRE SUPPRESSION**

  When a wildfire occurs within the forests they manage, the enterprise is responsible for organising and mobilising firefighting efforts. These brigades within PENF are the only one specified and trained teams for forest fires. They work in coordination with the DPR, firefighter brigades in a local level, CMC, and other relevant agencies to combat the fire and prevent it from spreading further.

- **RESOURCE MANAGEMENT**

  During a wildfire incident, the Enterprise is allocating firefighting resources, including personnel, equipment, and vehicles, to effectively control the fire. This involves collaboration as well with other firefighting agencies and neighbouring regions if the wildfire becomes too large to handle with local resources alone.

- **POST FIRE MANAGEMENT**

  After a forest fire is contained, PENF takes measures to assess the damage to the forested areas and initiates restoration efforts. By Law of Forest, it is obligatory for PENF to make restoration efforts such as reforestation activities to replant areas affected by the fire.

- **POST-FIRE ASSESSMENT**

  The Enterprise conducts post-fire assessments to evaluate the impact and damages of wildfire on forest ecosystems, wildlife, and the environment. This information helps in understanding the consequences of the fire and planning for future prevention and mitigation measures.

The PENF plays a vital role in managing forest fires within their forested areas to protect the valuable natural resources due to the fact they are first on the ground when the fire occurs.

MINISTRY OF ENVIRONMENT AND PHYSICAL PLANNING (MoEPP)

In the framework of efforts towards integration into the modern trends of environmental protection in Europe and beyond, and as an important aspect of the reform process, the North Macedonian Government established the Ministry of Environment (Law on the Amendment to and Supplementing the Law on Public Administration Bodies, Official Gazette of FYRM No.63/98).

Article 122 of the above law defines the competences of the ministry, among which those closely related to forests and the forestry sector are:

- monitoring of the state of the environment
- protection against noise and radiation
- conservation of biological diversity
- conservation of geological diversity, national parks, and protected areas and
- supervision of inspection in fields within its scope

Operating within the Ministry of Environment and Physical Planning (MoEPP), the State Inspectorate for Protection of the Environment is a competent body for the control of all legal and physical entities in the field of environmental protection.

The Ministry of Environment and Physical Planning (MEPP), plays a significant role in wildfire management and prevention. The Ministry generally contributes to forest fires in the following ways:

- **ENVIRONMENTAL POLICIES AND REGULATIONS**

  The MEPP formulates and implements environmental policies and regulations that may directly or indirectly impact wildfire prevention and control. This includes regulations related to land use, deforestation, fire prevention measures, and protection of natural resources.

- **FIRE RISK ASSESSMENT AND PLANNING**

  The Ministry may conduct fire risk assessments to identify areas vulnerable to forest fires. Based on these assessments, they can develop strategic plans to minimise fire risks, promote forest and ecosystem resilience, and enhance firefighting and response capabilities.

- **ENVIRONMENTAL EDUCATION AND AWARENESS**

  The MEPP can launch public awareness campaigns and educational programmes to inform citizens, communities, and stakeholders about the causes of forest fires, the importance of fire prevention, and responsible environmental practices.

- **PROTECTED AREA MANAGEMENT**

  Ministry is responsible for managing protected areas and takes measures to prevent forest fires in these ecologically sensitive regions. This includes implementing and managing human activities within the protected areas.

- **ENVIRONMENTAL IMPACT ASSESSMENT**

  The Ministry may conduct environmental impact assessments (EIAs) for projects or activities that could increase the risk of forest fires, such as large-scale land development or infrastructure projects. EIAs help identify potential environmental risks, including fire hazards, and recommend mitigation measures.

- **CLIMATE CHANGE MITIGATION AND ADAPTATION**

  The MoEPP contributes to climate change mitigation efforts, which indirectly helps reduce the risk of forest fires. By promoting sustainable practices and reducing greenhouse gas emissions, the Ministry supports long-term environmental stability.

MINISTRY OF LOCAL SELF – GOVERNMENT (MLSG)

Under the Law of Local Self – Government (Official Gazette of FYRM No.5/2002), the Ministry of Local Self-Government has a mission as a decentralised and sustainable system of local self-government that provides cohesion to citizens, delivers quality and standardised local public services, and generates balanced development of municipalities and planning regions.

MLSG ACTIVITIES
– Monitoring the development and proposing measures for the promotion of local self-government.
– Monitoring the state of territorial division and developing standards for the size, population and needs of local self-government units.
– Proposals of systems, policies, measures, and instruments for achieving more balanced regional development and for encouraging the development of economically underdeveloped areas.
– Realisation and use of funds intended for economically underdeveloped areas.
– Supervision under its jurisdiction.
– Performing other tasks established by law.

Municipalities through the Ministry of Local Self-Governance, in accordance with the Law on Firefighting, generate revenues that are used for the purpose of financing current operational activities and the purchase of firefighting equipment for TPPEs, their associations in the area of municipalities, and finances the engagement and needs of seasonal firefighters, volunteer firefighters and citizens who participate in firefighting actions.

The Ministry of Local Self-Government can contribute to wildfire management in the several different ways such as local fire prevention and preparedness: working closely with local governments and communities to implement fire prevention measures and preparedness plans tailored to the specific needs and risks of each region. This includes educating residents about fire safety, promoting responsible land use practices, and conducting drills to enhance preparedness.

Collaborating with Local Fire Departments coordinating and supporting the efforts of local fire departments and emergency services. This may involve providing funding for equipment, training programmes, and resources needed to respond to forest fires effectively. The Ministry of Local Self-Government can oversee the enforcement of fire-related regulations and restrictions within their jurisdiction. This includes enforcing burn bans, controlling outdoor burning, and ensuring compliance with fire safety measures. Engaging with local communities is essential in wildfire management. The Ministry can facilitate community meetings, workshops, and educational campaigns to raise awareness about fire prevention, safety measures, and evacuation plans.

PROTECTION AND RESCUE DIRECTORATE (DPR)

The Directorate for protection and rescue was established by the Law on Protection and Rescue in 2005 is an independent body of state administration. It was created by merging the Civil Protection from the Ministry of Defence and the Fire Protection Inspection from the Ministry of Interior (MoI). In the implementation of PR, the Directorate carries out the following tasks, among other things: planning, assessment of danger from natural disasters and other accidents, organising, preparing, and equipping the system for protection and rescue, functioning of the system for preventing and detecting the occurrence and removal of consequences, provision of material reserves, control, and assessment of the preparedness of the forces for protection and rescue and their training.

The organisational structure of the Directorate is regulated by the Rulebook according to which there are 6 sectors with 21 departments, 2 independent departments and 35 regional departments. Total number of employees is 265.

In terms of forest fires, DPR in North Macedonia plays a crucial role in managing and responding to forest fires that occur within the country's borders. Here's how this institution is related to wildfire management:

- **EMERGENCY RESPONSE COORDINATION**

  When a wildfire breaks out, the Directorate is responsible for coordinating the overall emergency response efforts. This involves mobilizing firefighting teams, coordinating with relevant agencies, and ensuring a well-organised and efficient response to combat wildfire.

- **COMMUNICATION AND INFORMATION SHARING**

  Effective communication is essential during wildfire incidents. The Directorate facilitates communication and information sharing among various agencies, local authorities, and emergency responders to ensure everyone is well-informed and working together cohesively.

- **RESOURCE MANAGEMENT**

  The Directorate oversees managing and allocating firefighting resources, including personnel, firefighting equipment, vehicles, and aerial assets such as helicopters and aircraft, to the affected areas. They ensure that resources are deployed strategically to control and extinguish the wildfire.

- **EVACUATION AND SAFETY MEASURES**

  In cases where forest fires pose a threat to communities, the Directorate is involved in planning and implementing evacuation procedures to ensure the safety of residents in the affected areas.

- **PREPAREDNESS AND PREVENTION**

  The Directorate works on developing plans and strategies to prevent forest fires or minimise their impact. This includes conducting training exercises, raising public awareness about fire safety, and implementing measures to reduce the risk of forest fires.

- **COLLABORATION WITH NEIGHBORING COUNTRIES**

  In case of large forest fires that require additional resources, the Directorate may collaborate with neighbouring countries and international organisations to request or provide assistance.

Overall, the DPR plays a pivotal role in coordinating and managing the response to forest fires, with the goal of minimizing damage, protecting lives and property, and ensuring the safety of communities affected by such incidents.

CRISIS MANAGEMENT CENTER (CMC)

The Crisis Management Centre is established in accordance with the Law on Crisis Management in 2005 as an independent body of the state administration. The Centre is also responsible for continuous inter-departmental and international cooperation, preparation and update of risk and danger assessment of the security of North Macedonia, proposes measures and activities to resolve a crisis, is the bearer of the overall support (professional, organisational, administrative and others) of the Steering Committee, and the Evaluation Group. According to the Crisis Management Law, 35 regional Crisis Management Centres have been established within the Centre, which are part of the operations and coordination sector. The total number of employees in the Centre is 290.

CMC is closely related to managing and responding to forest fires that occur within the country's borders. When a wildfire breaks out, the CMC plays a crucial role in coordinating the response efforts and mobilising resources to control and extinguish the fire.

Here's how the CMC is generally involved in wildfire management:

- **EARLY DETECTION AND ALERT**

  The CMC is responsible for monitoring various sources, such as weather forecasts and fire detection systems (MKFFIS), to detect forest fires as early as possible. Once a wildfire is detected, they promptly issue alerts to relevant authorities and the public.

- **COORDINATION**

  The Centre serves as the focal point (Steering Committee and Group for Evaluation) for coordinating the efforts of different agencies involved in firefighting and emergency response. This includes the fire department, forestry department, police, medical services, and other relevant organisations.

- **RESOURCE MOBILISATION**

  The Crisis Management Centre assesses the scale and severity of the forest fire and mobilises additional resources as needed through the 35 regional CMCs. This can include requesting assistance from neighbouring regions or international aid if the fire becomes too large to handle with local resources alone.

- **EVACUATION AND SAFETY MEASURES**

  During large forest fires, evacuations may be necessary to ensure the safety of residents and communities in the affected areas. The CMC is responsible for planning and implementing evacuation procedures, ensuring that people are safely moved to designated shelters or safer locations.

- **PUBLIC COMMUNICATION**

  Effective communication with the public is crucial during a forest fire. The CMC disseminates accurate information about the fire's status, safety measures, evacuation instructions, and any other relevant updates through various communication channels.

MINISTRY OF DEFENCE (MoD)

The Ministry of Defence (MoD) is competent and responsible for the effective functioning of the national defence system, defence preparations, overall support of the Army of the Republic of North Macedonia, strategic defence planning, efficient defence resource management, development of military capabilities to conduct defence missions, international defence cooperation, NATO integration, participation in European security and defence policy and continuous contribution to international operations.

An interdepartmental working group has been established within the Ministry of Defence, which has several responsibilities for overcoming the established weaknesses of the CMS and the PRS.

The Ministry of Defence is involved in wildfire management and response in several ways. While their primary focus is on national defence and security, they provide crucial support during large-scale forest fires or emergency situations. Here are some ways in which the MoD is involved in wildfire management:

- **AERIAL SUPPORT**

  The Ministry of Defence often has access to helicopters and aircraft that can be used for aerial reconnaissance and firefighting operations. These assets help in identifying fire hotspots, delivering water or fire retardants to suppress the flames, and transporting firefighting personnel and equipment to remote or hard-to-reach areas.

- **DISASTER RESPONSE**

  In many countries, the armed forces are trained and equipped to handle disaster response and emergency situations. During significant wildfire incidents, they are called upon to provide additional manpower and logistical support to assist firefighting efforts and evacuation operations.

- **EMERGENCY MEDICAL SUPPORT**

  The Ministry of Defence deploy medical teams to provide emergency medical assistance to firefighters and civilians affected by forest fires. They also set up field hospitals or mobile medical units in wildfire-affected areas in collaboration with Red Cross.

- **ENGINEERING SUPPORT**

  The military offer engineering expertise and resources to construct firebreaks, control lines, and temporary infrastructure needed during firefighting operations.

- **LOGISTICS AND TRANSPORTATION**

  The Ministry of Defence support forest fire management by providing transportation for firefighting teams, supplies, and equipment. They also assist in coordinating the movement of resources to and from affected areas.

- **INTELLIGENCE AND COMMUNICATIONS**

  The military's communication infrastructure and intelligence capabilities aid in coordinating firefighting efforts, disseminating critical information, and maintaining situational awareness during forest fires.

- **INTERNATIONAL COOPERATION**

  During severe wildfire events, countries may seek international assistance. The Ministry of Defence facilitate international cooperation by coordinating and deploying resources from their armed forces or collaborating with foreign military forces experienced in wildfire management.

- **SUPPORT FOR EVACUATION**

  In situations where large-scale evacuations are necessary, the military also helps organise and execute evacuation plans, ensuring the safety and welfare of affected communities.

The coordination and cooperation between different government agencies, including the Ministry of Defence, are crucial for an effective and comprehensive response to wildfire incidents.

MINISTRY OF INTERIOR (MoI)

The Ministry of Interior (MoI) in North Macedonia was established on April 27, 1991. This date marks its official creation after North Macedonia declared its independence from the former Socialist Federal Republic of Yugoslavia. MoI has been since responsible for various aspects of public safety, security, and administrative functions within the country.

ACTIVITIES AND DUTIES OF MoI

- Enforcement of national and public security system.
- Residence and temporary residence registration.
- Issuing citizenship and passports.
- Realisation and use of funds intended for economically underdeveloped areas.
- Movement and residence in border area.
- Control over national border crossing as well as certain activities concerning determination and resolution of border incidents and other border violations.
- Residence and movement of foreigners.
- Production, trade, storage and protection of flammable liquids, gases, explosives and other hazardous materials and their transport.
- Providing assistance in natural disasters including forest fires and epidemics.
- Procurement, possession, transport and marking control of weapons and ammunition.
- Performing surveillance under their authority and performing other duties as stipulated by law.

These are some ways the Ministry of Interior typically contributes to wildfire management:

- **EMERGENCY RESPONSE COORDINATION**

  In the event of a forest fire, MoI takes charge of coordinating emergency response efforts. This includes collaborating with other relevant government agencies, local authorities, and NGOs to ensure an effective and well-organised response.

- **AERIAL SUPPORT**

  MoI often has access to helicopters and aircraft that can be used for aerial reconnaissance and firefighting operations. These assets help in identifying fire hotspots, delivering water or fire retardants to suppress the flames, and transporting firefighting personnel and equipment to remote or hard-to-reach areas.

- **PUBLIC AWARENESS AND EDUCATION**

  The Ministry plays a role in raising public awareness about wildfire risks and prevention measures. They conduct educational campaigns and provide information on fire safety and the importance of responsible behaviour in fire-prone areas.

- **INVESTIGATIONS AND ANALYSIS**

  After a wildfire is contained, MoI conduct investigations to determine the cause of the fire. This information helps in understanding patterns and developing strategies to prevent future forest fires.

TERRITORIAL FIREFIGHTING BRIGADES

Territorial firefighting units are an organisational form of municipalities and were formed for the purpose of extinguishing fires, saving citizens' lives, and protecting property threatened by fires and explosions, providing technical assistance in accidents and dangerous situations. Firefighting, permanent, and uninterrupted performance are ensured by North Macedonia and the municipalities and are part of the Special State System for Protection and Rescue. Firefighting units have been established in 34 municipalities. Due to operational action when extinguishing large fires in the entire territory of RNM, 14 TPPEs also act as firefighting units of the republic (Republic Firefighting Units).

Firefighting brigades play a crucial role in responding to and managing forest fires. These specialised teams are trained to combat fires and other emergencies and are typically organised and operated at the local or regional level. Their involvement in forest fires can vary based on the country's firefighting infrastructure and the severity of the wildfire situation.

- **WILDFIRE PREVENTION**

  One of the tasks of firefighting brigades is to organise and contribute to wildfire prevention activities. They may conduct public awareness campaign and educate the public about fire safety measures to reduce the risk of forest fires.

- **STRUCTURE PROTECTION**

  In many cases, forest fires threaten homes, buildings, and infrastructure near the affected areas. Firefighting brigades also play a critical role in protecting structures from the advancing flames by using fire suppression techniques and applying fire-resistant measures.

- **INITIAL ATTACK**

  Firefighting brigades are often the first responders to forest fire incidents. When forest fire is reported, these teams quickly mobilise to the affected area to initiate firefighting efforts.

- **COORDINATION**

  Firefighting brigades work in coordination with other firefighting agencies, including regional and national firefighting services, to effectively manage forest fires. They follow a chain of command and cooperate to ensure a unified response.

- **REINFORCEMENT**

  As forest fires can escalate rapidly, firefighting brigades may need additional support. Depending on the severity and complexity of the wildfire, they may request assistance from nearby brigades, other fire departments, or specialised wildfire fighting teams.

- **EQUIPMENT AND TRENING**

  Firefighting brigades receive specialised training in wildfire suppression techniques and equipment use. They are equipped with fire engines, tools, and protective gear necessary for firefighting in challenging environments.

NATIONAL ASSOCIATION OF PRIVATE FORESTS OWNERS

The National Association of Private Forests Owners (NAPFO) is a citizens' association that represents the interests of over 60,000 owners of private forests and is the only one of its kind that exists in Macedonia. National Association of Private Forests Owners was registered in 1998 although its current name was

adopted in 2010 (Official Gazette of North Macedonia No.52 of April 16, 2010). Currently, it unites over 1,600 members organised in 25 municipal branches and 5 regional offices. The National Association of Private Forests Owners with its activities promotes the sustainable use of forests in private ownership and aims to achieve its sustainability by providing a wide range of services to its membership.

In terms of forest fires, the Association contributes to wildfire management in several ways:

- **EDUCATION AND TRAINING**

  The National Association of Private Forest Owners plays a crucial role in educating its members about wildfire risks, prevention strategies, and firefighting techniques. They provide training sessions and distribute informational materials to promote responsible forest management practices that reduce the risk of forest fires.

- **FIRE PREVENTION MEASURES**

  The Association works with its members to implement fire prevention measures in private forests. This includes creating firebreaks, removing dead vegetation, and conducting controlled burns under proper supervision and guidance.

- **EARLY DETECTION AND REPORTING**

  The association encourages its members to be vigilant in detecting and reporting forest fires promptly. They establish communication channels to relay information to relevant authorities swiftly, which can aid in quick response and containment of forest fires.

- **COMMUNITY ENGAGEMENT:**

  Private forest owners, through their association, engage with local communities to raise awareness about wildfire risks and promote community involvement in wildfire prevention and preparedness efforts.

PUBLIC ENTERPRISE "PASISHTA"

The Public Enterprise "Pasishta" was established with the consensus of the government (Official Gazette of North Macedonia. No.18/98) in 1998. PE Pasishta has activities, duties and establishes measures (in accordance with the *Law of Pastures 1998*) for cultivation, protection, and promotion and expansion of pastures as well as their reconstruction and development. The public enterprise for pastures is managed in such a way as to preserve the surface and increase the value of pastures in state ownership as well to ensure the greatest growth of grass provided by the natural conditions. "PE Pasishta" is organised into a Directorate (Skopje) and 19 subsidiaries. The operation of the Directorate is carried out through 3 sectors.

FIRE PROTECTION UNION OF MACEDONIA

Operates as an NGO in accordance with the Law of Fire Protection (Official Gazette of North Macedonia No. 67/4 September 2014) and the Law of Societies and Foundations (Official Gazette North Macedonia No. 52 of April 2010). As part of the Fire Protection Union of Macedonia, there are 98 voluntary firefighting companies, organised in 39 Municipal Fire Fighting Unions (RFPUs), and as per the latest membership census, they include 2600 volunteers as active members. Main activities, in accordance with Article 8 subsection 1 of the Statute of Fire Protection Union of Macedonia is defined as: Union implements measures and activities to prevent the occurrence of fires, extinguish fires and rescue people, property and values threatened by fires, natural disasters and other catastrophes.

Some general ways in which FPUM contribute to wildfire management include:

- **ADVOCACY AND POLICY**

  Unions can advocate for improved wildfire management policies and better resources for firefighting efforts. They may engage with government officials, policymakers, and relevant agencies to highlight the importance of effective wildfire management and the needs of firefighters.

- **FIRE PREVENTION AND COMMUNITY ENGAGEMENT**

  One of the key activities of the Fire Protection Union of North Macedonia is the prevention measures through education and propaganda. All of these activities are carried out trough engagement with the local community.

- **EMERGENCY RESPONSE**

  During wildfire events, firefighting unions can coordinate and mobilise their members to respond promptly and efficiently to control and extinguish forest fires. They may work in collaboration with the local fire departments and other emergency response agencies.

- **TRAINING AND EDUCATION**

  Firefighting unions often play a crucial role in providing training and education to their members. They may organise workshops, seminars, and practical exercises to enhance the skills and knowledge of firefighters in dealing with forest fires.

REAL ESTATE CADASTRE AGENCY (AREC)

In 2008, with the new *Law on Real Estate Cadastre*, i.e., with the adoption of the Decision of the Government of the Republic of Macedonia on appointing members of the Management Board of the Agency for Real Estate Cadastre no. 33-2022/6 of May 6, 2008, the State Office for Geodetic Works continues to operate as the Real Estate Cadastre Agency, as its legal successor. For the purposes of performing the works for establishment and maintenance of the Real Estate Cadastre, the management of the Geodetic-Cadastre Information System as well as the establishment, maintenance and public access to the National Spatial Data Infrastructure, the Agency for Real Estate Cadastre is established. AREC operates on the principles of legitimacy, expertise, efficiency, transparency, service orientation, professionalism and liability for its operation and the achieved results.

AREC ACTIVITIES AND DUTIES RELATED TO:
– Establishment and management of the Geodetic-Cadastre Information System,
– Performance of basic geodetic works,
– Real estate survey,
– Registration of real estate rights,
– Establishment and maintenance of the Real Estate Cadastre,
– Geodetic works for special purposes of significance to North Macedonia as defined by the Government of North Macedonia
– Production of state topographic maps,
– Administration of a Spatial Units Register,
– Establishment, maintenance, and public access to the National Spatial Data Infrastructure.

Some general ways in which AREC contribute to wildfire management include:

- **LAND USE PLANNING**

  The Real Estate Cadastre Agency could provide valuable data on land ownership and land use patterns. This information can be crucial for local authorities and wildfire management teams to plan and implement strategies to mitigate forest fires. Proper land use planning can help ensure that vulnerable areas are not densely populated or that firebreaks and other preventive measures are in place.

- **PROPERTY OWNERSHIP AND CONTACT INFORMATION**

  During forest fires, rapid and accurate communication with property owners is essential for evacuation and safety measures. The Real Estate Cadastre Agency may possess up-to-date contact information for property owners, which can aid authorities in issuing timely warnings and evacuation orders.

- **COLLABORATION AND INFORMATION SHARING**

  The agency collaborates with other relevant governmental bodies, such as forestry departments, emergency services, and environmental agencies. Through information sharing and collaboration, these organisations can collectively work on wildfire prevention, early detection, and response strategies.

- **MAPPING AND GIS DATA**

  The agency could maintain comprehensive geospatial data, including maps, aerial imagery, and GIS (Geographic Information System) data. These resources assist in identifying areas at risk of forest fires, mapping fire-prone regions, and analysing fire patterns to improve prevention and response efforts.

NATIONAL PARKS IN THE REPUBLIC OF NORTH MACEDONIA

National Park "Pelister"

Pelister National Park was declared by a law passed by the Presidium of the People's Republic of Macedonia on November 30, 1948, mainly to protect the well – preserved forest of the endemic five – needle pine (Pinus peuce - known as the Macedonian pine, or Molika). In December 2007, with a special law (Official Gazette of the North Macedonia No. 150/2007), part of the Baba Mountain with the Pelister peak was again declared a national park. Today, Pelister National Park covers an area of 17,150 ha. According to the Nature Protection Law, the Public Institution National Park Pelister - Bitola is responsible for the protection and management of the park.

National Park "Mavrovo"

The National Park "Mavrovo" was founded by a law of the National Assembly of the Republic of Macedonia dated 19th April 1949, by which the forest areas around the Mavrovo field were declared a National Park. In 1952, the National Park Mavrovo was enlarged to its present size of 73,100 ha, of which 27,000 ha of the total area are forests. According to law, the National Park "Mavrovo" was established "due to the particular natural beauty, historical and scientific significance of the forests and forest areas around the Mavrovo field. "NP Mavrovo" is organised into a Directorate within 3 Departments. The nature protection and monitoring department is responsible for protection of natural risks, fires, and external impact.

National Park "Galicica"

Galichica National Park — a national park in Macedonia since 1958. This park covers parts of the Galichica massif, with the coastal areas of Lake Ohrid and Lake Prespa. The area occupies 22,750 ha. Galichica Mountain is located in the southwestern part of the Republic of North Macedonia. It is a horst that rises between the Ohrid and Prespa Valleys. This shape of the Galichica Mountain and its position between the two largest lakes in the country has a special value. It is striking in the geographical environment with its imposing size. "NP Galichica" is organised into a Directorate within 4 Departments. Nature protection department is responsible for protection of natural risks, fires, and external impact.

National Park "Shar Planina"

According to the Law on declaring a part of Shar Mountain a National Park (Official Gazette of the Republic of North Macedonia No. 175/2021), "NP Shar Planina" is managed by the Public Institution National Park Shar Mountain. With the declaration of Shar Planina as a protected area of 62,705 ha, it was placed under protection and enabled the establishment of a system for sustainable management of an area that is a treasure of biodiversity, home to two thirds of all plant species in North Macedonia as well as to a rich and endemic plant and animal life. It has exceptional natural beauty, geodiversity, hydrological features, landscape, scenic and cultural values.

Public Enterprise "Jasen"

Public Enterprise "Jasen" was established as the administrative body by the Government Decision of 13th October 2005, which defines the mandate, role, competences and functioning of PE Jasen. As such, PE Jasen is subject to the Macedonian law regarding the conduct and management of public enterprises. The Public Enterprise for the Management and Protection of the Multipurpose Area "Jasen" - Skopje belongs to the category of special natural landscapes, formed for the purpose of protecting certain biocoenological, floristic, faunal, geological, and hydrological natural rarities. It covers an area of 24,000 ha across the mountain massifs of Suva Gora, Suva Planina and Karadzhica.

While the specific contributions of National Parks or protected areas in North Macedonia to landscape fire management may vary, here are some general ways they contribute:

- **CONSERVATION AND PRESERVING BIODIVERSITY**

  National parks and protected areas are often established to conserve natural habitats and protect biodiversity. By maintaining healthy ecosystems, these areas can become more resilient to forest fires and limit the spread of fires into adjacent regions.

- **FIRE PREVENTION MEASURES**

  Park authorities implement various fire prevention measures within the protected areas, such as clearing dry vegetation, establishing firebreaks, and enforcing regulations against activities that may cause forest fires, like campfires or smoking in restricted areas.

- **EARLY DETECTION AND RAPID RESPONSE**

  Many national parks have fire lookout towers and monitoring systems to detect forest fires early. When a wildfire is spotted, park rangers and firefighting teams can respond rapidly to contain and suppress the fire before it spreads.

- **COORDINATION WITH FIREFIGHTING AGENCIES**

  National parks collaborate with local firefighting agencies and other emergency services to coordinate efforts during wildfire incidents. They may also have mutual aid agreements with neighbouring regions to request additional resources if needed.

- **PUBLIC EDUCATION AND AWARENESS**

  National parks play a crucial role in educating visitors about fire safety and responsible behaviour in fire-prone areas. Raising awareness among tourists and nearby communities can help prevent accidental forest fires caused by human activities.

- **RESEARCH AND DATA COLLECTION**

  National parks can also contribute to wildfire management through research and data collection. Studying fire behaviour, fire ecology, and the impacts of forest fires on ecosystems can lead to better management strategies and policies.

ADMINISTRATION FOR HYDRO-METEOROLOGICAL AFFAIRS

The Administration for Hydrometeorological Affairs is a body within the Ministry of Agriculture, Forestry and Water Economy organised into a within 6 Sectors and 23 Departments. The Administration for Hydrometeorological Affairs, in accordance with the Law on Free Access to Public Information as a legal entity, publishes a list of information holders, which have been created and are owned by the Administration. HMRC publishes hydrological, meteorological, and climatological and agrometeorological information, provides analysis and weather forecast.

Some general insights on how HMRC is involved in wildfire management activities are provided below:

- **WEATHER FORECASTING AND MONITORING**

  The Administration for Hydrometeorological Affairs is responsible for providing weather forecasts and monitoring weather conditions in North Macedonia. During wildfire events, they issue special advisories and warnings to alert authorities and the public about elevated fire risks, high temperatures, low humidity, and strong winds that could contribute to fire spread.

- **EARLY WARNING SYSTEMS**

  HMRC often collaborates with other governmental bodies, such as forestry and emergency services and CMC to develop early warning systems for forest fires, such as MKFFIS. These systems use weather data from HMRC and generate fire danger indices to assess the likelihood of fire ignition and spread, enabling authorities to take preventive measures or respond promptly to wildfire incidents.

- **SUPPORT FOR FIREFIGHTING EFFORTS**

  During active wildfire events, the Administration for Hydrometeorological Affairs provides real-time weather data and forecasts to assist firefighting teams in their operations. This information helps firefighters understand the fire's behaviour, predict its movement, and allocate resources effectively.

- **RESEARCH AND DATA ANALYSIS**

  Hydrometeorological agencies conduct research on the links between weather patterns, climate change, and forest fires. Analysing historical wildfire data in conjunction with weather data can help identify trends and inform future wildfire management strategies.

PUBLIC ENTERPRISE "PARKOVI I ZELENILO" – SKOPJE

The Public Enterprise "Parks and Greenery" was established by the City of Skopje. Its basic activity is landscaping and maintenance of the public green spaces through:

- Maintenance of the public urban greenery
- Maintenance of the public extra-urban greenery

PE "Parks and Greenery" performs activity of public interest in the communal sphere on the territory of the City of Skopje. It realises its activity through the implementation of the work programme adopted by the City Council of Skopje. As the only public enterprise that is engaged in creating, landscaping and maintenance of the green spaces on the territory of the City of Skopje, it is a service of the citizens monitored by the professional services of the City of Skopje. PE "Parkovi I Zelenilo" is organised into a 13 Sectors with 31 Departments.

PE "Parks and Greenery" is an organisation responsible for the management, development, and maintenance of public parks, green spaces, and recreational areas in the country. While this enterprise primarily focuses on parks and greenery, its activities may also include efforts related to wildfire management in the areas it oversees.

Below are some of the ways the Public Enterprise "Parks and Greenery" is involved in wildfire management activities:

- **FIRE PREVENTION MEASURES**

  The enterprise may implement various fire prevention measures within the parks and green areas under its jurisdiction. This could include clearing dry vegetation, creating firebreaks, and installing fire-resistant landscaping.

- **EARLY DETECTION AND RAPID RESPONSE**

  Parks and recreational areas are vulnerable to forest fires, especially during dry seasons. The enterprise may have personnel or monitoring systems in place to detect fires early and respond rapidly to contain and suppress them.

- **COLLABORATING WITH FIREFIGHTING AGENCIES**

  The Public Enterprise "Parks and Greenery" could work closely with local firefighting agencies and emergency services to coordinate efforts during wildfire incidents. This collaboration ensures a prompt response and efficient use of resources.

- **PUBLIC EDUCATION**

  The enterprise may play a role in educating the public about fire safety and responsible behavior in parks and green areas. Informing visitors about fire risks and guidelines for preventing forest fires can help minimise potential fire incidents caused by human activities.

- **MANAGING FIRE RISKS**

  As part of its responsibilities, the Enterprise could assess fire risks in various parks and green spaces. By identifying high-risk areas, they can take proactive measures to reduce fire hazards and improve overall wildfire management.

- **RESTORATION AND RECOVERY**

  In the aftermath of a wildfire, the Public Enterprise "Parks and Greenery" may be involved in restoration efforts to rehabilitate affected areas and ensure their recovery.

HANS EM FACULTY OF FOREST SCIENCES, LANDSCAPE ARCHITECTURE AND ENVIRONMENTAL ENGINEERING (HEF) – SKOPJE, UKIM

HEF Institution is one of the three oldest faculties in the Republic of North Macedonia, which are also founding members of the Ss. Cyril and Methodius University. Established in 1947, as part of the former Faculty of Agriculture and Forestry, the institution bore the recognisable name Faculty of Forestry in Skopje for a long time, until 2019. Since then, for better representation of all aspects the faculty deals with nowadays, both in education and in science and practice, which are much broader than the classical understanding of forestry, the name of our institution is "Hans Em Faculty of Forest Sciences, Landscape Architecture and Environmental Engineering (HEF)". The faculty organises teaching activities in forestry, eco-engineering and eco-management, and landscape design.

The Hans Em Faculty of Forest Sciences, Landscape Architecture and Environmental Engineering (HEF) in North Macedonia plays a significant role in wildfire management through education, research, and collaboration with relevant stakeholders. Here are some ways in which HEF contributes to Landscape fire management:

- **EDUCATION AND TRAINING**

  The faculty offer academic programmes and training courses related to forest protection. These include courses on fire behaviour, fire ecology, climatology, fire prevention, and firefighting techniques. By educating future forestry professionals, the faculty helps build a skilled workforce capable of effectively managing forest fires.

- **RESEARCH AND INNOVATION**

  The faculty conducts research on various aspects of forest fires, such as fire behaviour, fire risk assessment, and the impacts of forest fires on ecosystems. Research findings can inform wildfire management strategies and help develop innovative approaches to prevention and control.

- **FIRE PREVENTION STRATEGIES**

  Through research and education, the faculty contribute to the development and implementation of fire prevention strategies. This may involve raising awareness about fire risks, promoting responsible behaviour in fire-prone areas, and suggesting measures to reduce human-caused forest fires.

- **COLLABORATION WITH FIREFIGHTING AGENCIES**

  The faculty collaborates with firefighting agencies, government departments, and other stakeholders involved in forest fire management. By sharing knowledge and expertise, the faculty can support the development of coordinated and effective wildfire response plans.

- **DEVELOPMENT OF FIRE MANAGEMENT PLANS**

  The faculty assists in the formulation of wildfire management plans for specific regions or protected areas. These plans may include fire risk assessments, fire response protocols, and strategies for ecological restoration after forest fires.

- **MONITORING AND DATA COLLECTION**

  The faculty contributes to wildfire management by monitoring fire activity, collecting data on fire incidents, and analysing fire trends. This data can help identify patterns and inform decision-making in wildfire management.

By combining education, research, and collaboration, HEF contributes significantly to wildfire management efforts and helps protect the country's forests, wildlife, and communities from the devastating effects of forest fires.

FACULTY OF AGRICULTURAL SCIENCE AND FOOD – SKOPJE UKIM (FASF)

The Faculty of Agricultural Sciences and Food was established on 16.12.1947 and is one of the founders of the University "St. Cyril and Methodius" University in Skopje. In its long-standing tradition, the faculty has carried out teaching, research, and application work, as well as active cooperation with domestic and foreign institutions. In terms of staff and equipment capacities, the faculty is a top institution in the field of Agriculture and Food. In February 2004, the Faculty of Agriculture changed its name to the current name of the institution, "*Faculty of Agricultural and Food Sciences*". The faculty organises teaching activities in agriculture, horticulture, animal biotechnology, processing of agricultural products, plant protection – phytomedicine, eco – Agriculture, agricultural economics, fruit growing, vineyards and winery, and food quality and safety.

Below are some of the ways in which the faculty contributes to Landscape Fire Management:

- **RESEARCH ON FIRE-RESISTANT PLANT SPECIES**

  The faculty's expertise in agronomy and plant sciences is utilised to research and identify fire-resistant plant species. By promoting the use of fire-resistant vegetation in landscaping and forest management, the spread of forest fires can be reduced.

- **FIRE PREVENTION EDUCATION**

  The faculty incorporates wildfire prevention topics into its curriculum, educating students about the causes of forest fires and the importance of responsible land management practices. Graduates from FASF can disseminate this knowledge to farmers, landowners, and local communities, promoting fire prevention and safety measures.

- **SUSTAINABLE LAND MANAGEMENT**

  Encouraging sustainable land management practices can help reduce the risk of forest fires. The faculty advocates for responsible agricultural practices that minimise fire hazards, such as controlled burning, crop rotation, and the creation of firebreaks.

- **COLLABORATION WITH FORESTRY AND ENVIRONMENTAL AGENCIES**

  Faculty also collaborates with forestry departments, environmental agencies, and fire authorities in North Macedonia. Joint research projects and knowledge-sharing initiatives can lead to more effective wildfire management strategies.

While the primary focus of the faculty is agricultural sciences and food technology, its interdisciplinary nature allows it to contribute valuable insights and expertise to various fields, including wildfire management.

MILITARY ACADEMY "GENERAL MIHAILO APOSTOLSKI" – SKOPJE

The "General Mihajlo Apostolski" Military Academy is the main educational institution for officers of the Army of North Macedonia, located in Skopje. Established on 7th of June 1995 with the ratification by the Law on the Military Academy (Official Gazette of the Republic of North Macedonia, no. 83 of 03.07.2009), with the first class of cadets entering the academy on 25th September 1995. In 1996, the Academy received the name "General Mihajlo Apostolski" Military Academy. The Military Academy, as the only military higher education and scientific institution in the Republic of North Macedonia, has the basic task of educating, training, and perfecting staff for the needs of: the ministry of defense, the armed force, the crisis management system, and the protection and rescue system. The Academy organises teaching

activities in social sciences, military logistics, military science and skills, security, crisis management, protection and rescue, and natural and military technical sciences.

Military academies play a significant role in wildfire management by providing education, training, and research to military personnel and civilians involved in firefighting and disaster response. Here are several ways in which a Military Academy is involved in wildfire management:

- **EDUCATION AND TRAINING**

  Military academy offers specialised courses, workshops, and training programmes for military personnel and civilian firefighters. These programmes can cover topics such as wildfire behaviour, fire suppression techniques, incident management, emergency response, and the use of firefighting equipment and technology.

- **DISASTER RESPONSE COORDINATION**

  Military academy assists in developing and implementing coordinated disaster response plans for forest fires. This involves working with other government agencies, emergency services, and non-governmental organisations to ensure an efficient and effective response to wildfire incidents.

- **RESEARCH AND DEVELOPMENT**

  Military academy has research facilities and resources that can be utilised to study wildfire behaviour, prevention strategies, and advanced firefighting technologies. Research findings can be used to improve firefighting tactics and develop new tools for wildfire management.

- **OPERATIONAL SUPPORT**

  During large-scale wildfire events, military personnel is mobilised to provide logistical support, transportation, and resources to aid firefighting efforts. They can assist in setting up base camps, providing communication systems, and transporting firefighting crews and equipment to critical areas.

- **AERIAL FIREFIGHTING**

  The Military academy has aviation programmes with helicopters and aircraft suitable for aerial firefighting operations. Training pilots and crews in water or retardant drops can significantly enhance firefighting capabilities.

- **COMMUNITY AND EDUCATION**

  Military academy engages in community outreach to raise awareness about wildfire prevention and preparedness. They participate in public education campaigns and collaborate with local authorities to organise drills and exercises.

It's essential to recognise that the specific involvement of a military academy in wildfire management may vary based on the academy's capabilities, resources, and the extent of forest fires in their region. Additionally, wildfire management is a complex and interdisciplinary field, requiring collaboration between various agencies, organisations, and stakeholders to effectively combat and prevent forest fires.

The success of the Landscape Fire Management System in the Republic of North Macedonia relies on the collaboration and effective coordination among diverse stakeholders, including government agencies, local communities, and NGOs. Each stakeholder plays a crucial role, from policy formulation and implementation to on-the-ground firefighting efforts, ensuring the protection of both human and natural assets in the face of landscape fires. As these stakeholders join forces, they create a resilient network capable of addressing the multifaceted challenges posed by forest fires, ensuring the protection of both the environment and the well-being of the nation.

B. ORGANISATIONAL SETUP OF THE SYSTEM

At the countrywide level, protection and rescue in North Macedonia is structured as a single unified mechanism for monitoring the progression and mitigating the consequences of natural disaster including forest fires that endanger the country's population, vital infrastructure, plant and animal life, and objects or site of distinctive cultural and historical importance.

At the ministerial level, the management of relief efforts concerning natural disasters such as forest fires is overseen by governmental bodies (Photo 7), aligning with statutes and additional guidelines that delineate their obligations. The state institution such as Crisis Management Centre (CMC), Directorate for Protection and Rescue (DPR), all bodies and institutions of the Assessment Group, all institution in the teering group and local agencies, public enterprises and organisations are responsible for executive actions aimed at preventing and lessening the aftermath of forest fires as a natural disaster falling under their jurisdiction. These preventive and alleviating measures, within the scope of their responsibilities, are further elaborated in the National Strategy for Protection and Rescue.

The DPR is a component of the Assessment Group, while the CMC is a constituent of the government's Steering and Assessment Groups.



Photo 7: *Overview of North Macedonian DRM governance*

The DPR and the CMC serve as the core of North Macedonia's Disaster Risk Management (DRM) system which also includes forest fire risk management. These government bodies coordinate the national-level activities by interacting with eight regional centres in Skopje, Tetovo, Ohrid, Bitola, Veles, Kumanovo, Shtip, and Strumica. The role of these government bodies is defined in the Law on Protection and Rescue and the Law on Crisis Management, which outline the responsibilities of participants, such as the state, local authorities, private companies, and public entities. In order to improve the efficiency and effectiveness of firefighting, the Government of the Republic of North Macedonia (summer 2023) made a decision appointing the Crisis Management Centre as the responsible institution for firefighting management.

In accordance with the relevant legislatives, the DPR and CMC has responsibility for:

ORGANISATION	ACTIVITIES AND DUTIES RELATED TO:
DPR	▪ Developing plans for protection and rescue ▪ Training protection and rescue forces based on predefined curricula and programmes ▪ Developing risk assessments in cooperation with state responsible authorities ▪ Organising and preparing protection and rescue system
CMC	▪ Performing activities that relate to providing continuity of the inter-departmental and international cooperation, consultations, and coordination of crisis management ▪ Preparing and updating a unified assessment of the risks and dangers to the security of the nation ▪ Proposing measures and activities for resolving a crisis and ▪ Executing any other activities laid down by law

Besides measures for prevention and pre-suppression, one of the preconditions for effective fire suppression is a clearly defined chain of command and coordination. According to the Law on Forests, the company/entity that manages forests has an obligation to organise the initial fire suppression response. This is usually the responsibility of the Public Enterprise "National Forests" via its regional subsidiaries (branch).

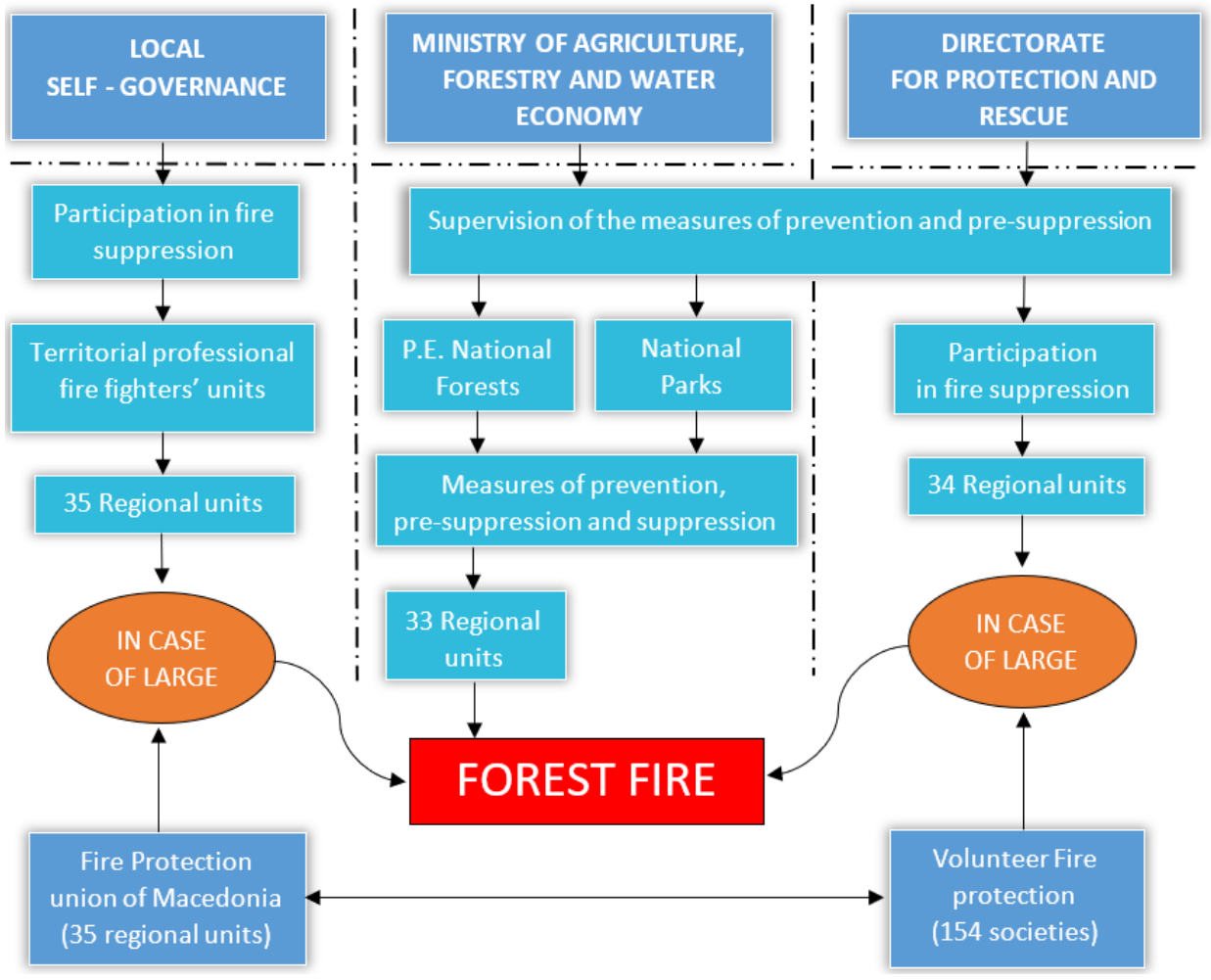


Photo 8: *Organisational suppression scheme of the landscape fire protection and management in the Republic of North Macedonia*

Every subsidiary of PENF has its own observatories with well trained and equipped personnel for initial alerting. Within the branches there is special trained team of people (forest fire fighters). At the initial stage of fire, they oversee fire suppression actions. Basically, they are first on the field when wildfire occur. If a fire cannot be suppressed by the PENF, they must call on the local or regional (if fire is of wider range) fire service for support, although the PENF is still in charge of the fire suppression operation. If the fire remains beyond their capacities, the DPR will contribute its resources. From this point, the DPR oversees all operations, even if the MFPU (volunteer firefighters) and the army are involved.

In case a state of emergency is officially declared by the government, the Crisis Management Centre will become responsible for coordinating the firefighting. This task includes the coordination of foreign assistance, for example targeting foreign aerial resources to the fire.

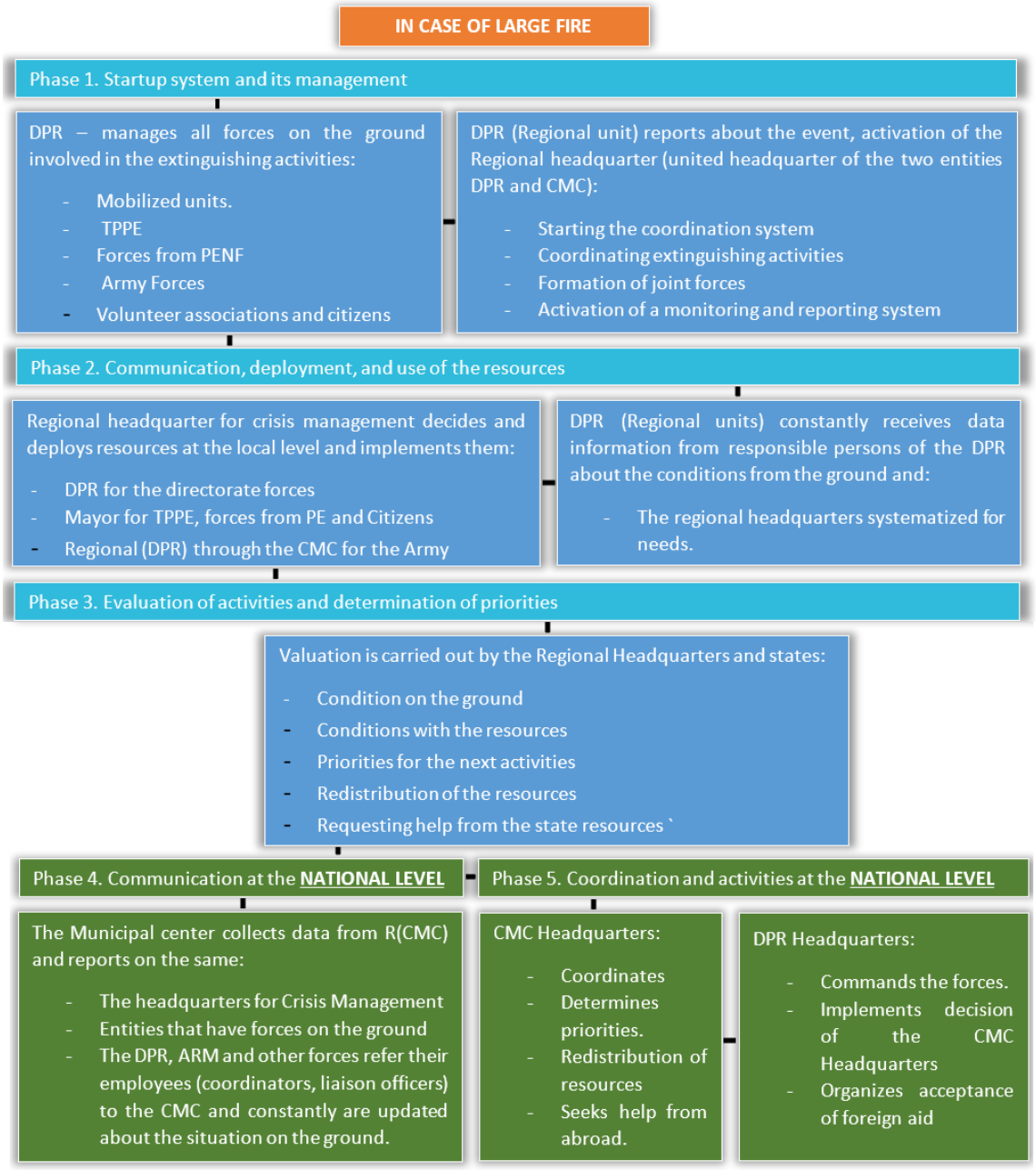


Photo 9: *Crisis Management System (CMS) in case of large-scale fire events*

C. LEGISLATION REGULATING THIS FIELD

The regulation framework governing the critical domain of Landscape Fire Management, serves as the cornerstone for ecosystems and communities protection from the devastating impacts of landscape fires. Legislative measures provided in this chapter are designed not only to delineate responsibilities but also to establish a cohesive strategy that balances environmental conservation with the protection of human lives and property. By delving into the intricacies of the legislation surrounding Landscape Fire Management, this chapter gain insights into the proactive measures, and collaborative efforts aimed at mitigating the risks associated with landscape fires.

This exploration sheds light on the dynamic interplay between legal provisions and the ever-evolving challenges posed by landscape fires, highlighting the integral role legislation plays in fostering resilience and sustainability in our natural environments. Therefore, a list of legislations regulating the field of landscape fire management and an overview of the types of legal frameworks are present bellow.

LEGISLATIONS REGULATING THE FIELD OF LANDSCAPE FIRE MANAGEMENT

No.

1 **Law on Local Self-Governance (Official Gazette of North Macedonia, No. of 29th January 2000)**

Article 1
General provision

(1) *This law regulates: competencies of the municipality; direct participation of the citizens in the decision-making; the organisation and the work of the organs of the municipality; municipal administration; the acts of the organs; the property ownership of the municipality; supervision of the work of the municipal organs; dissolution of the council of the municipality; mechanisms of cooperation between the municipalities and the Government of the Republic of North Macedonia; neighbourhood self-government; the protection of local self-government; determining of official languages in the municipalities; and other issues of importance to the local self-government.*

2 **Law on Protection and Rescue (Official Gazette of North Macedonia, No. 36/04, of 10th June 2004)**

Article 1
General provision

(1) This law regulates the system for the protection and rescue of people, the environment, material goods, natural resources, animal and plant life and cultural heritage from natural disasters and other accidents in peace, state of emergency and war in the Republic of North Macedonia.

3 **Law on Nature Protection (Official Gazette of North Macedonia, No. 67, of 4th October 2004)**

Article 1
General provision

(1) *This Law shall regulate the nature protection by protecting the biological and landscape diversity, and the protection of the natural heritage, in protected areas and outside of protected areas (hereinafter: protection of nature).*

(2) *In addition to the provisions of this Law, the use of natural resources for economic purposes shall also be regulated by the provisions of sectoral laws.*

4 **Law on Fire Protection (Official Gazette of North Macedonia, No. 67/4, of 14th October 2004**)

Article 1
General provision

(1) This law regulates the formation, organisation and operation of firefighting units, voluntary firefighting associations, firefighting, as well as the conditions for production, putting into use and maintenance of firefighting devices, equipment and means.

5 Law on Crisis Management (Official Gazette of North Macedonia, No. 29, of 4th May 2005)

Article 1

General provision

(1) The crisis management system is organised and implemented for the purpose of prevention, early warning and handling of crises that pose a risk to goods, health and life of people and animals, and are caused by natural disasters and epidemics or other risks and dangers that directly threaten the constitutional order and security of the Republic of North Macedonia (hereinafter: the Republic) or part of it, and for which there are no conditions for declaring a state of war or emergency.

(2) This law regulates the crisis management system in the Republic, namely: organisation and functioning, decision-making and use of resources, communication, coordination and cooperation, assessment of the threat to the security of the Republic, planning and financing, as well as other related issues with the crisis management system.

6 Law on Environment (Official Gazette of North Macedonia, No. 53, of 5th July 2005)

Article 1

General provision

(1) *This Law shall regulate the rights and the responsibilities of the Republic of North Macedonia, municipalities, the City of Skopje, and the municipalities of the City of Skopje as well as the rights and the responsibilities of legal entities and natural persons, in the provision of conditions required to ensure protection and improvement of the environment, for the purpose of exercising the right of citizens to a healthy environment.*

7 Law on Agricultural Land (Official Gazette of North Macedonia, No. 135, of 8th November 2007)

General provision

Article 1

(1) Agricultural land, as a good of general interest for the Republic of North Macedonia, enjoys special protection and is used under conditions and in a manner determined by this law. This law determines the use, disposition, and protection of agricultural land in the Republic of North Macedonia.

8 Law on Hunting (Official Gazette of North Macedonia, No. 26, of 24th February 2009)

General provision

Article 1

(1) Game is state property and as a good of general interest for the Republic of North Macedonia it enjoys special protection in the manner and under the conditions established by this law and the Law on Nature Protection. This law regulates the cultivation, protection, hunting and use of game and its parts.

9 Law on Forests (Official Gazette of North Macedonia, No. 64, of 22th May 2009)

General provision

Article 1:

(1) This law regulates the planning, management, management, cultivation, protection, and use (hereinafter: forest management), the preservation of forests as natural wealth and forest land, the realisation of the public functions of forests, the right and obligations to use forests., financing, as well as other issues of importance for forests and forest land according to the principle of biological, economic, social and ecological acceptability.

10 **Law on Urban Greenery (Official Gazette of North Macedonia, No.11/2018 and No.42,2020)**

General provision

Article 1:

(1) *This law regulates the planning, design, construction, maintenance, protection and reconstruction of urban greenery, its financing and management, as well as the supervision of the application of the provisions of this law.*

11 **Low on Fire Fighting (Official Gazette of North Macedonia. No. 168 of 21.11.2017)**

General provision

Article 1:

(1) *This law regulates the formation, organisation and operation of firefighting units, voluntary firefighting associations, firefighting, as well as the conditions for production putting into use and maintenance of firefighting devices, equipment and means.*

STRATEGIC DOCUMENTS

1 **National Strategy for Protection and Rescue (2014, 2023)**

In the five-year period for which the National Strategy for Protection and rescue priority will be raising awareness and increasing the responsibility of state administration bodies, local self-government units, public enterprises, institutions and services, commercial companies, as well as every citizen of the Republic Macedonia, for the fulfilment of the legal obligations for planning, preparation and implementation of measures for protection and rescue from natural disasters and other accidents.

2 **Strategy for the development of forest protection from fires, phyto pathological and entomological phenomena, with an action plan for the realisation of projects and purchases for needs of PE "National Forests"** adopted in September 2017

3 **NATIONAL PLATFORM FOR DISASTER RISK REDUCTION**

In 2009 was established the National Platform for disaster risk reduction as a Macedonian model. It comes out as a need for a multi-stakeholder national mechanism that would provide coordination as give political guidelines in the area of Disaster Risk Reduction (DRR). The document is based on constitutive elements, contextual stakeholders, and functional links on a political, administrative and expert level.

4 **THE NATIONAL STRATEGY FOR NATURE PROTECTION**

The national strategy for nature protection is prepared within the framework of the Programme for nature conservation in North Macedonia, project founded by the Swiss Agency for Development and Cooperation with coordination by Helvetas Swiss Intercooperation and Farmahem Skopje. The government of North Macedonia at the fifty-eighth session, held on 13.03.2018, adopted the National Strategy for Nature Protection (2017 – 2027)

5 **THE STRATEGY FOR ENVIRONEMNT AND CLIMATE CHANGE**

Creation of the Environment and Climate Change Strategy comes from a need of define objectives and priorities of policies in the area of environment and climate change for the period 2014 – 2020, which leads to improve quality of the environment and the life of the citizens.

6 **THE STRATEGY FOR SUSTAINABLE DEVELOPMENT OF FORESTRY IN MACEDONIA (2006)**

The strategy was prepared in 2005 and adopted by parliament in 2006. It is the basis and preparation for all major decisions regarding forestry in the next 20 years. The goals and measures listed in the Implementation Action Plan apply to all forests in the state. The goal of the Government is to increase the contribution of forestry in the state and rural economy through sustainable forest management. Forestry will offer products and services to improve the quality of life of all citizens. In the Strategy, forests are understood above all as resources to produce material goods such as wood and other forest products (medicinal plants, mushrooms, forest fruits, game, etc.).

V. HISTORY OF LANDSCAPE FIRES IN NORTH MACEDONIA FOR 2000 – 2021

The history of landscape fires in North Macedonia is a chronicle marked by the interplay of natural phenomena, human activities, and evolving land use patterns. This chapter embarks on a journey through time, delving into the historical context and dynamics of forest fires within the country. It seeks to illuminate the patterns, consequences, and implications of these fires, spanning a spectrum of metrics from the number of incidents and the extent of burned areas to the multifaceted damages incurred — ecological, economic, and societal.

As we delve into the annals of North Macedonia's landscape fire history, we aim to uncover the multifaceted story of forest fires — a narrative that spans decades, echoing the intricate relationship between nature and humanity. Through this exploration, the aim is to glean insights into the past, present, and future of landscape fire management in North Macedonia, forging a path towards a more resilient and sustainable coexistence with fire-prone landscapes.

Table 16. *Total burned area in ha by planning region:* ***Source of data:*** *State statistical office 2023*

	REGIONS								
	Vardar	Eastern	Southwestern	Southeastern	Pelagonia	Polog	Northeastern	Skopje	Total
2010	405	1,562	41	87	779	134	138	137	3,283
2011	662	952	371	824	828	513	4,030	522	8,702
2012	2,612	1,965	789	3,412	2,072	2,372	1,080	5,010	19,311
2013	542	319	192	193	715	149	-	707	2,817
2014	34	60	198	14	715	100	-	29	1,150
2015	516	612	708	41	693	127	-	12	2,709
2016	312	159	122	1,248	60	139	7	119	2,166
2017	1,391	342	122	823	3,256	1,531	304	316	8,085
2018	57	1,171	1,950	442	232	1,619	453	170	6,094
2019	1,030	1,533	2,102	1,790	2,010	-	992	1,204	10,661
2020	69	167	103	87	3	-	5	4	438
2021	1,203	1,289	1,680	2,621	1,872	1,491	594	670	11,420
Total	8,833	10,131	8,378	11,582	13,235	8,175	7,603	8,900	**76,836**

The data above (Table 17), indicates the total burned area to forest fires in North Macedonia for the years 2010 – 2021 by different planning regions. Significant variations in the total burned area from year to year, with a pick in 2012 being particularly challenging due to extreme forest fire events, most of in the Southeastern planning region.

It is noteworthy that the total burned area fluctuated significantly from year to year in each region. For example, the burned area in Pelagonia was 779 ha in 2012 but increased to 2,010 ha. Data from the State Statistical Office presented suggests that landscape fires are significant issue in North Macedonia, and the regions are affected differently by them.

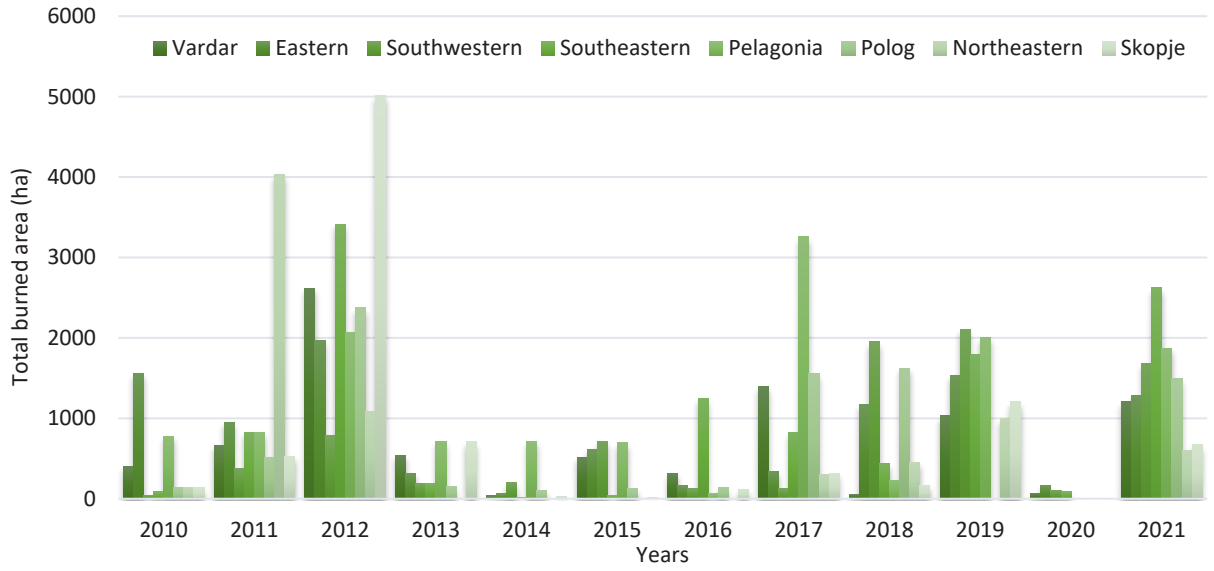
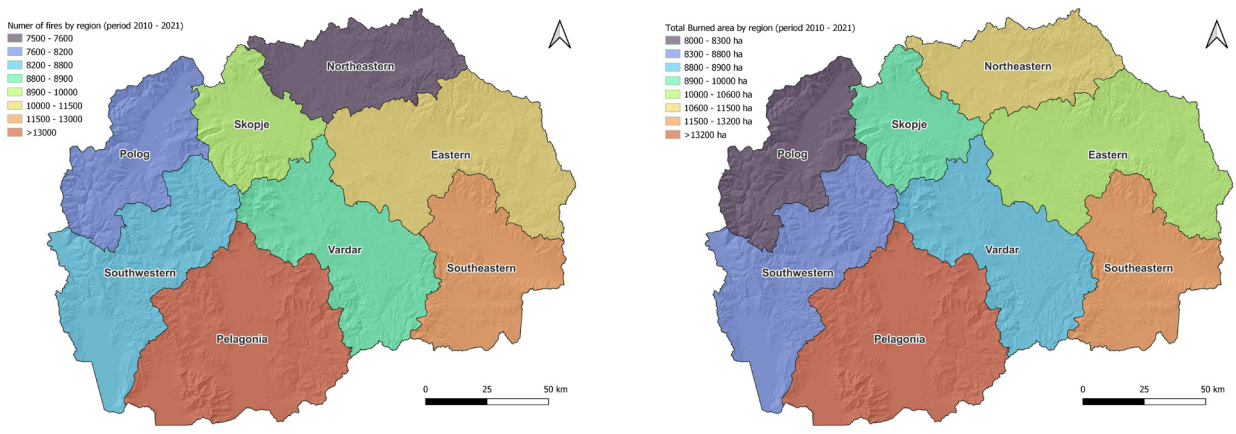


Chart 19. *Total landscape fire burned area (in ha) by the planning regions in North Macedonia:* ***Source of data:*** *State Statistical Office 2023*

The Southeastern region had the highest burning area (2012, 2016 and 2021), indicating that this region is burning more frequently than the others (Chart 19 and Map 14). However, it is important to note that other regions such as Eastern and Southwestern, also had high burned area in some years, suggesting that forest fires are a widespread issue in North Macedonia. The burned area due to the landscape fire events has been increasing in recent years with peaks in 2012, 2016, 2017 etc.



Map 14: *Total burned area by region (left) and Number of fires by region (right) for the period 2010 - 2021 (Maps created based on the data from State Statistical Office)*

Collection of data from annual country reports delivered to European Forest Fire Information System (EFFIS) by the Directorate for Protection and Rescue in North Macedonia are shown in Table 18. The reports cover a range of statistics related to landscape fires including the number of fires, total area burnt, and effort taken to prevent and combat these fires.

Overall, the analysis from the annual reports aims to provide a comprehensive picture of the period 2007 to 2021 (available information from 2007 till today) fire seasons across Europe, and to identify areas for improvement in fire prevention and management.

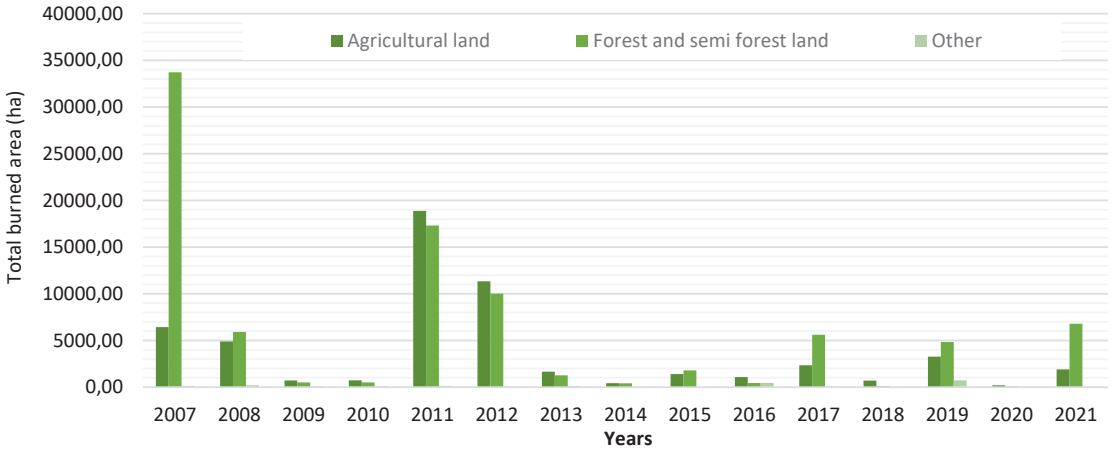


Chart 20. *Burned area by category agricultural land, forest, and semi-forest land and other for period 2007 – 2021:* ***Source of data:*** *EFFIS Annual Report for Republic of North Macedonia; DPR*

A total burned area varies significantly from year to year. In some years, such as 2007, 2011, and 2012, total burned area was quite high, while in other years, it was relatively low. The year with the highest value of burned area was 2007 with a total of 40,282 ha. This was followed by fire events in 2011 with a total burned area of 36,034 ha and 2012.

Table 17. *Landscape fire burned area in ha and number of landscape fires:* ***Source of data:*** *EFFIS Country annual fire report DPR*

	FOREST AND SEMI NATURAL		AGRICULTURAL		OTHER		TOTAL
	No. Fires	Burnt area (ha)	No. Fires	Burnt area (ha)	No. Fires	Burnt area (ha)	
2008	574	5,915	1,569	4,898	373	209	11,022
2009	80	503	455	714	334	89	1,306
2010	99	501	451	737	112	95	1,333
2011	523	17,308	1,805	18,874	555	148	`36,034
2012	483	10,020	1,098	11,342	718	55	21,417
2013	186	1,260	462	1,654	299	113	3,027
2014	62	412	364	427	231	7	846
2015	106	1,797	284	1,401	298	10	3,208
2016	60	1,089	372	1,089	258	463	2,002
2017	301	2,348	884	2,348	602	51	8,018
2018	19	707	341	707	266	38	840
2019	251	3,270	901	3,270	597	732	8,836
2020	48	195	259	195	286	6	269
2021	113	1,905	638	1,905	390	1	8,702
Total:	**2,905**	**89,297**	**9,883**	**55,991**	**5319**	**2,152**	**147,142**
Average	**208**	**5,953**	**706**	**3,733**	**380**	**144**	**9,809**

It's worth noting that the severity of the landscape fire season depends on a variety of factors beyond just the total burned area (Table 18), such as the number of fires (Chart 21), the duration of the season and the impact on local communities and ecosystems. However, in terms of total area burned, 2011 and 2007 appear to have been the most severe years in the period covered by this source of information.

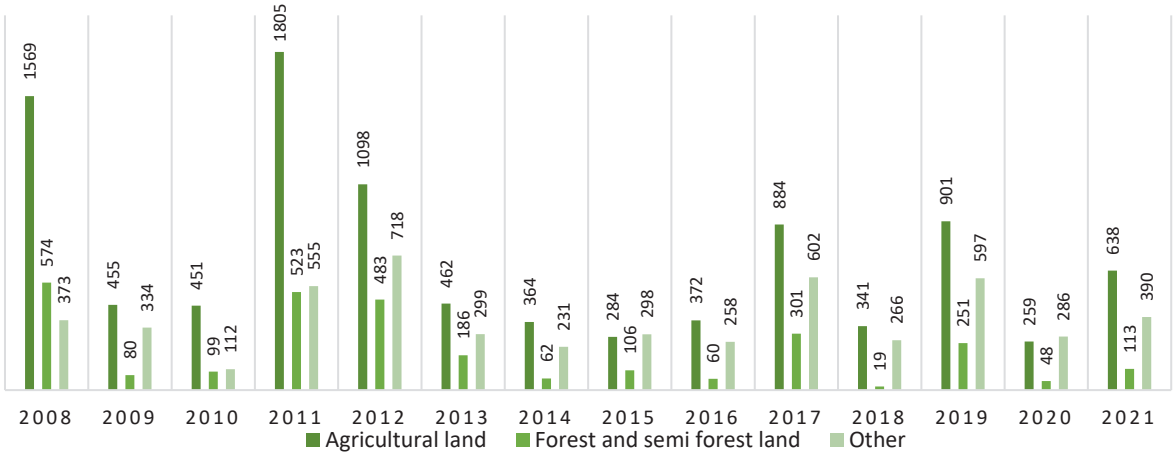
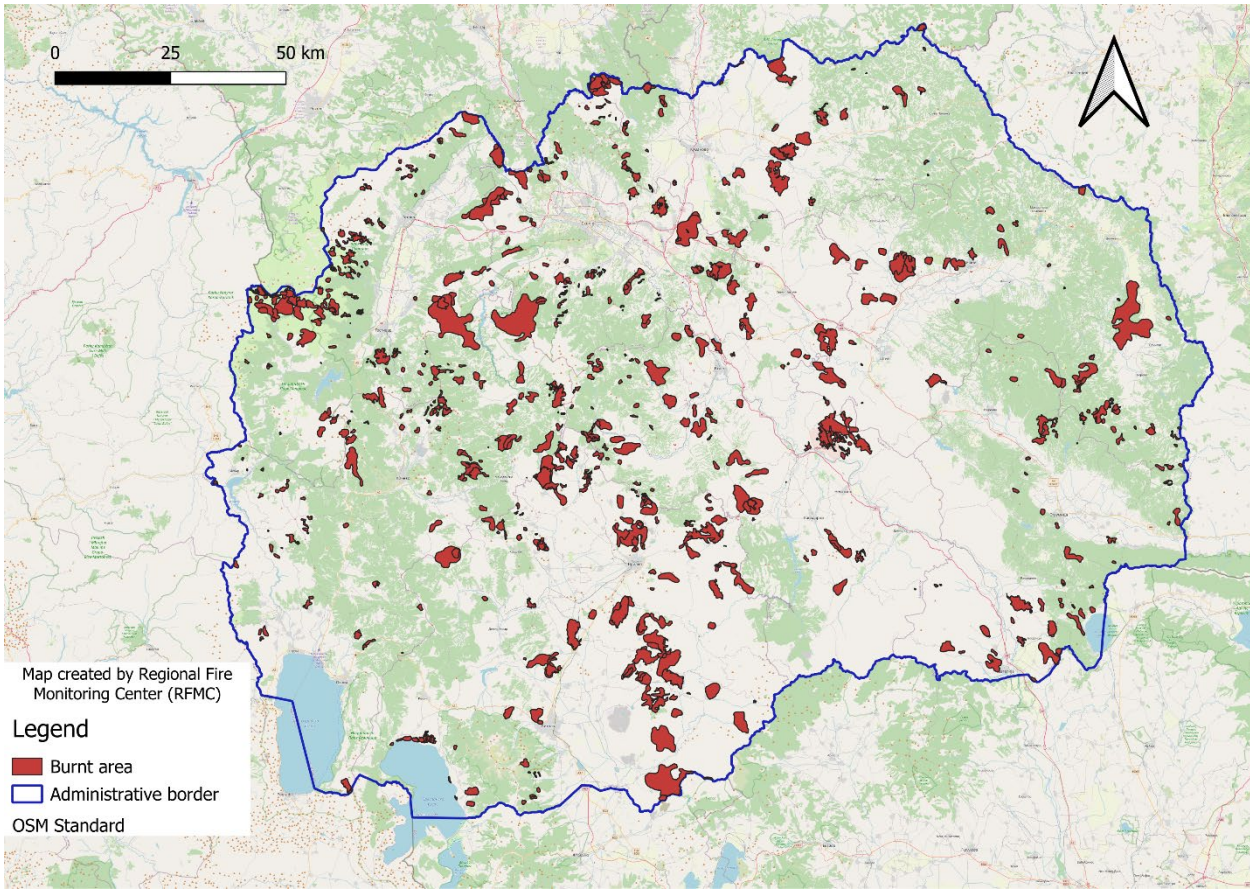


Chart 21. *Number of landscape fires in category agricultural, forestry and semi forest land and other for the period 2008 - 2021:*
Source of data: *EFFIS Annual Report for Republic of North Macedonia; DPR*

The most important insights from the EFFIS Annual Reports (DPR) are that agriculture consistently has the highest number of reported fires, with an average of 706 fires annually over the 14-year period. This suggests that agricultural activities are a significant source of fire incidents and where the focus should be pointed. Further, the number of forest fires varies over the years, with a peak of 574 fires in 2008 and a significant drop to 48 fires in 2020.

Annual average number of fire events in forest are about 207. This indicates fluctuations in forest fire incidents, which could be influenced by factors such as climate conditions and forest management practices. The data underscores the prominence of agricultural fires, the variability in forest fire incidents, and the importance of further analysis to determine the real causes. Effective fire management and prevention strategies are essential in light of this data.



Map 15: *Burnt area from Landscape Fires in North Macedonia (2008 - 2023)*

The data used for the purposes of creation of this map was 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 Center (RFMC) in Skopje. Besides the image formatted (.tiff) representation of the map shown above, the digital/interactive map (.qgis format – QGIS software must be installed) 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, and more.

Another source of data (Table 19) related to the fire history events for the state forests (about 90% of the forests in North Macedonia) are in accordance with the statistical analyses and department responsible for forest protection in Public Enterprise "National Forests" (PENF).

Table 18. *Number of forest fires associated with the forest fire total burned area in ha in North Macedonia for the period 2000 to 2021:* ***Source of data:*** *PE, National forests" 2023*

Years	Number of fires	Total burned area in ha
2000	476	46,235
2001	161	6,263
2002	65	1,186
2003	144	1,068
2004	94	892
2005	182	1,368
2006	138	2,085
2007	652	35,248
2008	249	7,411
2009	61	1,990
2010	106	2,239
2011	302	17,812
2012	367	16,716
2013	160	5,069
2014	109	818
2015	194	5,766
2016	150	3,585
2017	364	13,316
2018	129	2,822
2019	402	15,675
2020	102	1,233
2021	204	12,315
Total	5,640	201,121
Average 22y:	256	9,550 ha

PENF data reveals that a total of 5640 fires (average 256 annual fire events) occurred in North Macedonia during the period, resulting in over 201,121 ha of land being burned. The number of forest fires and burned areas varied significantly from year to year. For instance, in 2007 the country experienced the highest number of fires (652) and significantly burned an area of 35,248 ha. Another significant extreme fire season was in 2000 with total burned area of 46,235 ha associated with 476 number of fires.

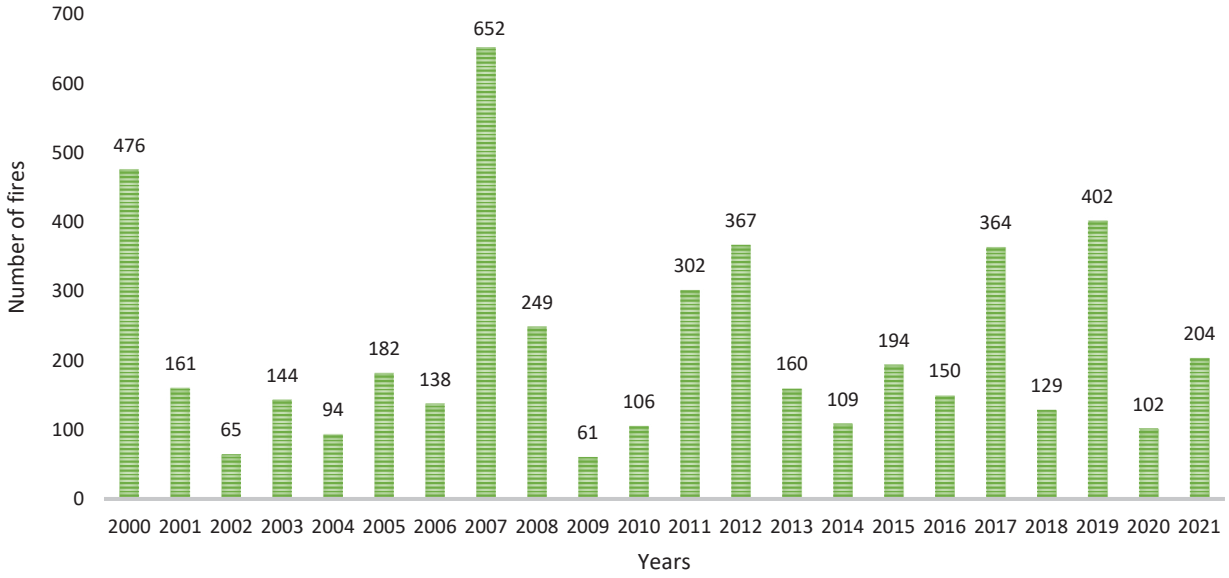


Chart 22. *Cumulative representation of the number of fires in North Macedonia for the period of 2000 to 2021:* ***Source of data:*** *PE, National forests" 2023*

On the other hand, in 2009, the country experienced a low number of fires (61) and a relatively small, burned area (1,991 ha). However, the trend in the number of fires was not consistent throughout the period, and there were some years with a low number of fires, such as 2002 and 2018.

A concerning phenomenon, specifically identified in the last decade, is the decrease of the ratio of total number of fires while facing increase of the total burned area (except two megafires in 2000 and 2007). This information from PE" National Forests" is essential to consider due to the fact they are managing around 90% of the forests in North Macedonia so as to develop effective strategies that address the specific challenges posed by landscape fires in North Macedonia.

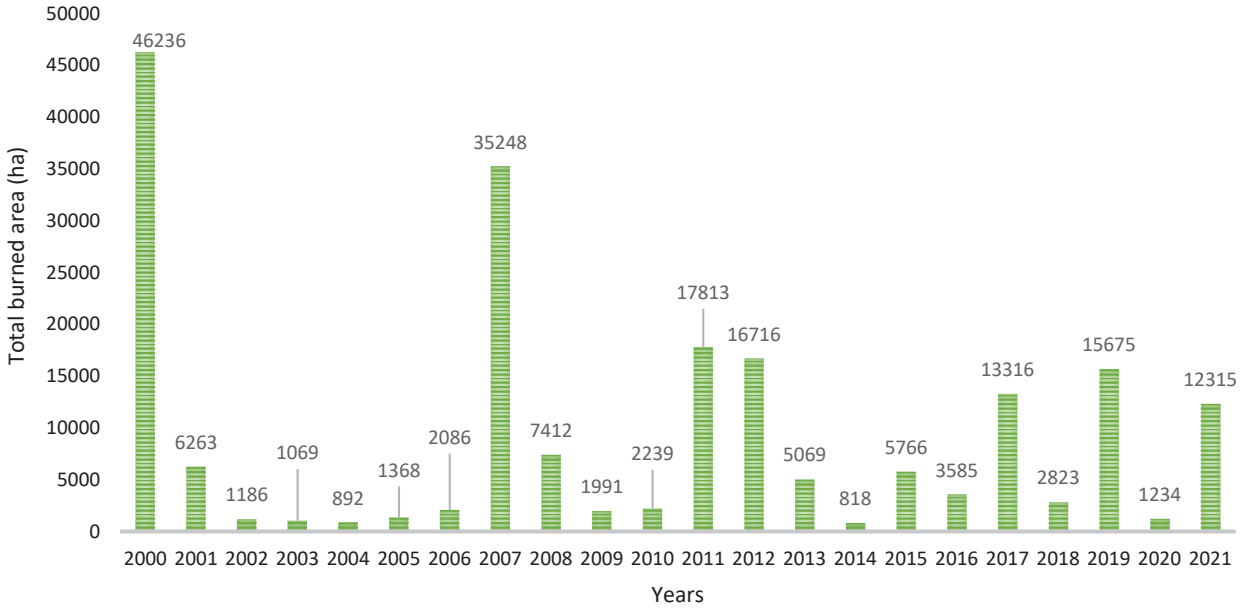


Chart 23. *Cumulative representation of burned area in ha by each year in North Macedonia for the period of 2000 to 2021:* ***Source of data:*** *PE, National forests" 2023*

Another indicator of fires in North Macedonia is the damages caused by forest fires. Table 19 provides damages caused by forest fires in terms of burned timber mass, suppression fees and total damages in euros over a period of 23 years from 2000 to 2022. The burned timber mass (Chart 24) varies widely from year to year, ranging from a low of 1,063 m^3 in 2005 to a high of 617,679 m^3 in 2007 and even the highest of 711,782 m^3 in 2000. The total burned timber mass over the 23 years was 2,495,835 m^3. This highlights the significant environmental impact of forest fires and their destructive nature.

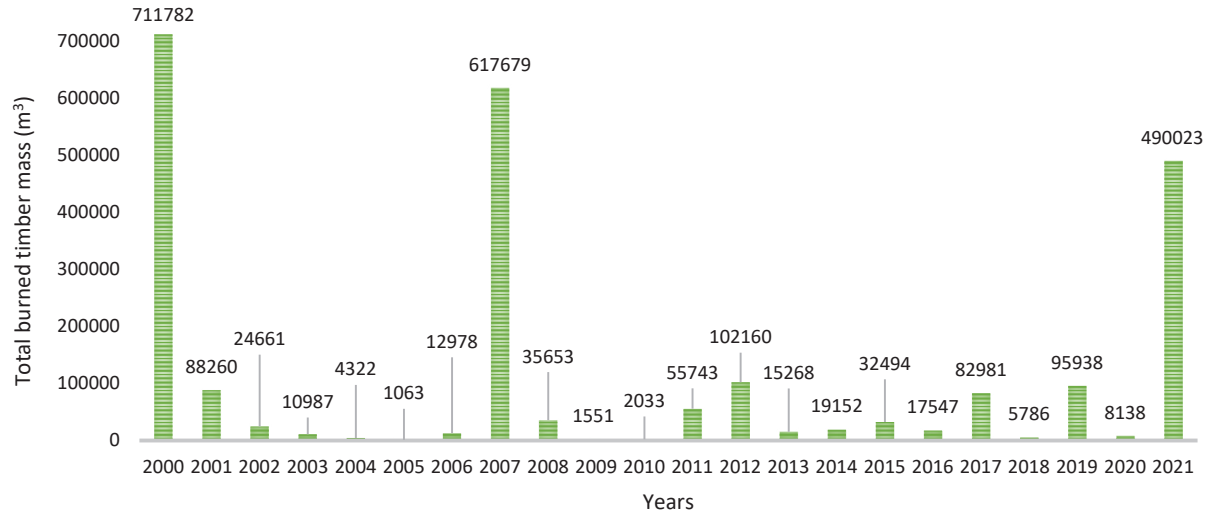


Chart 24. *Cumulative representation of the total burnt timber mass in m3 in North Macedonia for the period of 2000 to 2021*
Source of data: *PE National forests 2023*

Suppression costs varied significantly from year to year, ranging from 13,721 euros in 2014 to a high of 984,078 euros in 2000. Years 2007 and 2010 also show high fees in comparison to the other years of 383,852 euros and 463,464 euros, respectively. Total suppression fees incurred over the entire period were 4,448,602 euros. These fees represent the cost of fighting and containing the forest fires and reflect the resources required to deal with the impact of forest fires.

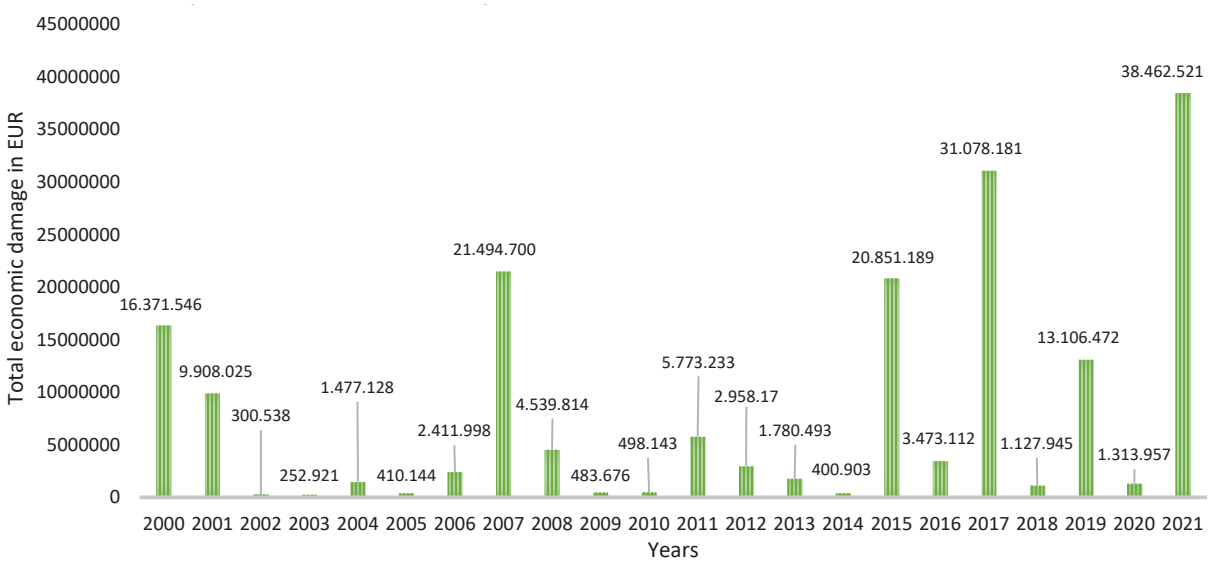


Chart 25. *Cumulative representation of the total economic damage in euros in the Republic of North Macedonia for the period of 2000 to 2021:* ***Source of data:*** *PE, National forests" 2023*

These are inclusive of the total damages caused by forest fires in euros including the total cost. The total damages varied from a low of 159,036 euros in 2009 to a high of 38,462,521 euros in 2021 (Chart 25, Table 20). Additionally, to 2021 fire events, due to the high severity and risk of devastating damages, the government declared a state of crisis for 30 days. These figures represent the significant economic impact of forest fires, which can be devastating to local communities, economies, and the environment.

Table 19. *Damages caused by forest fires in North Macedonia associated with burned timber mass, suppression fees and the total damages caused by fires in euros:* ***Source of data:*** *PE "National forests" 2023, State Inspectorate for Forestry and Hunting 2023*

Years	DAMAGES		
	Economic		
	Burned timber mass (m^3)	Suppression fees (EUR)	Total damage of fires (EUR)
2000	711,782	984,078	16,371,546
2001	88,260	67,066	9,908.025
2002	24.661	15,193	300,539
2003	10,987	44,775	252,921
2004	4,322	23,214	1,477,128
2005	1,063	42,018	410,144
2006	12,978	45,311	2,411,998
2007	617,678	383,852	21,494,700
2008	35,653	96,278	4,539,813
2009	1,551	146,555	159,036
2010	2,033	463,464	498,143
2011	55,743	137,865	5,773,233
2012	102,160	142,927	2,958,173
2013	15,268	169,905	1,780,493
2014	19,152	13,721	400,903
2015	32,494	39,104	20,851,189
2016	17,574	36,301	3,473,112
2017	82,981	95,532	31,078,181
2018	5,786	37,497	1,127,945
2019	95,938	163,373	13,106,472
2020	8,138	21,552	1,313,957
2021	490,023	107,101	38,462,521
2022	12,477	30,494	1,931,706
Total	2,495,835	4,448.602	170,173,856
Average 22y:	**113,447**	**202,209**	**7,735,175**

Over the last 20 years, forest fires have caused significant damage to North Macedonia's forests and natural resources. The highest burned area occurred in years 2000, 2007, 2012, 2017 and 2021 mainly in the Southeastern region. While the Southeastern region consistently experiences the most fires, significant fire damage is also seen in the Eastern and Southwestern regions. The average annual burned timber mass is around 113,447 m^3. The total economic damages for the last 2 decades are estimated to amount to 170,173,856 EUR or on average of 7,735,175 EUR per year.

A MAIN CAUSES

There are multitude of forest fire causes in North Macedonia, both natural and human induced. Human activities are responsible for many forest fires globally, with estimates ranging from 70 – 90% of all fires. Some of the most common human causes of forest fires include land use changes, agricultural expansion, urbanisation, industrial activities, and recreational activities.

Human – caused forest fires can be further categorised into intentional and unintentional. Unintentional fires may result from activities such as campfires, cigarettes, or equipment use, while intentional fires may be set for a variety of reasons, including land clearing, poaching or even vandalism.

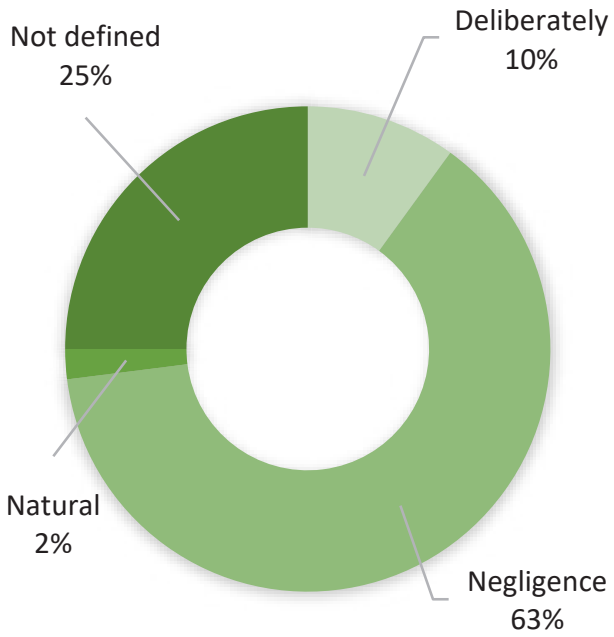


Chart 26. *Indicators of forest fire causes*

Indicators show that around 10% are deliberately caused, 65% are negligence, 2% are due to natural factors and for almost 25% the causes are not defined [Illegal logging, REC,2009]. In addition to these more traditional causes, there is a link between climate change and the increasing frequency and severity of forest fires in the region.

This chapter on the history of the landscape fires in North Macedonia integrates critical quantitative findings from various sources, providing a detailed account of the severity and impact of landscape fires over the 20 years period. Data from the State Statistical Office in 2023 reveals an alarming increase in the total burned area, with the Southeastern region consistently experiencing the highest burn area in 2012, 2016, and 2021. Pelagonia region dominates in terms of the number of fires, followed by the Southeastern and Eastern planning regions. In contrast, the Northeastern and Polog regions experience fewer fire events.

Analysing data from the EFFIS Annual Reports and collected by the DPR, agricultural burns consistently account for the highest number of fire events, averaging 706 fires annually over a 14-year period analysed. Further analysis of state forests, covering about 90% of North Macedonia's forests, aligns with statistical analyses and data from PENF. According to PENF data, North Macedonia witnessed a total of 5,640 forest fires, averaging 256 annual fire events, resulting in the burning of over 201,121 ha of land. Notable variations in the number of fires and burned areas occurred from year to year, with extreme seasons, like 2007, recording 652 fires and burning of 35,248 ha, and 2000, with 476 fires burning of 46,235 ha.

The chapter also highlights the economic impact of forest fires, as evidenced by damages in terms of burned timber mass, suppression fees, and total damages in euros over 23year period (2000-2022). The burned timber mass ranged from 1,063 m^3 in 2005 to the highest of 711,782 m^3 in 2000, emphasizing the significant environmental consequences. Suppression fees fluctuated from 13,721 euros in 2014 to 984,078 euros in 2000, with a total of 4,448,602 euros incurred over the entire period. The total damages, including suppression fees and other costs, reached approximately 170,173,857 euros, underscoring the substantial economic impact on local communities and the environment.

VI. LANDSCAPE FIRE RISK ASSESSMENT

As an essential endeavour for North Macedonia Landscape Fire Risk Assessment addresses the need to protect both its environment and its communities from the potentially devastating impacts of landscape fires. The purpose of this chapter is to provide an overview of the landscape fire risk assessment in North Macedonia, shedding light on the methodologies, challenges that play a pivotal role in preserving the country's natural treasures and ensuring the safety of its inhabitants. This chapter explore the unique characteristics of the Macedonian Forest Fire Information System (MKFFIS) as one of the components of the Landscape fire risk assessment.



Photo 10: *Risk Management Cycle*

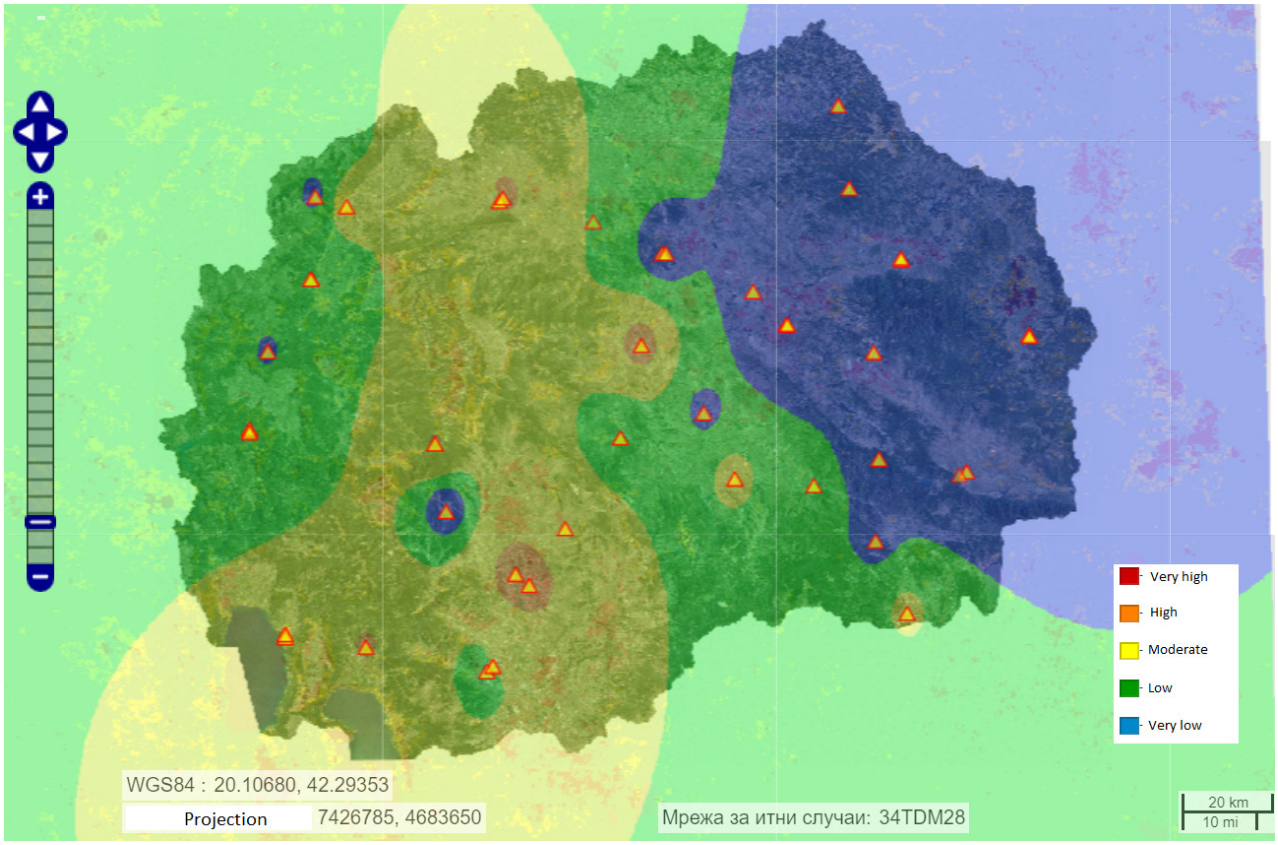
The Forest Law stipulates, among other things, an obligation for the MAFWE to establish and manage information system for the register of forest fires, with the purpose to improve the monitoring of forest fires. The method and conditions for keeping the records of forest fires is prescribed in the Regulations (Regulations on the method of collecting data, keeping the register of forest fires and the conditions for using the data – Official Gazette of the Republic of Macedonia number 82/2015).

According to the Rulebook from 2015, records on each fire is kept in Macedonian Forest Fire Information System (MAKFFIS) and are entered by all stakeholders in the forest and fire management system at the regional and national level. A key check of the data entered into the system in terms of forest fires is carried out by State Inspectorate for Forestry and Hunting according to the regulations adopted in 2015.

MKFFIS is publicly available to all citizens who want to obtain basic information about the situation with forest fires in North Macedonia. More detailed information is available only for institutions, stakeholders closely related to the field of forest management and landscape fire management. Currently more than 500 users from different institutions have access to the MKFFIS system.

This system contains several tools for monitoring and assessing the risk of forest fires for:

- Daily prediction of the danger of forest fires through a map of hotspots.
- Daily monitoring of the forest vegetation exposure through a vegetation map
- Forest vulnerability monitoring, for which a vegetation dryness map and a daily Fire Weather Index (FWI) map have been introduced, and
- Monitoring the capacity and measures of the institutions, topographic maps, maps of facilities, infrastructure and resources have been placed.



Map 16: *Forest vulnerability monitoring, for which a vegetation dryness map and a daily Fire Weather Index (FWI) map*

This system uses input data for fire risk assessment that is mostly automatically connected to other systems and providers. Namely:

- Data for the hotspot map and the vegetation dryness map are automatically generated using satellite images from the SEVIRI (Spinning Enhanced Visible and Infrared Imager) and MODIS (Moderate Resolution Imaging Spectroradiometer) satellites.
- Data for the fire weather index map relating to the parameters of wind speed and direction, temperature, humidity, and rain are downloaded from the automatic meteorological stations of the

hydrometeorological service while the topographic and other maps are downloaded from the Real Estate Cadastre Agency.

- Data for the forest vegetation map, which refer to types and age of forest, diameter, wood mass, etc., are entered by PE "National Forests" through the GFIS system.

Therefore, after every fire event, the subsidiaries of PENF have an obligation within 8 (eight) days from extinguishing the fire electronically in the MKFFIS system to fill out a statistical sheet (records) for wildfire, which contains:

- location data,
- time of occurrence,
- localising and extinguishing the fire,
- reasons and conditions for its occurrence,
- hired human and material resources for extinguishing,
- used extinguishing tactics as well as data on victims and data on damage.

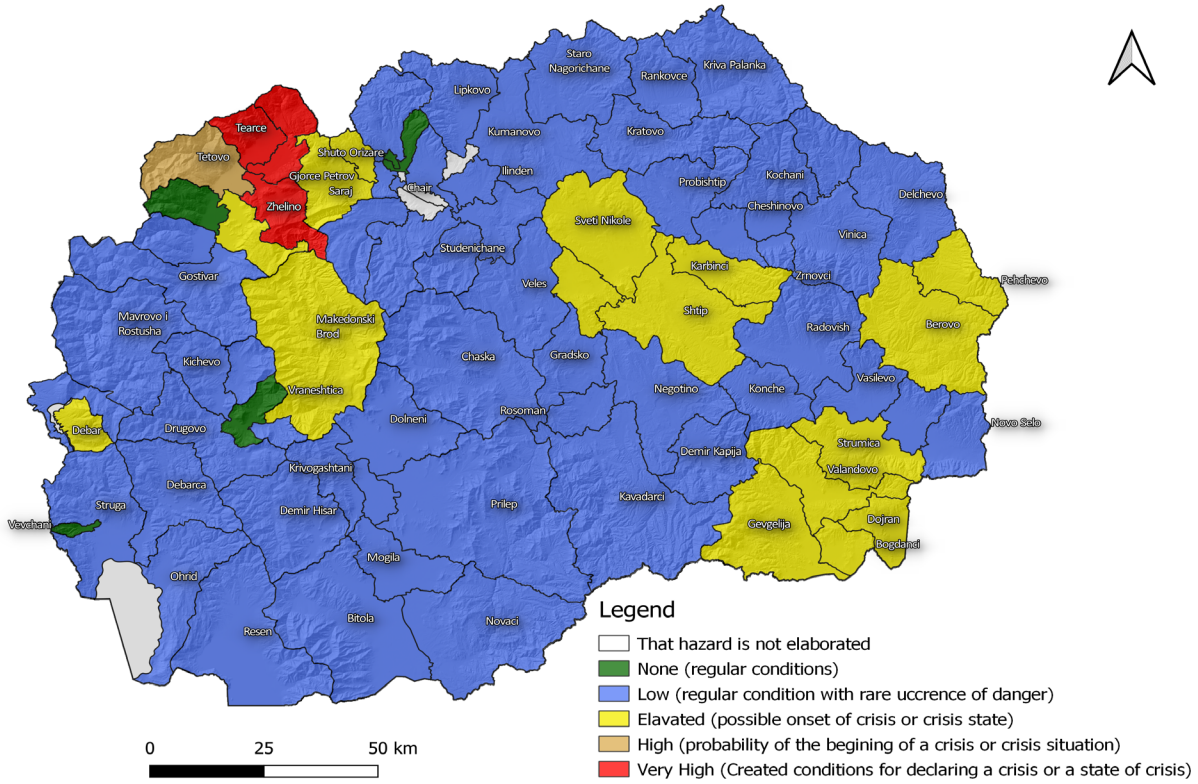
Forest Fire History is created using entry data from the statistical sheets (Wildfire records) by PENF. Considering the importance of the MKFFIS as a tool for prevention, early warning and monitoring of forest fires, it is especially important all competent institutions to use the system and regularly update the data on the fires that have occurred.

A. FIRE RISK ASSESSMENT

Based on Article 45 paragraph 3 of the Law on Crisis Management ("Official Gazette of the Republic of Macedonia" no. 29/05, 36/11, 41/14, 104/15, 39/16 and 83/18 and "Official Gazette of the Republic of North Macedonia" no. 215/21), the Government of the Republic of North Macedonia, at the session, held on 13th June 2023, passed a regulation on:

"METHODOLOGY FOR DEVELOPING ASSESSMENT OF THE SECURITY THREAT TO THE REPUBLIC OF NORTH MACEDONIA FROM ALL RISKS AND DANGERS, ITS CONTENT AND STRUCTURE, THE METHOD OF STORAGE AND UPDATE AS WELL AS DETERMINATION OF THE ENTITIES IN THE CRISIS MANAGEMENT SYSTEM TO WHICH THE FULL OR EXTRACTS OF THE ASSESSMENT SHALL BE DELIVERED"

The risk assessment methodology for the security of the Republic of North Macedonia follows a structured approach involving data collection, analysis, and mitigation. This methodology systematically identifies and evaluates risks, considering factors such as probability and impact. Vulnerabilities are analysed, and strategies are developed to address potential threats. Collaboration with crisis management entities enhances the assessment's accuracy. Using this methodology, a National Forest Fire Risk map is created (Map 17). White - risk level 0, Green – risk level 1, Blue – risk level 2, Yellow – risk level 3, Orange – risk level 4, Red – risk level 5.



Map 17: *Forest fire risk level by municipalities (Map developed in accordance with the dataset by CMC)*

VII. EXISTING PROJECTS

The chapter delves into the existing and ongoing projects and initiatives that form the cornerstone of our national efforts to mitigate the devastating impacts of landscape fires.

Existing projects represent the culmination of duration, collaboration, and dedicated work by government agencies, local communities, and various stakeholders. These endeavours are designed to tackle the multifaceted challenges posed by landscape fires, including prevention, preparedness, response, and recovery. Overview and list of all projects that have been implemented in the last 10 years in the field of Landscape Fire Management, with information on objectives, scope, implementer, stage, and deliverables.

1	**Name**		
	Construction of integrated system for detection and prevention of forest fires in Nevestino and Makedonska Kamenica / Interreg – IPA CBC		
	Stage: Ongoing	**Duration:** 12.01.2021 – 11.01.2023	**Budget:** €391,841,52
	Donor: Programme co-funded by EU and National funds of the participating countries		
	Implementer: Leading partner: Municipality of Nevestino, Kyustendil, PP2: Public Enterprise Kamena Reka, Makedonska Kamenica East region		
	Link:	http://www.ipa-cbc-007.eu/projects-funded/construction-integrated-system-detection-and-prevention-forest-fires-nevestino-and	
2	**Name**		
	Joint Forest Fire Prevention actions in the cross-border region		
	Stage: Finished	**Duration:** 27.01.2021 – 26.01.2023	**Budget:** €458,365,90
	Donor: Programme co-funded by EU and National funds of the participating countries		
	Implementer: Leading partner: Municipality of Stip, East region PP2: Directorate General Fire Safety and Civil Protection – Ministry of Interior Sofia, Outside eligible area – BG		
	Link:	http://www.ipa-cbc-007.eu/projects-funded/joint-forest-fire-prevention-actions-cross-border-region	
3	**Name**		
	Volunteers across the border		
	Stage: Finished	**Duration:** 31.12.2020 – 30.06.2022	**Budget:** €397,457,46
	Donor: Programme co-funded by EU and National funds of the participating countries		
	Implementer: Leading partner: Municipality of Berovo, East Region PP2: Association "Together for Sandanski" Blagoevgrad, Bulgaria		
	Link:	http://www.ipa-cbc-007.eu/projects-funded/volunteers-across-border	

4	**Name**		
	Early Fire Detection and Ranging for Disaster Prevention and Management (eFIDAR)		
	Stage: Ongoing	**Duration:** 13.10.2021 -	**Budget:** €1,392,073,50
	Donor: Programme co-funded by EU and National funds of the participating countries		
	Lead Partner: Region of Central Macedonia **PP1:** Crisis Management Centre **PP2:** Centre for development of the South-East planning region		
	Link:	https://www.ipa-cbc-programme.eu/approved-project/87/	
5	**Name**		
	Cross-Border Cooperation in Forest Fire Fighting		
	Stage: Finished	**Duration:** 18.02.2021 – 17.02.2023	**Budget:** €395,361,14
	Donor: Programme co-funded by EU and National funds of the participating countries		
	Implementer: Leading partner: Association of Southwestern Municipalities – Blagoevgrad, Bulgaria PP2: Centre for development of the South-East planning region		
	Link:	http://www.ipa-cbc-007.eu/projects-funded/cross-border-cooperation-forest-fire-fighting	
6	**Name**		
	Cross-Border Cooperation programme North Macedonia – Albania for 2021 - 2027		
	Stage: Ongoing	**Duration:** 2021 – 2027	**Budget:** €1,379,000,00
	Donor: Funded by EU Instrument for pre-accession assistance (IPA – III)		
	Implementer: In North Macedonia: Deputy prime Minister for European Affairs, National IPA Coordinator (NIPAC) and CBC Structure established under IPA III In Albania: Government of Albania, National IPA Coordinator (NIPAC) and CBC Structure established under IPA III legal framework		
	Link:	https://ipacbc-mk-al.eu/web/wp-content/uploads/2022/03/Third-Draft-of-the-IPA-III-Cross-Border-Cooperation-Programme-Republic-of-North-Macedonia-Republic-of-Albania-2021-%E2%80%93-2027_July-2021..pdf	
7	**Name**		
	Capacity Building for Ecosystem Based Disaster Risk Reduction through Sustainable Forest Management in North Macedonia		
	Stage: Finished	**Duration:** 02.12.2017 – 01.12.2022	**Budget:** / €
	Donor: Japan International Cooperation Agency (JICA)		
	Implementer: PP1: Crisis Management Centre, North Macedonia PP2: Public enterprise National Forests, North Macedonia PP3: Ministry of agriculture, forestry and water economy, North Macedonia		
	Link:	https://www.jica.go.jp/project/english/north_macedonia/001/outline/index.html	
8	**Name**		
	Fight Illegal Forest Actions FIFA		
	Stage: Finished	**Duration:** 17.09.2021 – 01.02.2023	**Budget:** / €
	Donor: Federal Financial Assistance, through the USFS International programmes.		
	Implementer: Regional Centre for Forestry and Rural Development (REFORD)		
	Link:	https://refordcentre.org/new-project-fight-illegal-forest-actions-fifa/	

9	**Name**		
	Supporting the reforms in Policy and Legislation in Forestry in North Macedonia		
	Stage: Ongoing	**Duration:** 2023 – 2025	**Budget:** €1,300,000.00
	Donor: Project founded by the EU (IPA III)		
	Implementer: EU, represented by EC in the North Macedonia, Ministry of Agriculture, Forestry and Water economy as a primary beneficiary of the project.		
	Link:	https://www.slideshare.net/francferlin7/forestry-strategic-and-legal-framework-in-north-macedonia	
10	**Name**		
	Cross Border FIRESHIELD		
	Stage: Ongoing	**Duration:** 01.02.2023 – 01.08.2024	**Budget:** €730,316.00
	Donor: Project co-founded by the EU		
	Implementer: Lead applicant: Municiaplity of Vrapciste, North Macedonia Co-applicants: Municipality of Cerrik, Albanik and Municipality of Bogovinje, North Macedonia CARITAS Ngo, Albania		
	Link:	https://ipacbc-mk-al.eu/portfolio/cross-border-fireshield/	
11	**Name**		
	Development and implementation of a smart and sustainable integrated forest fire management system in the cross-border area (DISSIWMS)		
	Stage: Ongoing	**Duration:** 02.12.2021 – 03.12.2024	**Budget:** €799,989.34
	Donor: Project co-founded by the EU		
	Implementer: Lead applicant: Protection and Rescue Directorate (PRD) Co-applicants: Municipality of Struga and Librazhd		
	Link:	https://ipacbc-mk-al.eu/portfolio/development-and-implementation-of-a-smart-and-sustainable-integrated-forest-fire-management-system-in-the-cross-border-area-dissiwms/	
12	**Name**		
	Prevention of risks for environmental sustainable practices for agro-produces PRESPA		
	Stage: Ongoing	**Duration:** 15.12.2021 – 15.06.2024	**Budget:** €797,255.02
	Donor: Project co-founded by the EU		
	Implementer: Lead applicant: Association Centre for Civic Initiative (CCI); Co-applicants: Destination Management Organisation (DMO) Municipality of Resen, North Macedonia Municipality of Devoll, Albania		
	Link:	https://ipacbc-mk-al.eu/portfolio/prevention-of-risks-for-environmental-sustainable-practices-for-agro-producers-prespa/	

13	**Name**		
	Effective prevention and mitigation of flooding consequences in the cross-border region German – Bosilovo		
	Stage: Finished	**Duration:** 29.09.2022 – 29.09.2023	**Budget:** €259,221.53
	Donor: Project co-founded by the EU Interreg IPA – CBC		
	Implementer: Lead applicant: Municipality of German, Blagoevgrad PP2: Municipality of Bosilovo, South-east region		
	Link:	http://www.ipa-cbc-007.eu/projects-funded/effective-prevention-and-mitigation-flooding-consequences-cross-border-region-garmen	
14	**Name**		
	Improvement of capacities for Natura 2000 and CITES		
	Stage: Ongoing	**Duration:** 01.06.2022 – 01.06.2024	**Budget:** €2,214,100.00
	Donor: Project co-founded by the EU IPA 2014 - 2020		
	Implementer: NIRAS IC Sp.z.o.o. in consortium with the Polish Society for protection of Birds, EFTAS Fernerkundung Technologietransfer GmbH; FARMAHEM Dooel Skopje and Macedonian Ecological Society (MES) and Strichting BirdLife Europe		
	Link:	https://www.moepp.gov.mk/	

This chapter highlights a spectrum of projects aimed at fortifying North Macedonia's protection against the landscape fires. Notable efforts include the construction of an integrated fire detection system, joint prevention actions across borders, and the eFIDAR disaster prevention project. These initiatives stress the importance of collaboration, technology, and early detection. International partnerships, exemplified by the Cross-border Cooperation with Bulgaria and Albania, emphasize shared responsibilities in fire management. Meanwhile, projects like Capacity Building for Disaster Risk Reduction and DISSIWMS focus on local empowerment and technological innovation.

Environmental considerations are embedded in projects like PRESPA, addressing risks to agro-produces, and initiatives like FIRESHIELD, targeting broader ecological sustainability. The collective impact of these landscapes a concerted effort to bolster North Macedonia's resilience and response capabilities against the persistent threat of the landscape fires.

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

The following chapter explores the landscape fire management system, an essential component of landscape fire management. Landscape fire management encompasses a set of proactive and strategic approaches designed to reduce fire risks, maintain healthy ecosystems, and protect communities from the devastating consequences of uncontrolled fires events. This chapter will provide an in-depth analysis of the strengths and weaknesses of landscape fire management system, shedding light on the various aspects of this crucial system and the challenges and opportunities it presents in the context of fire prevention, suppression, and recovery or post-fire management. By understanding its intricacies, stakeholders can better harness the potential of landscape fire management to achieve balanced and effective wildfire management outcomes.

A. PREVENTIVE MEASURES

Preventive measures in landscape fire management represent a proactive and strategic approach to reducing the risk of fires before they occur. These measures are fundamental in minimizing the potential for fire ignition and the severity of fire events. Prevention strategies encompass a wide range of actions, from land-use planning and vegetation management to public education and policy development. By addressing the root causes of landscape fires and implementing safeguards to protect communities and ecosystems, preventive measures serve as a vital component in protection against the devastating impacts of uncontrolled fires. This chapter delves into the significance and multifaceted nature of preventive measures, underscoring their pivotal role in mitigating the risk and consequences of landscape fires.

STRENGHTS	WEAKNESSES
– Existence of legal regulations, rules, programmes, strategy, and plans – Existence of planning documents that include measures to reduce the degree of fire risk – Good cooperation with the countries of the region – Existence of National Association of Private Forests owners – Large area of forest under state ownership (easier implementation of preventive and planning measures) – Existence of various sources of data related to landscape fires – Conducting public awareness campaigns by all stakeholders in the LFM system	– Incomplete enforcement of existing laws – Incomplete implementation of existing planning documents – Absence of a National Landscape Fire Management Plan – Large number of private forest owners with small land parcels (average 0.6ha) – Absence of NAPFO involvement in any strategic/planning documents – Absence of a unified methodology for collecting data on open space fires – Lack of public awareness of the impact of Climate change and changed weather conditions – Insufficient (human and economic) resources for the implementation of fire protection measures – Overlapping of the legal competences of responsible institutions in the LFM system – Slow resolution of criminal or misdemeanour proceedings – No regulation for abandoned land (with the increased fuel accumulation) – Absence of National Fuel Classification Methodology – Absence of fuel management regulations and measures

**While existing laws and regulations can be a strength, it's important to note that the effectiveness of these measures often depends on their enforcement and adaptability to changing wildfire dynamics, such as those influenced by climate change.*

B. PREPAREDNESS (READINESS/PRE-SUPPRESSIVE)

Pre-suppressive measures or preparedness measures designed to facilitate the organised management of landscape fires, recognizing that it is impossible to entirely prevent them. The ability to swiftly respond and contain fires relies on consistent, ongoing systemic preparations that run in parallel with the management of forests and land-use management in general. The primary objective of these measures is to enable a rapid and efficient response in localising or extinguishing landscape fires. These measures are implemented continuously throughout the year, without any particular order of priority.

STRENGHTS	WEAKNESSES
– Early Warning System MKFFIS exists – Established monitoring and early detection of fires through observatories built (towers) at key points – Community engagement – Coordination and collaboration between the responsible institution in the LFM system exists – Existence of so-called "System for notification and alarm" together with the existence of Ordinance for signs and alarm – Existence of North Macedonia Risk Assessment from all risks (CMC and DPR) – Existence of forest fire risk assessment at the management unit's level (PENF) – Existence of the yearly operative plan for forest fire protection – Existence of number 112 (number for emergency calls) – Organising training for firefighters by the responsible institutions in the LFM system – There are capacities for management with UXO	– Communication challenges or non-existence of effective inter-institutional communication and coordination – Not functional "Notification and Alarm System" (outdated equipment since 1980) – Outdated forest fire risk assessments methodology – Not sufficient openness of forests with the forest roads – There is no map for UXO – There is no harmonised LF suppression training – There is no proper legal regulation and methodology for fuel breaks constructions – Luck of LFM scientific research – Luck of "An integrated system for providing accurate and timely information on the current state and forecast of the weather and weather conditions (meteorological conditions, meteorological parameters...)" – Variable community engagement (not all residents may actively participate in community preparedness efforts) – Not enough implementation of community resilience programmes/initiatives to build community resilience and self-sufficiency – There are no forest management methods aimed to forest fire risk reduction

Preparedness, often referred to as readiness or pre-suppressive measures, is a critical phase in landscape fire management, encompassing proactive strategies and actions taken before a fire event occurs.

It involves various activities, such as landscape fire risk assessment, community education, emergency planning, and resource allocation, aimed at reducing vulnerabilities and enhancing the capacity to respond effectively to forest fires. Preparedness measures lay the foundation for swift and coordinated responses during fire incidents, helping to protect lives, property, and ecosystems while minimizing the potential impact of these destructive events.

C. SUPPRESSIVE MEASURES

Suppressive measures, an integral component of landscape fire management, encompass a range of strategies and actions designed to control, contain, and ultimately extinguish landscape fires. When fires threaten lives, property, and the environment, suppressive measures become the frontline response to combat these destructive fire events. From the use of firefighting resources, controlled burns, and fire-breaks to aerial water and retardant drops, suppression efforts aim to halt the progress of the fire events, mitigating their immediate and long-term impact. This chapter delves into the various suppressive measures employed in landscape fire management, highlighting their significance in protecting communities and natural landscapes from the devastating effects of uncontrolled fires.

STRENGHTS	WEAKNESSES
– Specially trained firefighters for forest fires – Top-bottom Crisis Management Centre as a central point of the Crisis Management System – Aviation support from the Ministry of Interior and the army – Existence of professionally trained staff for extinguishing forest fires – Good cooperation and support during suppression stage with the countries of the region – Existence of volunteer firefighting units across the country	– Not sufficient openness of forests (forest road infrastructure) – High suppression costs – Insufficient technical equipment – Insufficient number of volunteer firefighting units – Lack of coordination during fire events – Lack of sufficient command system during large landscape fire events – Weak aerial firefighting capacities

D. POST-FIRE MANAGEMENT MEASURES

Post-fire management measures are a critical phase in the comprehensive landscape fire management process, focusing on the period after fire has been contained and extinguished. In this phase, the primary objectives are to assess the damage, facilitate recovery and rehabilitation and restoration of affected ecosystems, and support communities in their efforts to rebuild and adapt to a landscape transformed by fire. Post-fire management encompasses a broad range of actions, from reforestation and habitat restoration to community resilience building, and is vital for promoting long-term recovery, reducing future landscape fire risks, and fostering resilience in the face of recurrent fire events.

This chapter explores the significance and multifaceted nature of post-fire management measures, shedding light on the crucial role they play in mitigating the consequences of landscape fires.

STRENGHTS	WEAKNESSES
– Legal framework about restoration of burned forest areas based on existing law – Existence of law regulation for post fire management – Ecosystem regeneration (especially in the plantation) – Forest fire records (report sheet) in eight days after fire event – Existence of the human and technical capacities	– Unclear private forest ownership (no marked borders of each parcel) – Slow resolution of criminal or misdemeanour proceedings – Absence of a unified methodology for collecting data on fire events (post-fire analysis) – Infrastructure damage slows down recovery period for the community and ecosystem in general – Unsatisfied use of MKFFIS platform by the stakeholders (no data entry for some forest fire events) – Human displacement temporary or long term – Luck of LFM scientific research

Landscape fire management encompasses three key phases: prevention, suppression, and post-fire management, each with distinct strengths, weaknesses, opportunities, and threats. Prevention's strengths lie in proactive risk reduction and education while its weaknesses include limited control over natural ignition sources, climate change etc. Suppression excels at protecting lives and property but faces challenges like resource limitations and environmental concerns. Post-fire management focuses on ecological recovery, though invasive species and resource constraints can hinder efforts. Opportunities across all phases include innovation, community collaboration, and research, while threats encompass climate change, political decisions, and public resistance. A holistic, adaptive approach is vital in tackling the complexities of landscape fire management.

IX. LANDSCAPE FIRE MANAGEMENT GUIDELINES

Effective landscape fire management is paramount in protecting communities, ecosystems, and resources from the devastating impacts of landscape fires. In the years marked by increasingly severe and frequent fire events, the development and implementation of comprehensive Landscape Fire Management Guidelines have become essential. These guidelines serve as a crucial framework for fire prevention, preparedness, response, and recovery efforts, enabling stakeholders involved through their participatory approach in the preparation to collaboratively mitigate the risks associated with landscape fires and ensure the sustainable management of natural environments.

This chapter will delve into the key guidelines that underpin effective landscape fire management, providing valuable pathways for improvement of the existing LFM for land managers, emergency responders, policymakers, and the local community.

The guidelines are split into seven (7) main topics such as:

- (1) Strengthening the fire management governance model
- (2) Management and validation of the rural areas
- (3) Training and qualifications
- (4) Landscape fire risk assessment
- (5) Landscape fire data management
- (6) Landscape management
- (7) Public communication and awareness

1. STRENGTHENING THE FIRE MANAGEMENT GOVERNANCE MODEL

1.1. IMPROVEMENT IN INTER-INSTITUTIONAL COMMUNICATION AND COOPERATION

Enhancing communication and collaboration among relevant institutions is paramount for effective landscape fire management. Strengthening channels of communication and fostering a culture of cooperation will facilitate the timely sharing of information, resources, and expertise. This will enable a more coordinated and efficient response to fire incidents, ultimately reducing the impact of fires on landscapes and communities. Furthermore, effective landscape fire management requires inter-institutional communication and cooperation across all phases: prevention, preparedness, suppression and post-fire management. Clearly define roles and responsibilities, establishing integrated communication systems with shared databases for consistent information dissemination. In the post-fire management, it's crucial to ensure coordinated recovery efforts. Conduct joint damage assessments, share recovery resources, and implement restoration projects to rehabilitate affected areas. Continuous collaboration and communication across all phases are essential for mitigating fire impacts and ensuring effective management.

1.2. INVOLVEMENT OF LOCAL AUTHORITIES AND COMMUNITIES IN THE LF

Engaging local authorities and communities is essential for ensuring the success and sustainability of landscape fire management fostering ownership, trust and cooperation. By involving them in decision-making processes, training programs, and awareness campaigns, empower the local community and authorities to take ownership of fire prevention and mitigation efforts in their areas. This grassroots involvement fosters a sense of responsibility and cooperation, leading to more resilient communities and landscapes.

1.3. SCIENCE – POLICY – PRACTICE INTERFACE

Incorporating expertise from diverse fields through transdisciplinary approaches enriches decision-making processes and enhances the scientific basis of landscape fire management strategies. By interfacing experts, scientists, researchers, practitioners, stakeholders, local communities and societies in the governance model and decision-making process, the stakeholders can utilize cutting-edge knowledge, methodologies, and technologies to implement evidence-based policies and realistic practices that address many of the complex landscape fire management challenges.

1.4. SKILLED FORESTRY PROFESSIONALS – A DRIVING FORCE FOR LFM

Investing in the education and training of professionals within the forestry sector is vital for building a skilled workforce capable of implementing effective landscape fire management policies and strategies. By equipping individuals with the necessary knowledge, skills, and resources, empower them to become the bearers of future sustainable forest management practices and proactive landscape fire measures.

1.5. WELL DEFINED INTERINSTITUTIONAL RESPONSIBILITIES AND AUTHORITIES

Addressing the issue of overlapping responsibilities among institutions is crucial for streamlining operations and avoiding inefficiencies in landscape fire management. With a systemic solution, clear delineations of roles and responsibilities can be achieved, along with efficient mechanisms for coordination and collaboration. This approach minimizes duplication of efforts and ensures that resources are utilized effectively to address fire risks and emergencies.

1.6. ENGAGEMENT OF THE PRIVATE FOREST AND LAND OWNERS IN THE LFM

Engaging private forest owners, farmers and landowners in the landscape fire management system is essential for comprehensive landscape fire prevention and mitigation efforts. Collaborative partnerships with these stakeholders can facilitate the implementation of land management practices that reduce fire risks, such as fuel reduction, and firebreak implementation and maintenance. Involving them in the decision-making processes and providing support and incentives, can promote responsible land stewardship and enhance the resilience of rural landscapes.

1.7. NATIONAL LFM PLAN

Building and adopting a national plan for landscape fire management provides a strategic framework that is legally obligated to enforce the prioritization of fire prevention. It also takes into account and coordinates efforts in preparedness, response, and recovery. By establishing clearly defined objectives, priorities, and action plan, stakeholders can align resources and initiatives to effectively address landscape fire risks and enhance landscape resilience nationwide.

1.8. WELL-BALANCED INSTITUTIONAL BUDGET FOR LFM

Sufficient financial support for LFM to relevant institutions involved in landscape fire management is essential for ensuring the implementation and taking actions of effective fire prevention, preparedness, and response measures as well as post-fire management. A well-balanced budget across all institutions/stakeholders involved in the LFM, provides stability and predictability, enabling agencies to plan and execute activities efficiently and respond promptly to emerging fire threats. By prioritizing investments in fire management capabilities, and enhancing capacities to protect landscapes, communities, and biodiversity from the impacts of landscape fires.

1.9. INTRODUCTION OF LFM PRINCIPLES IN EXISTING LEGAL LEGISLATION

Incorporating landscape fire management principles into existing legal legislation is essential for creating a cohesive and effective landscape fire management environment. This integration ensures that fire prevention, preparedness, response, and recovery measures are legally mandated and standardized. Legal frameworks should encompass guidelines for land use, resource allocation, community engagement, and inter-sectoral coordination and coordination. By embedding these principles into legislation, the government can enhance accountability, ensure consistent application of best practices, and improve overall landscape fire resilience.

1.10. A SYSTEMATIC APPROACH FOR THE MANAGEMENT OF ABANDONED LAND AND LAND WITH UNSETTLED OWNERSHIP

Developing a systemic solution and approach for managing abandoned land and land with undefined ownership is critical for addressing fire risk and promoting landscape resilience. This may involve establishing legal frameworks, mechanisms, and incentives to facilitate land tenure regularization, property registration, and dispute resolution processes. By clarifying land ownership and management rights, decision-makers can better proceed with land-use planning, facilitate responsible stewardship, and reduce the vulnerability of landscapes to fires caused by unregulated land management practices.

1.11. SCIENCE IN LFM

Investing in science in landscape fire management is essential for developing evidence-based strategies to mitigate fire risks and understanding the complex dynamics of landscape fires by studying integrated disciplines such as fuel dynamics, fire behaviour modelling, ecology, climatology, remote sensing, and the effectiveness of management techniques. Through empirical studies, field experiments, and advanced simulations, researchers aim to enhance predictive capabilities, define best land management practices, and minimize the ecological, economic, and social impacts of the fires. Guided by interdisciplinary collaboration and evidence-based approaches, this research fosters resilience in fire-prone landscapes, informing policymakers, land managers, and communities to make informed decisions and adapt to changing fire regimes.

2. ACTIVELY MANAGING AND VALUING RURAL AREAS

2.1. INTRODUCTION OF THE LFM PRINCIPLES IN THE RURAL DEVELOPMENT

Introducing the principles of the landscape fire management with rural development initiatives offers an opportunity to promote sustainable practices that support economic growth while minimizing the environmental impact of landscape fires. By fostering synergies between landscape fire management and rural development, aim to create resilient communities and landscapes that thrive in a changing climate.

2.2. FINANCIAL SUPPORT IN THE RURAL DEVELOPMENT PROGRAMMES FOR LFM

Securing dedicated funds for landscape fire management within a rural development program (RDP) is essential for LFM activities. By earmarking resources specifically for landscape fire management, can be ensured that adequate funding is available to support critical LFM initiatives. By providing targeted subsidies and resources by the RDPs, local organizations, such as community groups, NGOs, and cooperatives aim to develop the skills, infrastructure, and networks needed to effectively prevent, monitor, and respond to landscape fires. This proactive investment in landscape fire management not only enhances landscape resilience and rural development but also protects rural communities and livelihoods from landscape fires.

2.3. BUILDING OF RURAL DEVELOPMENT ENTITIES CAPABLE TO CONDUCT LFM PRINCIPLES

Building the capacity of entities or other forms of bodies, responsible for rural landscape fire management is essential for fostering an integrated and coordinated LFM approach. This includes investing in training, equipment, technology, and personnel to improve the effectiveness and efficiency of landscape fire management operations. By fostering collaboration and information sharing among entities, optimize resource allocation, enhance situational awareness, and ensure a timely and coordinated response to landscape fire incidents across rural landscapes.

3. TRAINING AND QUALIFICATION

3.1. QUALIFIED PROFESSIONALS/STAFF TASKED TO ADDRESS FLM PRINCIPLES

Implementing strategic workforce planning initiatives is crucial to ensure that the governance structure and LFM system have a continuous supply of qualified professionals. This involves identifying current and future staffing needs, recruiting, and retaining skilled professionals, providing ongoing training and professional development opportunities, and succession planning to fill leadership roles. By investing in human capital at all levels, build a sustainable and resilient LFM system capable of effectively addressing fire risks over the short, medium, and long term.

3.2. TAILOR-MADE TRAINING PROGRAMMES

Designing and implementing a comprehensive tailor-made program is essential for equipping personnel with the knowledge, skills, and competencies needed to effectively manage landscape fires in all phases from planning, prevention, preparedness suppression, and post-fire management. These programs should cover various topics, including fire behaviour, safety procedures, equipment operation, communication protocols, incident management, and environmental stewardship. Furthermore, strengthening the criteria within the process of certification and qualification standards for different positions in the LFM is essential for ensuring the personnel possess, competencies, credentials, and roles in the LFM. By providing hands-on training, simulations, and practical exercises, aim to ensure that personnel are well-prepared to respond to diverse landscape fire scenarios and mitigate risks to life, property, and the environment.

4. FIRE RISK ASSESSMENTS

4.1. ASSESSMENT OF LF RISK PERCEPTION OF DIFFERENT SOCIO-ECONOMIC GROUPS

Understanding the diverse perspectives and LF risk perceptions of various socio-economic groups is essential for developing targeted and effective landscape fire mitigation strategies. Conducting comprehensive LF risk perception assessments involve engaging with communities to identify their unique vulnerabilities, concerns, and priorities related to landscape fire management. By incorporating these insights into decision-making processes, aim to tailor interventions, communication strategies, and outreach efforts to better meet the needs and expectations of different demographic groups, ultimately enhancing community resilience.

4.2. LANDSCAPE FIRE RISK ASSESSMENT

Building a robust fire risk assessment methodology is critical for accurately identifying and prioritizing areas of high landscape fire vulnerability. This involves defining clear criteria, indicators, and thresholds for assessing factors such as fuel load, weather conditions, topography, and human activities that contribute to fire risk. Creating comprehensive landscape fire risk maps at both regional and national levels enabling informed decision-making and strategic planning in all phases of landscape fire management. Adopting a coherent and standardized approach to fire risk assessment and mapping can greatly improve the effectiveness of landscape fire management measures, including resource allocation, rural development, National spatial planning, and landscape fire prevention and mitigation efforts.

4.3. NATIONAL FUEL CLASSIFICATION AND FUEL MAP

Developing an official fuel classification scheme categorizes different types of vegetation and biomass according to their flammability and contribution to fire behaviour. This standardized country classification scheme specified for vegetation types in North Macedonia will help fire managers to assess fuel conditions, predict fire behaviour, and prioritize fuel management efforts for maximum effectiveness. Based on the National fuel classification scheme, creating a country fuel map will provide valuable spatial information on fuel types, distribution, and abundance, enabling better planning and decision-making in landscape fire management. By mapping fuel characteristics at a national scale, stakeholders can identify high-risk areas, target fuel management interventions, and allocate resources more efficiently to mitigate fire hazards and protect vulnerable landscapes and communities. Finally, a national fuel classification and fuel map should serve as essential information used for fire behaviour prediction and provide vital information for proper landscape fire management.

5. LANDSCAPE FIRE DATA MANAGEMENT

5.1. LANDSCAPE FIRE MANAGEMENT STATISTIC

Building a unified and standardized data collection method ensures consistency and accuracy in gathering information related to landscape fire management. By establishing common protocols and procedures, stakeholders can streamline data collection processes and improve the quality and reliability of landscape fire data for analysis and decision-making. Furthermore, facilitating access to landscape fire data for all stakeholders involved in landscape fire management enhances collaboration and informed decision-making. By implementing mechanisms for data sharing and transparency, stakeholders can access timely and relevant information to support their respective roles in fire prevention, preparedness, response, and post-fire efforts. As a baseline platform to be used as MKFFIS, which enables forest fire incident reporting and maintaining a comprehensive forest fire register, where

stakeholders monitor fire trends, assess impacts, and identify areas for targeted intervention. Frequent updating and upgrade of the MKFFIS (legally and technically) will ensure that fire records remain accurate and up to date, providing valuable insights for landscape fire management planning and decision-making.

6. LANDSCAPE MANAGEMENT

6.1. APPLICATION OF STATE OF THE ART TECHNOLOGIES

Leveraging new technologies, including digitalization and best practices, enhances the effectiveness and efficiency of landscape management efforts. By integrating innovative tools such as remote sensing, geographic information systems (GIS), and predictive modelling, stakeholders can improve landscape management, fire detection, monitoring, response capabilities, and post-fire management leading to more proactive and targeted interventions to mitigate landscape risks.

6.2. INTRODUCTION OF PROPER FUEL MANAGEMENT PRACTICES

Implementing effective fuel management practices is crucial for reducing the risk and severity of landscape fires and is essential for maintaining fire-resilient landscapes. These practices involve a variety of techniques aimed at reducing the quantity and connectivity of combustible materials, such as dry vegetation and underbrush, and primary construction of fuel breaks. Regular maintenance of these fuelbreaks ensures their effectiveness in containing landscape fires and protecting communities and ecosystems. Further, fuel management includes measures such as controlled burns, vegetation clearing, and fuel reduction programs to mitigate the buildup of combustible materials and create fire-resilient landscapes. Effective fuel management not only reduces fire risk but also promotes healthier ecosystems by restoring natural fire regimes, enhancing biodiversity, and improving habitat quality. These practices are a critical component of a comprehensive fire management strategy, ensuring long-term sustainability.

7. PUBLIC COMMUNICATION AND AWARENESS

7.1. PUBLIC COMMUNICATION AND PUBLIC ENGAGING TOOLS

Identifying the most effective communication and engagement tools tailored to specific and different target groups enhances the reach and impact of fire management initiatives. By understanding the preferences and characteristics of various audiences, stakeholders can deploy targeted messaging through channels such as engagement of social media sometimes as a leading role, community meetings, and educational workshops to effectively convey fire prevention and preparedness information. Once the communication tools are prepared, there is a need of developed tools for measures of the performances of the communication process which allows the stakeholders to assess the effectiveness and reach of their messaging efforts. By collecting data on audience engagement, message retention, and behaviour change, stakeholders can evaluate the impact of communication strategies and identify areas for improvement to optimize future outreach campaigns and initiatives.

7.2. LANDSCAPE FIRE MANAGEMENT AND EDUCATION

Implementing targeted media campaigns and integrating fire management education into school curricula from an early age instils lifelong awareness and responsibility for fire prevention. By reaching young people through age-appropriate messaging and educational programs, stakeholders can foster a culture of fire safety and prevention, empowering future generations to mitigate fire risks and protect communities and ecosystems. Establishing an organized system of education for fire prevention at various levels of organization ensures comprehensive and consistent outreach efforts. By providing training and resources for fire prevention practices, all different target groups can equip individuals and communities with the knowledge and skills needed to mitigate fire risks and respond effectively to fire emergencies.

7.3. LFM PUBLIC AWARENESS

Public awareness of landscape fire management is essential for educating communities about fire risks, promoting prevention measures, facilitating early detection and reporting, empowering preparedness, fostering community resilience, addressing misconceptions, and advocating for sustainable land management practices. Through targeted educational campaigns and community engagement efforts, public awareness initiatives empower individuals to become active participants in fire prevention and mitigation, ultimately contributing to safer, more resilient landscapes. By raising awareness and promoting proactive engagement, these initiatives help build resilient communities capable of effectively responding to landscape fires while minimizing their impact.

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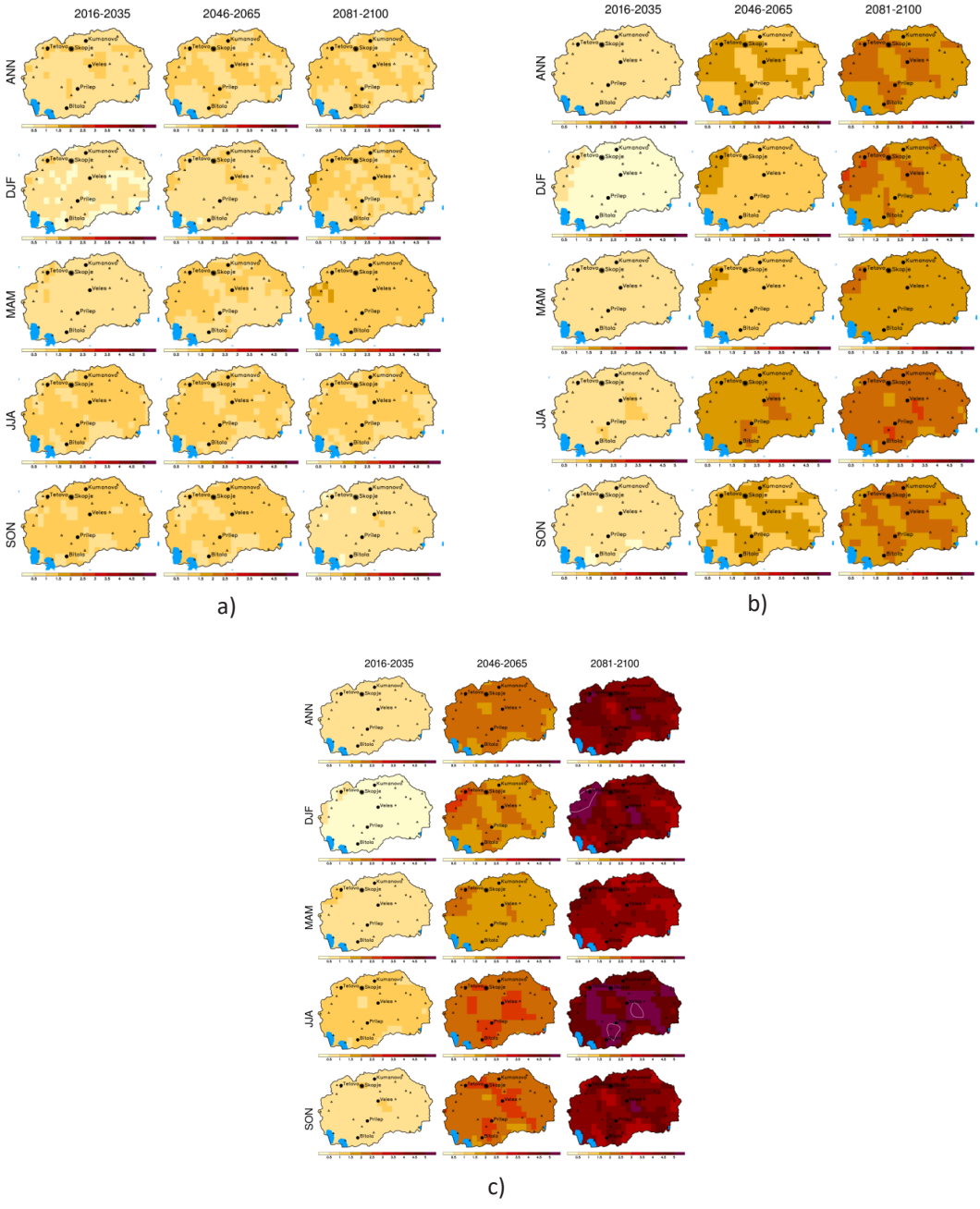
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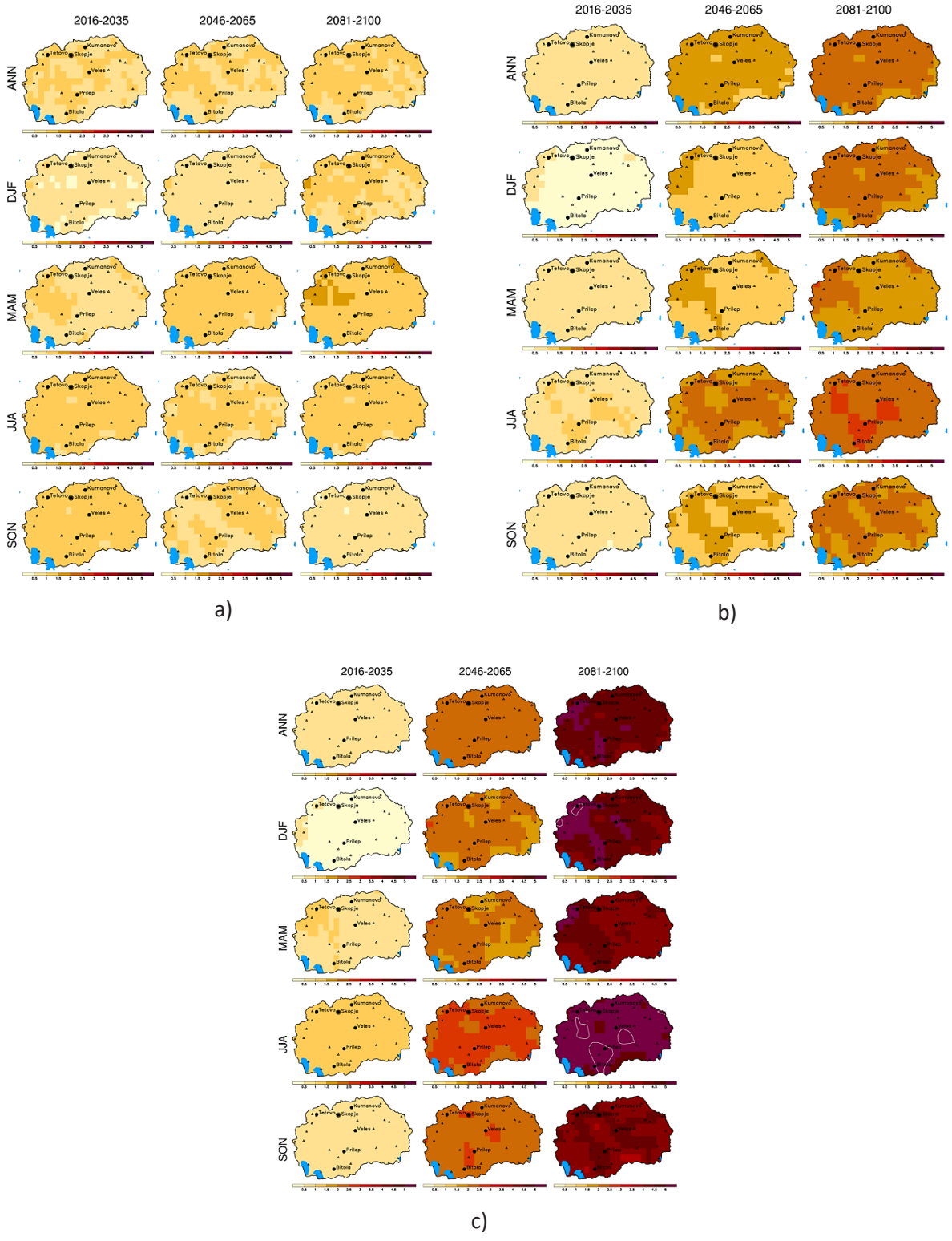
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ANNEXES

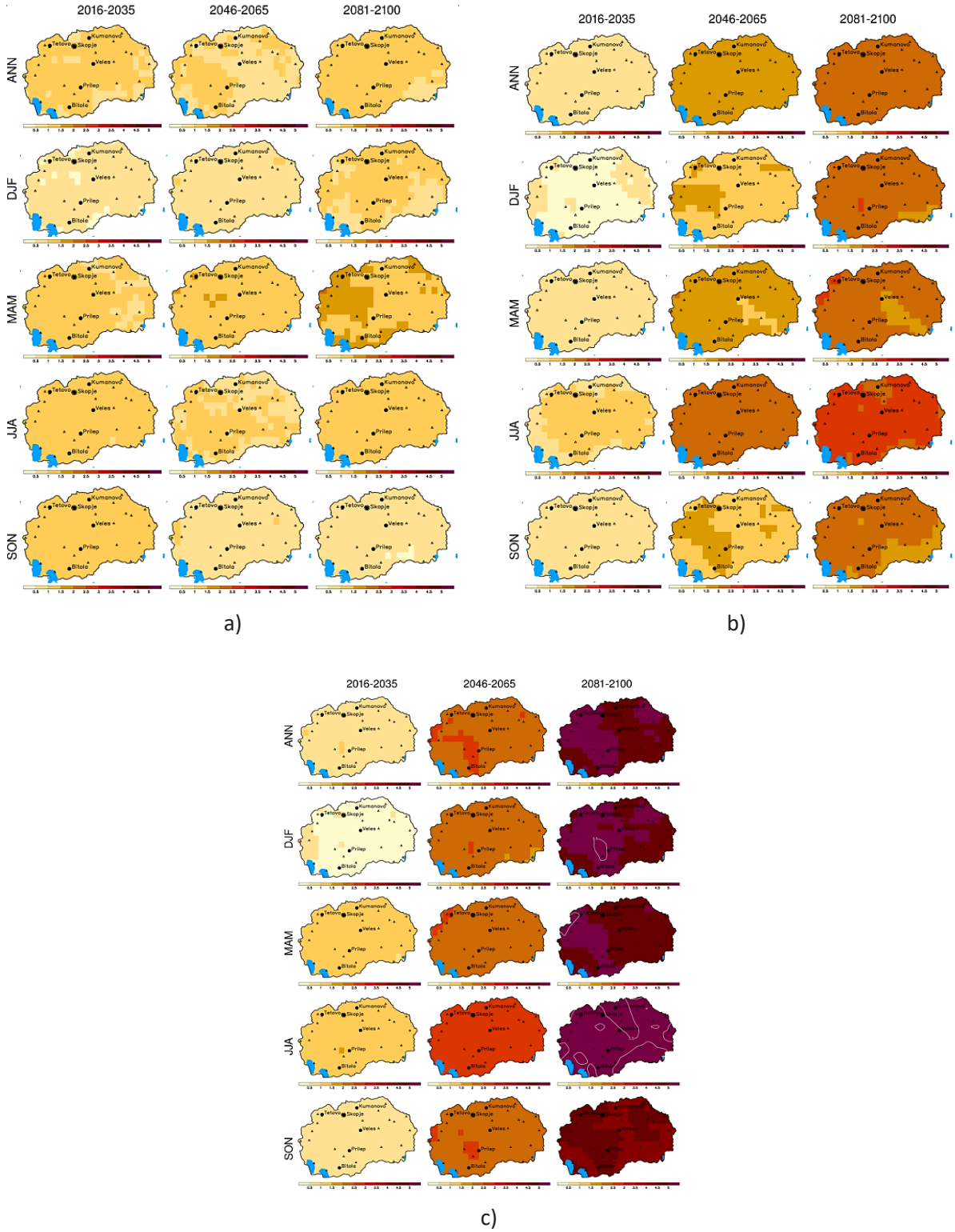
ANNEX A



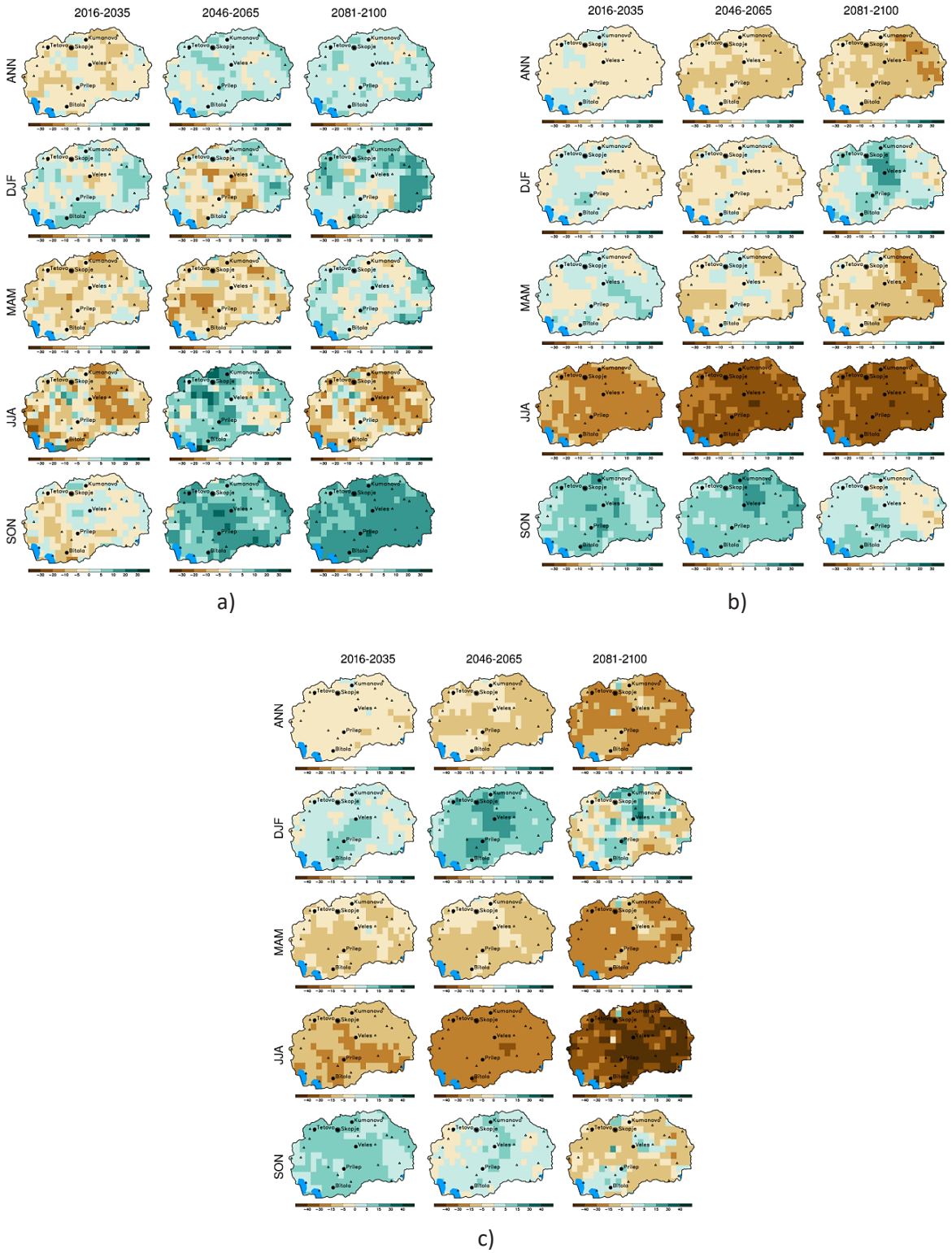
Map A1: *Future **daily minimum temperature** change, for three future periods, 2016-2035, 2046-2065 and 2081-2100 with respect to the period 1986-2005, on annual level and for winter (DJF), spring (MAM), summer (JJA) and autumn (SON), for the RCP2.6 scenario (a) and RCP4.5 scenario (b) and 8.5 scenario (c).*



Map A2: *Future **daily mean temperature** change, for three future periods, 2016-2035, 2046-2065 and 2081-2100 with respect to the period 1986-2005, on annual level and for winter (DJF), spring (MAM), summer (JJA) and autumn (SON), for the RCP2.6 scenario (a) and RCP4.5 scenario (b) and 8.5 scenario (c).*



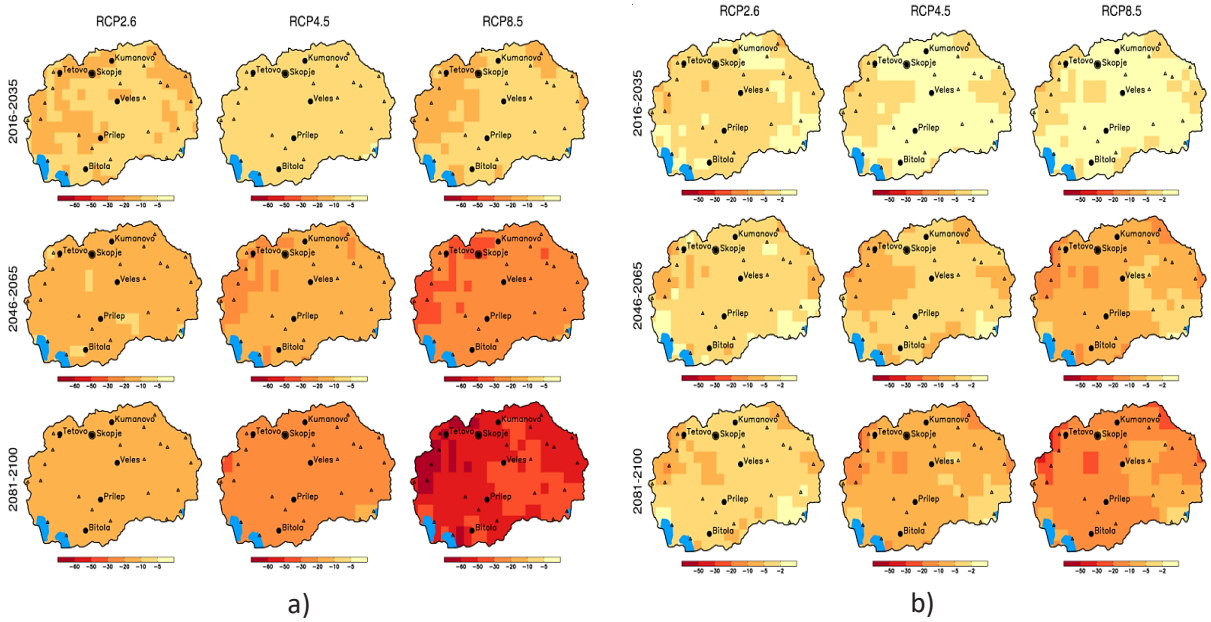
Map A3: *Future **maximum daily temperature** change, for three future periods, 2016-2035, 2046-2065 and 2081-2100 with respect to the period 1986-2005, on annual level and for winter (DJF), spring (MAM), summer (JJA) and autumn (SON), for the RCP2.6 scenario (a) and RCP4.5 scenario (b) and 8.5 scenario (c).*



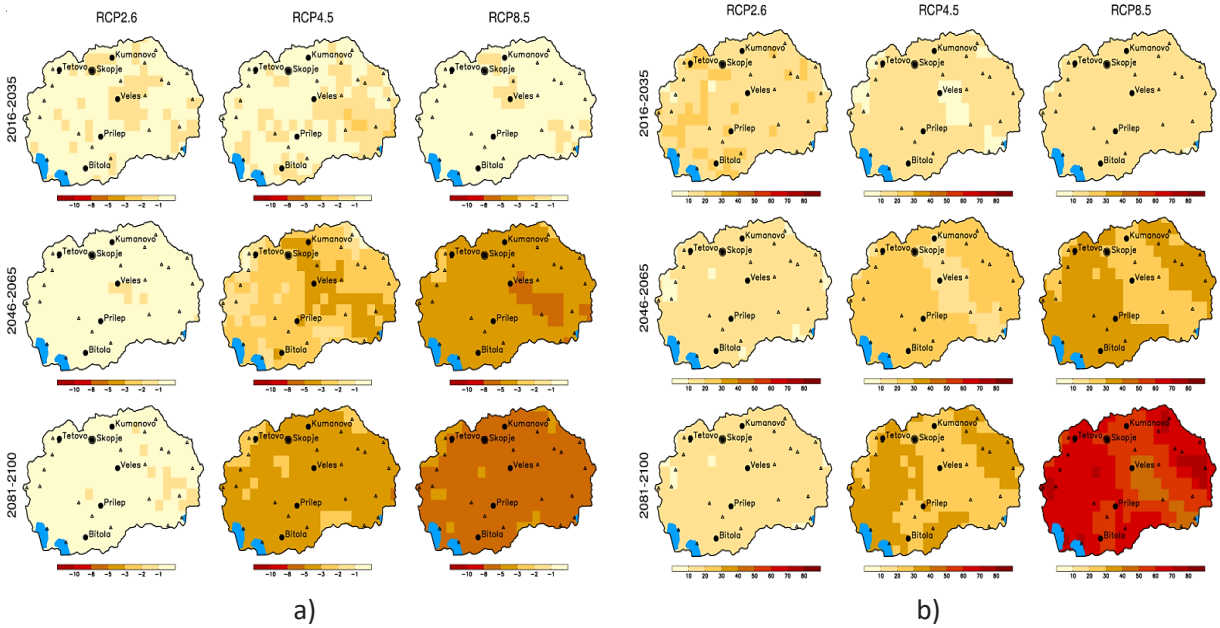
Map A4: *Future **precipitation** change, for three future periods, 2016-2035, 2046-2065 and 2081-2100 with respect to the period 1986-2005, on annual level and for winter (DJF), spring (MAM), summer (JJA) and autumn (SON), for the RCP2.6 scenario (a) and RCP4.5 scenario (b) and 8.5 scenario (c).*

ANNEX B

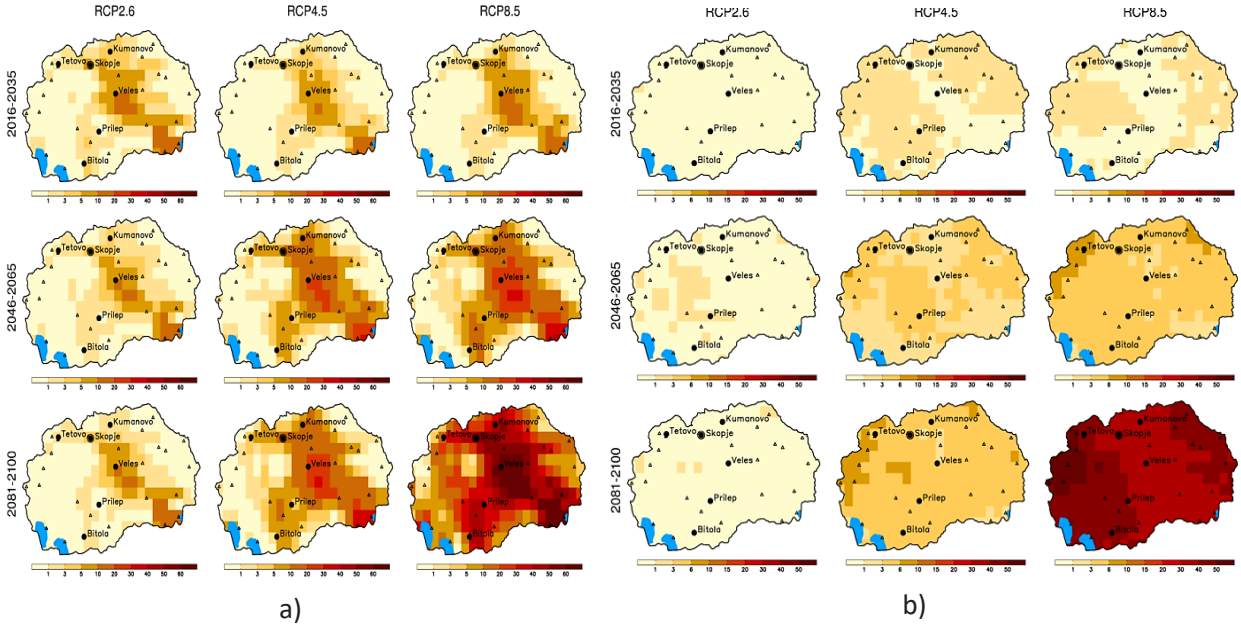
CLIMATE INDICES CHANGE



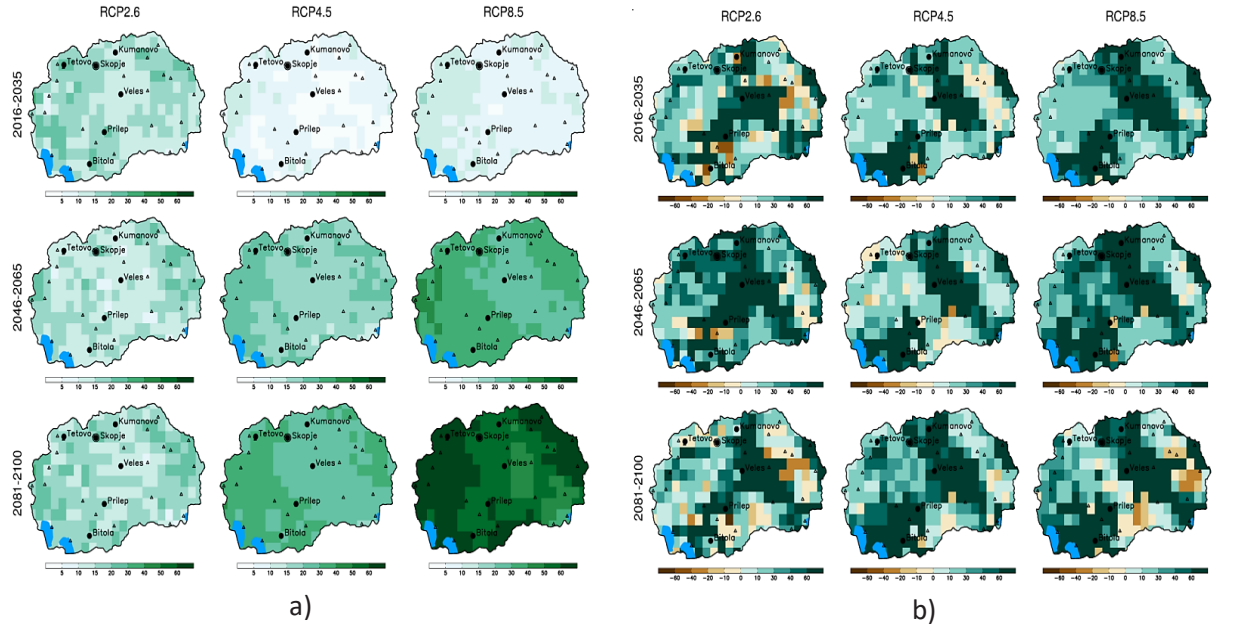
Map B1: ***FROST AND ICE DAYS****: Future annual change in frost days (a), and annual change in ice days (b) for three future periods, 2016-2035, 2046-2065 and 2081- 2100 with respect to the period 1986-2005 for the RCP2.6, RCP4.5 and RCP8.5 scenarios.*



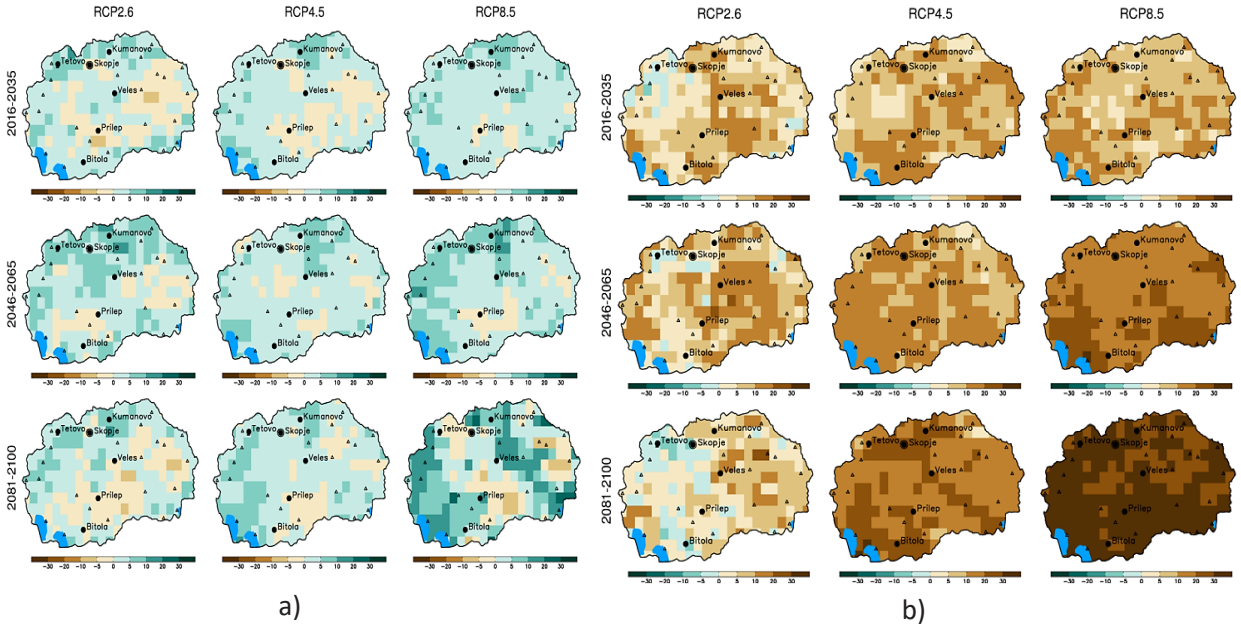
Map B2: ***COLD WAVES AND SUMMER DAYS****: Future annual change in cold waves (a), and annual change in summer days (b) for three future periods, 2016-2035, 2046-2065 and 2081- 2100 with respect to the period 1986-2005 for the RCP2.6, RCP4.5 and RCP8.5 scenarios.*



Map B3: ***TROPICAL NIGHTS AND EXTREME HEAT WAVES****: Future annual change in tropical nights (a), and annual change in extreme heat waves WSDI – number of events in 20 years period(b) for three future periods, 2016-2035, 2046-2065 and 2081- 2100 with respect to the period 1986-2005 for the RCP2.6, RCP4.5 and RCP8.5 scenarios.*



Map B4: ***GROWING SEASON LENGHT AND NUMBER OF DAYS WITH EXTREME PRECIPITATION****: Future annual change in tropical nights (a), and annual change in extreme heat waves WSDI – number of events in 20 years period(b) for three future periods, 2016-2035, 2046-2065 and 2081- 2100 with respect to the period 1986-2005 for the RCP2.6, RCP4.5 and RCP8.5 scenarios.*



Map B5: ***DAILY MAXIMUM PRECIPITATION AND CONSECUTIVE DRAY DAYS****: Future annual change in annual daily extreme precipitation change (a), and future annual change in consecutive dry days (b) for three future periods, 2016-2035, 2046-2065 and 2081- 2100 with respect to the period 1986-2005 for the RCP2.6, RCP4.5 and RCP8.5 scenarios.*