CROATIA

Management of Wildfire Risk

TAFF Technical Assistance Financing Facility for Disaster Prevention and Preparedness

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Disclaimer

ACRONYMS

AAL	Average Annual Loss
BBB	Build Back Better
DG ECHO	Directorate-General for European Civil Protection and Humanitarian Aid Operations
DHMZ	Croatian Meteorological and Hydrological Service
DLD	Disaster Loss Data
DRM	Disaster Risk Management
DRMC	Disaster Risk Management Cycle
DRR	Disaster Risk Reduction
EC	European Commission
ECS	Electronic Communication Services
EECC	European Electronic Communications Code
EU	European Union
EUSF	European Union Solidarity Fund
EWS	Early Warning System
FRMP	Flood Risk Management Plan
FWI	Fire Weather Index
GDP	Gross Domestic Product
GFDRR	Global Facility for Disaster Reduction and Recovery
GIS	Geographic Information System
HVZ	Croatian Firefighting Association (Hrvatska Vatrogasna Zajednica)
ICT	Information and Communication Technology
IPCC	Intergovernmental Panel on Climate Change
IWFRM	Integrated Wildfire Risk Management
MoA	Ministry of Agriculture
MoI	Ministry of the Interior
MSR	Monthly Severity Rating
NAS	National Adaptation Strategy
NDRMS	National Disaster Risk Management Strategy
NDRRS	National Disaster Risk Reduction Strategy
NGO	Nongovernmental Organization
NRA	National Risk Assessment
NRRP	National Recovery and Resilience Plan
NSDS	National Sustainable Development Strategy
OTT	Over-the-Top
PPE	Personal Protective Equipment
PRAF	Peer Review Assessment Framework
SDGs	Sustainable Development Goals
SFDRR	Sendai Framework for Disaster Risk Reduction
SOP	Standard Operating Procedure
SRUUK	Early Warning and Crisis Management System
SSR	Seasonal Severity Rating
UCPM	Union Civil Protection Mechanism
UNDRR	United Nations Office for Disaster Risk Reduction
UNICEF	United Nations Children's Fund
WUI	Wildland-Urban Interface

KEY TERMS

Wildfire:[1] Any unplanned or uncontrolled fire affecting natural, cultural, industrial, and residential landscapes (UNDRR adapted from FAO). An unusual or extraordinary free-burning vegetation fire that poses significant risk to social, economic, or environmental values. It may be started maliciously, accidentally, or through natural means (UNEP).[2]

Forest fire: An unwanted fire burning forests and wildlands.[3]

Bush fires: The same meaning as wildfire but is the term used in Australia, New Zealand, and Africa. It is an unplanned fire in a vegetated area (as opposed to an urban area).[4]

Other types of fires:[5]

- **Accidental fire:** Fires resulting from unintentional human actions.
- **Arson fire:** Fires set intentionally and maliciously.
- **Controlled fire:** Fires managed for specific purposes, usually with precautions.
- **Uncontrolled fire:** Fires that are not managed or controlled, typically wildfires.
- **Natural fire:** Fires caused by natural events, such as lightning.
- **Prescribed fire/mild fire:** Intentionally set and controlled fires for European Commission: Directorate-General for Environment, management.

Integrated wildfire risk management (IWFRM): This approach relies on coordinated use of resources, integrated policy frameworks, collaboration among stakeholders, society-wide engagement, and capacity development. This approach is rising in prominence given climate change impacts and the demand to address the wildfire challenge in an integrated and holistic manner.

Wildfire risk: Assessed by considering vulnerable areas where people, ecological, and socioeconomic values are exposed to fire danger.[6]

Exposure: The situation of people, infrastructure, housing, production capacities, and other tangible human assets located in hazard-prone areas.

Vulnerability: The conditions determined by physical, social, economic, and environmental factors or processes which increase the susceptibility of an individual, a community, assets, or systems to the impacts of hazards.

Wildlands/wilderness areas: Areas governed by natural processes. They are composed of native habitats and species and are large enough for the effective ecological functioning of natural processes. They are unmodified or only slightly modified and without intrusive or extractive human activity, settlements, infrastructure, or visual disturbance.[7]

Wildland-urban interface (WUI): Areas where human development meets or intermingles with wildland vegetation. These areas often face heightened wildfire risk.[8]

Firebreak:[9] Man-made areas with a reduced fuel load that act as barriers to stop or slow down fire spread.

Early warning system (EWS): An integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication, and preparedness activities that enables individuals, communities, governments, businesses, and others to take timely action to reduce disaster risks in advance of hazardous events. *Annotation: Multi-hazard EWSs address several hazards and/or impacts of similar or different types in contexts where hazardous events may occur alone, simultaneously, cascadingly, or cumulatively over time, taking into account the potential interrelated effects.*

Nature-based solutions:[10] Solutions "inspired by, supported by, or copied from nature" and "simultaneously provide environmental, social, and economic benefits and helps to build resilience" by bringing "more and more diverse nature and natural features and processes into cities, landscapes, and seascapes" (EC).

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[1] Definition as per Casartelli, V., and J. Mysiak. 2023. Link.
[2] Ibid.
[3] Tedim, F., G. Xanthopoulos, and V. Leone. 2015.
[4] Price, O. 2019. Link.
[5] Huidobro, G., L. Giessen, and S. L. Burns. 2024.
[6] Oom, D. et al. 2022.
[7] Wild Europe. 2013. Link.
[8] Silva, J. S., ed. 2010.
[9] Casartelli and Mysiak 2023.
[10] Ibid.

Building code: A set of ordinances or regulations and associated standards intended to regulate aspects of the design, construction, materials, alteration, and occupancy of structures which are necessary to ensure human safety and welfare, including resistance to collapse and damage.

Coping capacity: The ability of people, organizations, and systems, using available skills and resources, to manage adverse conditions, risks, or disasters.[11]

Resilience: The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including ensuring the preservation, restoration, or improvement of its essential basic structures and functions.[12]

'Build back better' (BBB) principle:[13] The use of the recovery, rehabilitation, and reconstruction phases after a disaster to increase the resilience of nations and communities by integrating disaster risk reduction measures into the restoration of physical infrastructure and societal systems and into the revitalization of livelihoods, economies, and the environment. *Annotation: The term 'societal' is not to be interpreted as a political system of any country.*

Damage: Total or partial destruction of physical assets existing in the affected area. Damage occurs during and after disasters and is measured in physical units (that is, square meters of housing, kilometers of roads, and so on).[14]

Losses: refer to indirectly quantifiable losses (declines in output or revenue, impact on wellbeing, disruptions to flow of goods and services in an economy), or additional operational costs associated with response and initial repairs.[15]

Reconstruction: The medium- and long-term rebuilding and sustainable restoration of resilient critical infrastructures, services, housing, facilities, and livelihoods required for the full functioning of a community or society affected by a disaster, aligning with the principles of sustainable development and 'BBB', to avoid or reduce future disaster risk.

Rehabilitation: The restoration of basic services and facilities for the functioning of a community or society affected by a disaster.

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[11] Ibid.
[12] World Bank. 2021. Link.
[13] Definition as per the NSDRR 2024–2035. Link.
[14] World Bank. 2021.
[15] Global Facility for Disaster Reduction and Recovery (GFDRR), website. Link.

EXECUTIVE SUMMARY

Wildfire risk is increasing in Croatia. Between 2010 and 2021, the cost of damage due to wildfires across the country totaled over €249 million;[16] the 2017 fire season burned 67,666 ha of land and caused an estimated €109 million in losses;[17] and the 2022 season recorded 149 fires. Even within the span of one year, in 2024, 21 percent more open-air fires were recorded compared to 2023 for the same period.[18] In fact, Croatia experienced over a thousand additional wildfires in 2024 compared to the previous year. This increase highlights both the rising frequency and severity of wildfires, with 29 precent more vegetation fires and a burned area of 26,807 ha, over four times larger than the previous year. The 2024 Croatian National Risk Assessment (NRA) reports that Split-Dalmatia County—a popular tourist destination—faces very high wildfire risk, while the counties of Istria, Šibenik-Knin, Zadar, and Dubrovnik-Neretva all face a high risk.[19] The sectors most affected by wildfire include forestry, tourism, infrastructure, and public services. Across the country, an average of 73 percent of critical assets—including 94 percent of power lines and 97 percent of road segments—are located in areas with high or very high wildfire hazard.[20] In the context of the country's Mediterranean climate, changing agricultural land use, and tourism, wildfire risk is intensifying, particularly in coastal areas, hinterlands, and islands and particularly during the spring and summer months. It is expected that wildfire risks and impacts will compound with heat and other extreme meteorological conditions arising from changes, leading to increased socioeconomic and environmental impacts.

This report summarizes the results of a rapid review of wildfire risk and management capacity in Croatia, and it highlights potential risk management priorities to inform policy dialogue and future research. The review considers capacity across multiple dimensions, including governance, understanding of earthquake risk, risk reduction and mitigation, early warning and public awareness, preparedness and emergency response, recovery and post-disaster financing, and cross-cutting topics such as social resilience and the role of the private sector. For each of these dimensions, the report draws on available information to review the general context and current arrangements, including key challenges and opportunities for improvement.

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[16] GoC 2024a.

[17] Posavec, S., et al. 2023. Link.

[18] GoC 2025. Link.

[19] GoC 2024b. Link.

[20] *See* World Bank 2024b, Link, spatial exposure analysis of emergency response assets to single and multiple hazards, including wildfires.

KEY MESSAGES

The following key messages emerge from the review of wildfire risks and risk management capacity in Croatia:

1. Croatia faces a high risk of wildfire, which can have significant impacts on livelihoods, the economy, and infrastructure. Croatia is one of the European Union (EU) Member States most affected by wildfire, ranking fourth in terms of annual average burned area.[21] Counties with vulnerable communities and potentially strained firefighting capacity are at the highest risk.

2. Wildfire risks in Croatia are expected to intensify, especially in coastal areas and rural hinterlands, and lead to increased economic and intangible losses. Initial analysis in the Croatian NRA, which considers future climate scenarios, projects that wildfire risk will increase in the northeast and west along the coast of the country.[22] According to the NRA, wildfire is one of the greatest future threats to the country, and measures for reducing wildfire risk are urgently required.

3. Croatia has made efforts to establish a solid legal framework for wildfire risk management at national and subnational levels. Alongside traditional fire suppression measures, the country has increasingly prioritized and invested in wildfire prevention and reduction actions, integrating them into national laws and cross-sectoral initiatives. However, this approach could be improved by enhancing links with adaptation, strengthening financial resilience, promoting long-term resilience through awareness, and scaling up prevention and preparedness efforts.

4. Croatia has made progress in regular assessments of fire risk at multiple levels, though more work is needed to ensure harmonized data collection, interinstitutional coordination, and standardized and digitalized assessments. Efforts are being made to improve risk assessments, enhance the wildfire risk management system, and accordingly prioritize prevention and preparedness measures.

5. Croatia has recognized the importance of shifting from suppression to prevention in recent decades, but gaps remain in the implementation of wildfire prevention measures at local level. Forest protection and fire prevention measures have been implemented by public stakeholders, including the state-owned forest management company Croatian Forest Ltd. Nevertheless, there is a need for greater investment in proper landscape management, including nature-based solutions, modern farming techniques, and sustainable forest management, especially related to wildland-urban interfaces (WUIs).

6. Public support and awareness contribute to effective wildfire risk management. The overall level of preparedness can be increased by improving early warning at the sub-national level, and by educating the public (especially tourists, schoolchildren, and vulnerable populations) about fire risks, impacts, and safety measures. These steps have the potential to reduce impacts during wildfire events.

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[21] Note: as a percentage of total country area.

[22] Rapid analysis by CIMA Foundation for the World Bank (2024b) noted that the northeast of the country is characterized by large grasslands, croplands and broadleaved forests, expected to suffer higher surface fire occurrence in the future.

7. Croatia's firefighting system, which is regulated and operated by the Croatian Firefighting Association (HVZ) and includes professional and voluntary firefighters, conducts effective firefighting operations and has reduced wildfire impacts. Split is one of the areas that has seen recent investments in firefighting capacity, including a new station and a tunnel to reduce response times. However, challenges remain in several areas, including modernization of infrastructure, equitable resource distribution, local operational capacity across the entire country, and interoperability of multiple firefighting entities.

8. Croatia continuously invests in innovations to enhance wildfire preparedness and response, including technology, equipment, training, and methodologies. New technologies and digital tools, such as video surveillance, wildfire risk visualization panels, and firefighting drones, have been adopted through EU and national initiatives to support wildfire monitoring, forecasting, and firefighting operations. These could be further utilized after they are adjusted to the Croatian context and systems.

9. The lack of comprehensive post-fire recovery plans and financing schemes hinders recovery and reconstruction after a wildfire event. Penetration rates for household and agriculture insurance are low, while public compensation for disaster damage is limited to less than 5 percent. Nevertheless, a few actions have been undertaken to support wildfire recovery and resilience under national laws and strategic plans; these focus on forest restoration, infrastructure resilience, and disaster relief support.

10. The private sector and socially vulnerable groups have a role to play in managing wildfire risks. Wildfires disproportionately affect socially vulnerable households and cause more catastrophic losses in areas with more vulnerable communities and more limited firefighting capacity. While public authorities are investing in risk reduction, private stakeholders are implementing prevention measures in key vulnerable sectors (such as forestry, tourism, and transportation) and are also developing innovative technological solutions.

PRIORITIES GOING FORWARD

Croatia should prioritize investments across several aspects of wildfire risk management, as outlined in the recommendations below:

1. **Continue to improve the fire protection system and legal framework by addressing disparities in local-level capacities, improving coordination between stakeholders, and ensuring transparent funding allocation based on fire risks and coping needs.** Reflect climate projections and the increasing wildfire risk in national wildfire protection laws and local and sectoral planning.

2. **Continue to improve understanding of wildfire risk by creating consistent, standardized methodologies for fire assessments that allow quantitative analysis of wildfire impacts and fully comparable results across counties.** Enhance wildfire data management by establishing an online national database on wildfire risks, trends, and impacts, and ensure seamless data sharing among stakeholders at multiple levels.

3. **Scale up and systematize efforts to mainstream wildfire prevention in land use planning** by enhancing climate-smart forestry practices, promoting sustainable land management, and integrating wildfire prevention measures into spatial and rural planning frameworks, especially in WUIs and counties with high fire risks.

4. **Scale up low-regret and win-win wildfire prevention measures with environmental and climate co-benefits.** Promote forward-looking risk reduction measures, adaptation strategies, and more efficient and sustainable land use. Apply a common methodology and clear criteria for selecting and prioritizing measures, such as cost-benefit analyses, multicriteria analyses, and cost-efficiency, and establish a monitoring and evaluation system to ensure full and effective implementation.

5. **Improve the early warning system at the local level and promote education and information campaigns** to enhance preparedness for wildfires and increase public awareness of wildfire risks, impacts, and safety measures. Tailor messages for different target groups such as vulnerable people, tourists, migrants, and so on.

6. **Invest in innovative solutions and tools for wildfire prevention, detection, and suppression.** For example, increase the use of unmanned aerial firefighting vehicles (drones) and artificial intelligence (AI)/big data–driven surveillance, and expand video monitoring networks and remote sensing capabilities. Integrate these solutions into national databases, equipment, and training to support firefighting response and post-fire recovery and to share lessons learned at local and regional levels, especially during wildfire seasons.

7. **Increase response capacities in counties with strained operational readiness through enhanced infrastructure and equipment, as well as knowledge training and exchange programs.** Leverage both traditional and modern IT tools, such as virtual reality and online learning, to attract and retain qualified professionals and volunteers.

8. **Strengthen financial resilience against wildfires** by identifying potential gaps and needs, developing a comprehensive strategy for disaster risk financing and insurance in line with a risk-layering approach, and updating/establishing new instruments as relevant.

9. **Develop wildfire recovery frameworks/plans, especially for potential hotspot areas.** Take post-disaster needs and impact assessments into account and incorporate build back better (BBB) principles, including adaptation and mitigation, sustainable forest restoration, and community resilience.

10. **Invest in measures to increase social resilience and inclusion, and engage the private sector.** Improve understanding of social vulnerabilities to ensure inclusive emergency response. Use social protection measures that can be scaled up in case of wildfires to support the population most in need. Simultaneously, continue the dialogue with private sector actors to enhance their resilience, business continuity planning, and participation in prevention and preparedness investments.

INTRODUCTION

This report is part of a series focusing on improving the understanding of the needs and priorities for disaster resilience investments in relation to two disaster risks: wildfires and earthquakes. The broader objective is to provide actionable insights and recommendations that can guide the European Union (EU) and its Member States in making informed, strategic investments to enhance resilience against wildfires and earthquakes.

This report focuses on wildfire risk management in Croatia and describes current risk trends, risk management capacity, and investment needs and recommended approaches. It is complemented by two other country-specific case studies for Cyprus and Romania as well as an EU-wide policy note on wildfire risk management overview based on existing information and data gathered across EU Member States.[23]

This report provides a rapid, high-level overview based on already existing information and data. In addition, consultations with key national and EU organizations as well as researchers have been conducted to improve understanding of the key areas listed above. The note can serve to inform policy dialogue and future research.

In the context of Croatia, it is important to clarify the definition of wildfire risk, which encompasses all types of vegetation across open and urban spaces. *Wildfires* are the most encompassing category, referring to any unplanned fire affecting natural or semi-natural areas, including forests, shrublands, grasslands, agricultural zones, and even green spaces within urban environments. *Forest fires* are a common and particularly destructive type phenomenon, typically affecting dense wooded areas in coastal and inland regions, especially during the hot, dry summer months. G*rassland fires* and *shrubland fires* often spread quickly due to wind and low moisture, posing threats to farmland, infrastructure, and nearby settlements. In some rural areas, fires may originate from agricultural practices but escalate into uncontrolled burns. Additionally, Croatia experiences *wildland-urban interface fires*, where vegetation fires threaten or penetrate built-up areas, creating high-risk scenarios for human life and property. The combined impact on natural ecosystems, farmland, and human infrastructure makes these vegetation fires a significant environmental and socioeconomic concern across Croatia.

The analysis is structured following the Union Civil Protection Mechanism (UCPM) Wildfire Peer Review Assessment Framework (PRAF).[24] This report also considers the integrated wildfire risk management (IWFRM) principles and includes the following elements:[25]

[23] Overseas Countries and Territories are not considered.
[24] Casartelli and Mysiak 2023.
[25] Ibid.

1. **Governance of wildfire risk management** focuses on the overall governance framework for wildfire risk management, including the strategies, institutional frameworks, coordination mechanisms, financing strategies, and systemic resilience related to wildfire risk at the national and sub-national levels.

2. **Understanding wildfire risk management** examines the identification, analysis, evaluation, communication, and capacities associated with assessing the risk of wildfires.

3. **Wildfire risk prevention, reduction, and mitigation** reviews wildfire prevention and exploring landscape management practices, innovation and knowledge services, and administrative capacities related to wildfire prevention.

4. **Wildfire early warning and awareness** examines the processes and measures for monitoring and providing timely warnings of wildfire events through early warning systems (EWSs), as well as information campaigns that enhance public awareness and understanding of wildfire risks.

5. **Wildfire preparedness and emergency response** focuses on the actions taken during the response phase of a wildfire event, as well as activities that enhance operational preparedness, such as contingency planning, training and exercises, and the development of response capacities.

6. **Wildfire recovery, reconstruction, and post-disaster financing** covers the processes and actions taken after a wildfire event, including damage assessment, restoration efforts, recovery planning, and climate proofing for future disaster events.

7. **Cross-cutting topics:** social resilience and inclusion explores ways to address the disproportionate impact of disasters on vulnerable populations (such as children, the elderly, and low-income households) and counties with low fire coping capacities. Meanwhile, the private sector covers relevant stakeholders' involvement in the context of wildfire risk management, including private forest and landowners, insurance companies, business owners, tourist companies, transportation carriers, and so on.

WILDFIRE RISK PROFILE AND RISK TRENDS

This chapter provides an overview of wildfire risk trends in Croatia, focusing on historical, current, and future wildfire risks and impacts. It presents exposure, losses, and socioeconomic resilience related to wildfire events in Croatia based on available data and information. The section considers both historical events and future climate projections to showcase the significant wildfire risks in the country and how such risks could intensify in the future.

OVERVIEW

Croatia's changing climate and socioeconomic factors are contributing to increasing and shifting wildfire risk both in coastal areas and in rural hinterlands, with substantial impacts on livelihoods, infrastructure, and key sectors such as forestry and tourism. Due to its Mediterranean climate and geographical features, Croatia is exposed to high wildfire risks, especially during the spring and summer months. Anthropogenic factors such as the increased number of tourists and the abandonment of previously cultivated agricultural areas also contribute to exacerbated wildfire risk. The country's coast, surrounding hinterland, and islands are hotspots for wildfire hazards, with counties like Split-Dalmatia, Primorje-Gorski Kotar, and Zadar facing high wildfire risks, particularly when considering social vulnerability and coping capacity.[26] Intensified wildfire events and prolonged fire seasons in the future could overwhelm firefighting capacity, leading to long-term impacts on human health, air quality, and forest ecosystems.

Wildfires have caused severe damage and losses over the past decade, and this is expected to increase. Croatia is one of the European Union (EU) countries most affected by wildfires, ranking fourth in terms of annual average burned areas (as a percentage of total country area). Total damage due to wildfires totaled €249 million between 2010 and 2021, and losses are projected to increase over the next decades.[27] Several extreme wildfire events occurred, including the 2017 fire season with the highest annual burned area (67,666 ha) and the 2022 fire season with the highest number of fires (149).[28] Wildfires tend to have unequal sectoral impacts, affecting particularly forestry, tourism, and critical infrastructures for energy, transport, food, public services, and national and cultural heritages. Considering EU-wide available exposure data, Croatia's critical infrastructure is highly exposed to wildfire risk with 73 percent of the critical assets, 94 percent of the power lines, and 97 percent of the road network segments in Croatia located in areas of high wildfire risk.[29]

CURRENT WILDFIRE RISK AND AREAS WITH HIGH RISK

Croatia is at high risk of wildfires due to its climate and geographical features. Croatia's climate is characterized by hot and dry summers, particularly along the Adriatic coast, and related high wildfire hazard.[30] Depending on meteorological conditions (especially wind speeds), wildfires can also spread beyond borders to neighboring countries such as Slovenia and Bosnia and Herzegovina.[31] Often neglected allochthonous and autochthonous pine forests close to tourist destinations inadvertently increase the possibility of wildfire occurrence. The plant cover of the Adriatic coast, in addition to cultivated species, also consists of coastal forest communities which, given the drier climate and the xeromorphic structure of the plant cover, are much easier to burn than continental forests. Since Mediterranean plant species are abundant in resin (conifers) and essential oils, coastal forests are more susceptible to fires than the deciduous forests of the continental part, which are more difficult to ignite and less able to support fire.[32]

The Dalmatian coast is particularly affected by wildfire risk. Croatia's coastal regions and its surrounding hinterland and islands are wildfire hazard hotspots (Figure 1).[33] The Dalmatian coast with islands (especially central ones) is the most endangered area throughout the country due to specific endemic ecosystems with highly flammable plant cover and prolonged dry periods.[34] At the NUTS-3 level, the 2024 NRA classifies the county of Split-Dalmatia as at very high wildfire risk and the counties of Istria, Šibenik-Knin, Zadar, and Dubrovnik-Neretva as at high risk (Figure 2).[35] Significant social factors that favor the development of wildfires are the demographic picture and tourist potential of the area, which have changed over time. It is necessary to highlight the influence of the high frequency of people (mostly tourists but also locals) and often their improper behavior on the pronounced frequency of wildfires in the Mediterranean area.[36]

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[26] World Bank 2024b; Ravnateljstvo civilne zaštite 2024. Link.

[27] GoC 2024a, Link.; Background analysis undertaken by CIMA Foundation for World Bank 2024b.

[28] EFFIS. 2024.

[29] Based on World Bank 2024b. The exposure analysis does not consider the structural vulnerability of people, buildings, or infrastructure, so it does not provide an estimate of the potential damage, loss, or disruption.

[30] GoC 2024a.

[31] GoC 2024a.

[32] Mamut, M. 2011.

[33] The Dalmatian Hinterland refers to the part of Dalmatia that is not coastal and has borders presented in the counties of Split-Dalmatia and Šibenik-Knin.

[34] GoC 2019, Link.

[35] GoC 2024b

[36] Mamut, M. 2011.

When considering anthropogenic factors from the last several decades, such as changes in rural population and lifestyles, high-risk areas are emerging in the rural hinterland. Rural exodus, abandonment of agricultural land, and reduction in pasture and grazing are the main changes in the environment that consequently influence changes in fire regimes, occurrence, and behavior. The Mediterranean part of Croatia is characterized by a mosaic landscape reflecting small-scale diversity in topography mainly due to long exploitation of the land. Economic reorientation has displaced agriculture and livestock farming, which has led to a massive population migration from the islands and from the hinterland to tourist resorts and towns by the sea, thus reducing rural populations.[37] Many previously cultivated and managed agricultural areas have been abandoned and are being overrun by meadow and forest vegetation. Former natural obstacles for the spread of fire (organized olive groves, vineyards, fruit fields, arable land, and so on) have thus become new fire hotspots outside the former forested areas. When this kind of landscape is not appropriately maintained, hotspots of combustible fuel for fire outbreaks arise.[38]

Spring and summer are the two critical periods of increased wildfire risks and occurrences but with varying spreading behavior and impacts.[39] In the spring months of February, March, and April (especially when accompanied by drought and wind), an increased number of fires occur because of the burning of weeds and other biowaste left after clearing agricultural and forest areas, mostly in three NUTS-2 regions: City of Zagreb, Northern Croatia, and Pannonian Croatia.[40] In the past, rural populations used fire as a tool for clearing the land, but controlled burning was carried out under different circumstances than it is nowadays. The surrounding land was mostly for agricultural use. However, in recent decades, most of those areas are no longer arable, and fires that are caused unintentionally can affect and spread on abandoned and overgrown land. However, spring fires are less concerning because they are less intense, and the surrounding environment is less suitable for their spread than in summer. In spring, after relatively high humid periods, autumn, and winter, the temperatures are usually lower, and the presence of moisture in the air, soil, and vegetation is high.[41] Meanwhile, in the summer months of July, August, and September,

[37] Nodilo, J. 2003.

[38] Mamut, M. 2011.

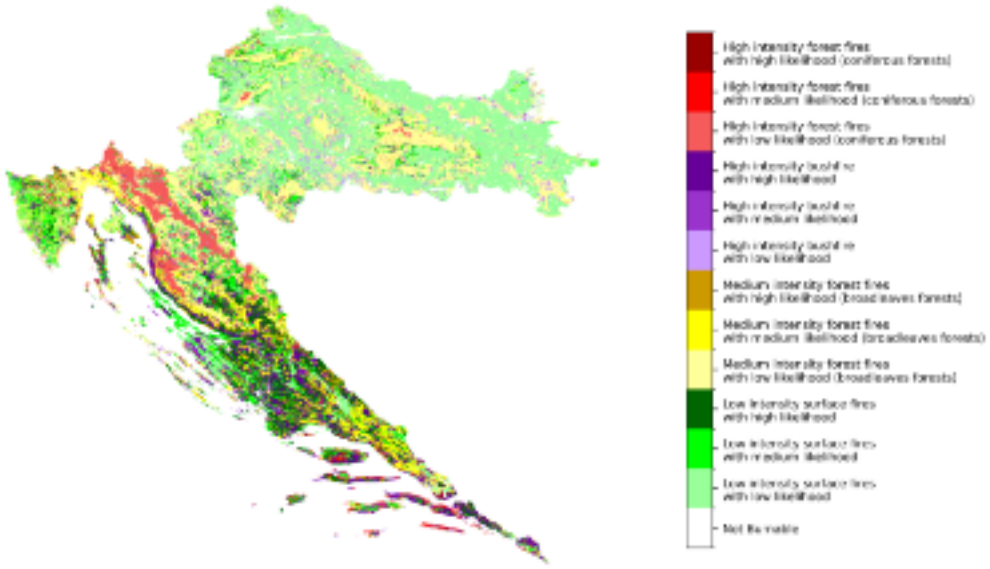
[39] GoC 2019e, Link.

[40] In the 2019 NRA, the area is referred to as Continental Croatia, which is one of the two NUTS-2 regions of Croatia between 2013 and 2021. In 2021, Continental Croatia was replaced with three NUTS-2 regions: City of Zagreb, Northern Croatia, and Pannonian Croatia. *See* Croatia Bureau of Statistics 2021, Link.

[41] Delač, D., I. Kisić, I. Bogunović, P. Pereira. 2021. Link.

Figure 1. Current wildfire hazard in Croatia, mean 2008–2020

Source: Based on background analysis undertaken for World Bank, 2024b. Note: In the study, wildfire hazard is described as the likelihood of wildfire occurrence characterized by a certain degree of severity, given topographic, land cover, and climatic data, with annual temporal resolution. The hazard is defined by a combination of wildfire susceptibility, which represent the likelihood of a fire to spread after the ignition, and four main macro vegetation classes which allow to discriminate fire behavior among grassland, shrubland, low flammable forests, and highly flammable forests.



with extended periods of hot dry weather, there is also an increased number of fires, mostly in the coastal area and on the islands of the NUTS-2 region Adriatic Croatia.

Several coastal counties face extremely high wildfire social risk when considering social vulnerability and coping capacity. Wildfires cause more catastrophic losses if an area has more vulnerable communities and low firefighting capacity.[42] The wildfire social risk index considers the country's social vulnerability[43] as well as coping capacity indicators related to wildfires (such as the number of fire stations) and the information on wildfire hazard. The result suggests extremely high wildfire social risk indexes in three coastal counties (Split-Dalmatia, Primorje-Gorski Kotar, and Zadar), indicating high levels of wildfire risks and social impacts and low levels of fire resilience in these regions (Figure 3). It is important to note that this index mainly indicates lower vulnerability and coping capacity and is not an indication of wildfire susceptibility. In fact, susceptibility is high in continental regions, but coping capacity is also estimated to be higher.

Croatia is one of the EU countries most affected by wildfires in terms of burned area. From 2006 to 2023, wildfires have burned on average 13,647.44 ha of land annually, which accounts for 0.24 percent of Croatia's total country area.[44] As a result, the country ranks 4th among all EU countries in terms of annual average burned areas (as a percentage of total country area) (see Figure 4).[45] Wildfires in Croatia have significant adverse effects on agriculture, forest biodiversity, and ecosystems, particularly in the Mediterranean regions such as Dalmatia. These fires, often exacerbated by human activities, have led to the destruction of vast areas of forest and agricultural land. In terms of forest biodiversity, wildfires may contribute to the loss of native species and habitats. Repeated fires can favor fire-resistant species over others, leading to a decline in species diversity.[46]

IMPACTS OF WILDFIRES

[42] Coughlan, M., Ellison, A., Cavanaugh, 2019. Link.

[43] Assessed based on national data for a list of social vulnerability indicators, including average annual income and the number of vulnerable populations such as the elderly, children, females, people with disabilities, and the low-income group. For details, see rapid analysis undertaken by CIMA Foundation for World Bank, 2024b. This is an initial assessment considering climate change projections in risk modeling, combining social vulnerability and coping capacity, giving a basis for future analysis and refinements.

[44] Joint Research Center (JRC) 2024, Link.

[45] EFFIS 2024.

[46] Ožura M. et al. 2018, Link.

Figure 2. Current wildfire risk in Croatia by NUTS-3 regions

Source: Based on Republic of Croatia 2024.

Figure 3. Social Vulnerability Index (left) and Wildfire Social Risk Index (right) of Croatia

Source: Background analysis undertaken for World Bank, 2024b.

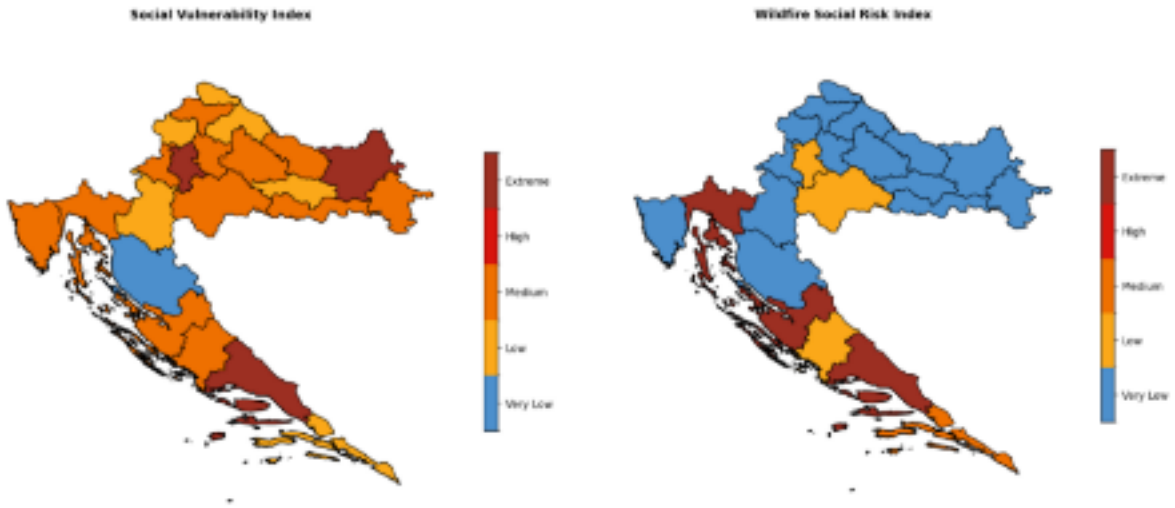


Figure 4. Annual average burned areas by wildfires (as % of country area) between 2006 and 2023 by EU countries

Source: Based on JRC. 2024. EFFIS Estimates for European Union. Link.

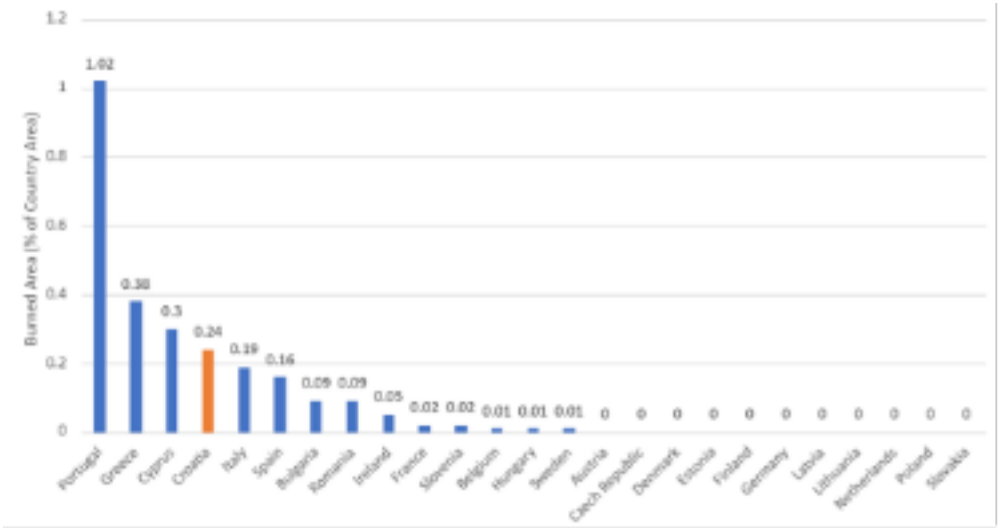


Figure 5. Distribution of burned areas and number of fires in Croatia in 2006–2025

Source: EFFIS. 2025. EFFIS Annual Statistics for Croatia. Link. Note: Statistics in the charts up to 2023 show full-year statistics. 2025 is updated up to September. Fires mapped in EFFIS of about 30 ha or larger.

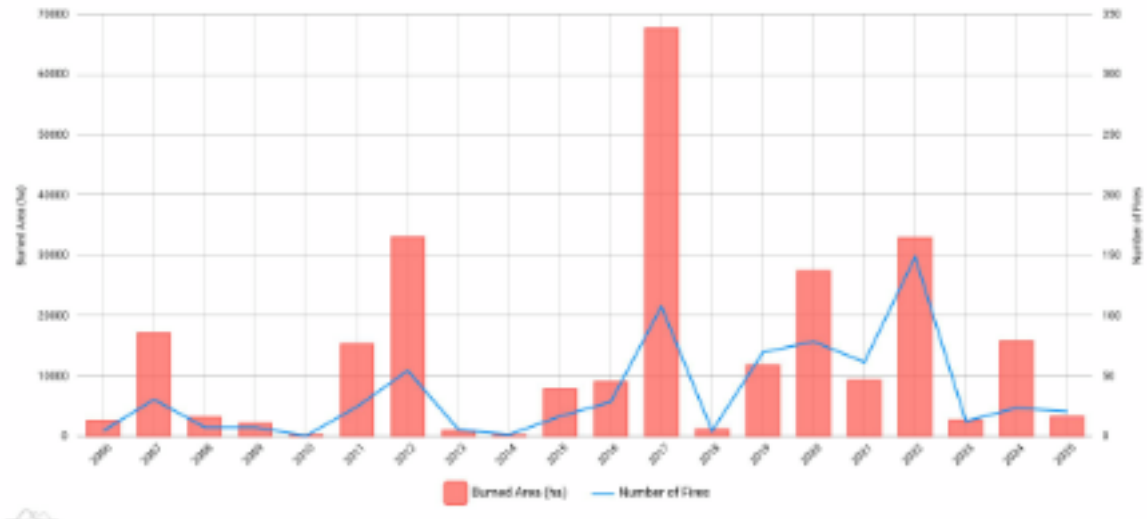


Figure 6. Burned area scars in Croatia and neighboring countries

Source: EFFIS 2017.

In the past two decades, several extreme wildfire events have occurred in Croatia. These include the 2017 fire season with the highest annual burned area and the 2022 fire season with the highest number of fires (see Figure 5). In 2017, Croatia experienced one of the most severe fire seasons in history: wildfires burned a total of 67,666 ha of land,[47] which is seven times higher than the average area burned from 2007 to 2017 and nearly one-fifth of the overall burned area from 2010 to 2020 (see Figure 5, Figure 6).[48] The fire season started early in March, but most of the damage occurred in July and August, including the largest fire of the season in Split-Dalmatia County that burned more than 5,000 ha of land. In July, unexpected fires occurred in the wildfire-urban interface (WUI) of Split and made multiple runs into the densely populated areas, causing what Croatian firefighters called the 'mother of all fires'.[49] 2022 was another year of a devastating fire season, with the highest number of fires recorded (149) in the last decade and more than 34,000 ha of land being burned.[50] Over three-quarters of the fires occurred in March 2022, which included Croatia's two largest fires of the year that both occurred in Gračac municipality and were around 4,000 ha in size.[51] Though in 2022, the number of fires was even higher than in 2017 (108), the area burned was almost less than half, which could be due to the different nature of the fires, meteorological conditions, and the effectiveness of firefighting operations.[52]

Over the past decades, wildfires have caused severe damages and losses in Croatia, harming the well-being of citizens and the economy. Between 2010 and 2021, wildfires have caused a total damage of more than €249 million in the country.[53] A total average annual loss (AAL)[54] of €25.9 million per year was estimated for wildfire impacts on infrastructures,[55] forests,[56] and road networks between 2008 and 2019.[57] The coniferous sector is the most affected (accounting for 38 percent of the total AAL), followed by residential buildings and road networks (accounting for 28 percent and 1 percent of the total AAL respectively). Wildfires also lead to human loss and health impacts, with an average estimate of around 7 people affected per 10,000.[58]

[47] Only fires of 30 ha or larger are recorded in the EFFIS annual statistics.

[48] San-Miguel-Ayanz, J., et al. 2018, Link.

[49] Tomasevic, et al. 2022, Link.

[50] San-Miguel-Ayanz, J., et al. 2023, Link.

[51] Ibid.

[52] For instance, during the 2017 wildfire of Split, meteorological conditions not only led to rapid escalation and expansion of the fire zones but also limited the effectiveness of firefighting operations. See Tomasevic et al., 2022.

[53] GoC 2024a.

[54] AALs from wildfires are calculated for all the categories combining the array of average annual probability of being affected by a wildfire with the potential damage maps. See background analysis undertaken by CIMA Foundation for World Bank 2024b.

[55] Including residential buildings, commercial infrastructure, industrial facilities, health care facilities, and education buildings.

[56] Including broadleaves and coniferous forests.

[57] Based on analysis by CIMA Foundation for World Bank, 2024b which provides an initial assessment considering climate change projections in risk modeling, combining social vulnerability and coping capacity, giving a basis for future analysis and refinements.

[58] World Bank 2024b; WHO 2024.

In Croatia, wildfires particularly affect the forestry and agricultural sectors and lead to significant economic losses. Wildfires have an unequal sectoral impact, making some sectors more vulnerable than others and experiencing greater losses. By causing damage to forests and additional silviculture work, wildfires lead to significant economic losses in the forestry and timber production sector and negatively affect the management and business plans of state-owned forest companies and private landowners. From 2013 to 2022, there was a total of around €8.7 million loss for the first-age class, around €21 million loss for growing stock, and around €297.1 million loss for non-wood forest functions on state-owned forests.[59] The 2017 wildfire was the most devastating, causing a total loss of more than €109 million.[60] Wildfires also lead to large reconstruction costs and generate long-term environmental damage, such as major disruptions to the ecosystem and increased emission of carbon dioxide and air pollution.[61]

In addition, wildfires put at risk select types of critical infrastructure and hence essential services to the population. Direct flames, as well as strong winds and wind-borne debris, can damage buildings and critical infrastructure. According to the 2019 NRA, critical infrastructures[62] in sectors such as energy, transport, food, public services, and national and cultural heritages are among the most affected (see Annex 2).[63] Infrastructure less affected is in the sectors of communication and information technology, health care, water management, finance, and the production, storage, and transportation of dangerous substances. An EU-wide exposure analysis by the World Bank also suggests high exposure to wildfire hazards[64] for critical infrastructure and networks in Croatia (Table 1).[65] Over 76 percent of police and fire stations in Croatia are exposed to high and very high wildfire hazards (a total of 554 buildings exposed).[66] For education and health facilities, a lower proportion are exposed—69 percent (315) and 57 percent (95), respectively (see Annex 3). In addition, over 94 percent of power lines and 97 percent of road network segments in Croatia are exposed to high and very high wildfire hazards (see Annex 2). During the summer fire season, some road networks might be closed due to wildfires, such as the Adriatic motorway and the main A1 highway (Zagreb-Dubrovnik), especially the parts near coastal cities.

[59] Posavec, et al. 2023.

[60] Ibid.

[61] GoC 2019e.

[62] Note that in 2022, Croatia has adopted the Directive (EU) 2022/2557 on the resilience of critical entities and repealing Council Directive 2008/114/EC and updated the definition of critical infrastructure and the associated sectors. For the current nomenclature of critical infrastructure, see European Union 2022, Link

[63] GoC 2019d.

[64] See Annex 2 for the classification of wildfire danger in the exposure analysis for the critical infrastructures. Five classes are defined in line with the approach taken in the JRC Pan-European Wildfire Assessment. The analysis computed the wildfire hazard as a function of three base layers (two fire danger layers and the burnable fuel layer) used by JRC, rather than using the wildfire risk index. Assets with wildfire values of 4 or 5 are considered as being exposed to high wildfire hazard. See World Bank 2024c.

[65] The exposure analysis does not consider the structural vulnerability of people, buildings, or infrastructure, so it does not provide an estimate of the potential damage, loss, or disruption. See World Bank 2024b.

[66] World Bank 2024b.

Table 1. Summary table of wildfire exposure by type of assets

Source: World Bank. 2024b. From Data to Decisions: Tools for Making Smart Investments in Prevention and Preparedness in Europe. Link. Note: the analysis uses open-source data, hazard information, and location of assets.

Critical assets	Exposure to high and very high wildfire (% of total)
Education facilities	315 (69)
Health facilities	95 (57)
Fire stations	373 (79)
Police stations	181 (76)
Total assets	**964 (73)**
Roads	2,811 km (97)
Powerlines	8,148 km (94)

Tourism is both a contributing factor to wildfire risk and a highly affected sector. As Croatia is increasingly becoming an important tourist destination in southeastern Europe, wildfires also affect people's perception of the country's overall security during the tourist season, and this leads to losses in the tourism sector.[67] Many visitors are not sufficiently aware of the dangers posed by wildfires. The meteorological conditions and environment are usually different from where the tourists come, which leads to careless lighting of fires in open spaces for barbecues, smoking, and so on In 2017, most fires occurred during the summer in the wildfire-urban interface (WUI) of Split (66 percent of the number of fires and 85 percent of the affected surfaces), with unexpected downslope fire spread to the coastal populated area.[68] As a historic and touristic city that is listed as a UNESCO World Heritage Site, Split has more than 720,000 tourists visiting during the year, especially in July and August when wildfires are the most frequent. The Split wildfire occurred on the last night of the Ultra Festival (July 16), which attracted more than 150,000 visitors to the city, that weekend alone.[69] The fire lasted nine days and burned 5,122 ha of land; three houses were burned and 46 were damaged, and in addition, 18 cars, 11 olive groves, and two greenhouses were burned.[70] The total loss of the fire was estimated to be $20.6 million (€19.7 million, 2017 exchange rate); a total of 168 vehicles, 796 firefighters, and more than 200 soldiers were deployed for firefighting.[71]

Wildfires also lead to environmental damage and disruption in the forest ecosystem.[72] According to the 2019 NRA, wildfires not only cause air pollution and disruption of biological and landscape diversity but also lead to long-term environmental impacts through the emission of carbon dioxide and other greenhouse gases.[73] In addition, wildfires in Croatia could also cause dangerous soil erosion and mudflows, as well as deterioration of soil physical and chemical properties.[74] Moreover, the country has the second highest percentage (36.7 percent) coverage of the Natura 2000 sites in Europe (with respect to the size of the country),[75] with wildfires being viewed as one of the most prevalent threats in these areas, especially in coastal and sea nature parks.[76] The disruption caused by wildfires on the environment and ecosystem could also lead to negative economic implications, as European evidence shows that 75 percent of all corporate loan exposures in the Euro area have a strong dependency on at least one ecosystem service.[77] Nevertheless, though wildfires cause negative environmental effects, they can also lead to an increase in biodiversity. This may happen through the emergence of numerous pioneer communities and, consequently, new animal species. The consequences of a forest fire, depending on the location of the event, can be strongly reflected in the environment through social and ecological functions and are mostly the result of human behavior.[78]

PROJECTED WILDFIRE RISK, HOTSPOT REGIONS, AND IMPACTS

In the future, wildfire risks and impacts are expected to greatly intensify under the effects of changing climate. The conditions for the emergence and spread of wildfires due to climate change are becoming increasingly favorable, which is reflected by a doubling in the average Seasonal Severity Rating (SSR) of the Canadian Forest Fire Weather Index (FWI)[79] in the more recent climatological period 1991–2020 compared to the older climatological period 1961–1990 (see Figure 2 in Annex 2).[80]

[67] GoC 2019e.
[68] San-Miguel-Ayanz, J., et al. 2018; Tomasevic et al. 2022.
[69] Tomasevic et al. 2022.
[70] Ibid.
[71] Ibid.
[72] Marziliano, P.A., et al. 2024, Link; Pausas, J.G.; Keeley, J.E. 2021, Link.
[73] GoC 2019e.
[74] Delač, D., I. Kisić, P. Pereira. 2022, Link; PAP/RAC. 2021, Link.
[75] Santoro, A., Piras, F., Fiore, B., Bazzurro, A., & Agnoletti, M. 2024, Link
[76] Tišma, S. Demonja, D., Malić-Limari, S. and M. Janković. 2025, Link.
[77] Boldrini, S., et. al. 2023, Link.
[78] Ožura 2018.
[79] Canadian Forest FWI (van Wagner 1974, 1987) is used globally to *assess the meteorological hazard of vegetation* fires. Seasonal ferocity (SSR) is part of this model, used as an indicator of the potential seasonal meteorological danger of vegetation fires.
[80] DHMZ 2023, Link.

The trend of SSR growth is due to the rise in air temperature and the prolongation of dry periods during the summer months. For the future, the 2024 NRA indicates that wildfires will be one of the disasters that are under extremely negative impacts of climate change, indicating a significant increase in fire frequency and intensity as well as vulnerability and exposure to wildfires in the country.[81] The fires generally spread from north to south and from inland to the coast and islands in the summer period and vice versa in the winter and early spring period.[82] In the future, the number of days of higher fire danger[83] is expected to increase, with an intensity of change predicted to be strongest in the 3°C global-warming scenario and milder in the 1.5°C scenario.[84] The two NUTS-2 regions, Pannonian and Northern Croatia, will be subject to a higher expectation of surface fire occurrence as they are characterized by croplands and broadleaved forests, while the hazard is expected to rise mostly in the shrubland in the central part of Adriatic Croatia (see Figure 7).[85] The most significant expansion of the population exposed to the risk of wildfires happens in the WUIs, where scrubland and woods are close to urban areas.[86] Projections in the 2024 NRA indicate that wildfires, among 14 other studied disasters, represent the greatest future threat for Croatia.[87] Along with acceptable and tolerant risks, wildfires are rated in the NRA as unacceptable and require urgent measures for risk reduction, to bring them to an acceptable level.

In Croatia, wildfire risk compounds with heat and other extreme meteorological conditions, which is likely to intensify. The intensity of the wildfire increases if it occurs with prolonged dry periods and other extreme weather events, such as strong wind, high and dry air temperature, and lightning strikes.[88] Lightning-induced wildfires could have enormous consequences and cause various damages to critical infrastructures such as the power system network.[89] Although such events currently do not occur often in the country, projections until 2100 show that there will be more extreme weather conditions (such as thunderstorms and droughts) in the future, leading to increased wildfire risk and impacts.[90]

Intensified wildfire risk is projected to lead to increased economic losses. Under the SSP585 scenario, the AAL in Croatia is expected to increase sharply from €25.8 million today to €30.8 million in 2050 (Figure 8).[91] Among all the sectors analyzed, the coniferous forest is the most affected, with an AAL of around €11 million that accounts for 36 percent of the total AAL in the country. Meanwhile, the residential building sector faces the highest increase in losses, with a €2 million increase in AAL (from around €7.3 to €9.3 million). The forestry sector[92] is the second most affected in terms of increase in losses, with a €1.7 million increase in AAL (from €11.6 to €13.3 million), mostly due to coniferous forest (from €9.7 to €11 million). There is also a slight increase of €0.7 million in losses due to road networks affected (from €3.3 million to €4 million). In addition, an EU-wide study modelled that potential damages to critical infrastructures and investments in the energy, transport, industrial and social sectors due to wildfires could increase under future climate because of increased structural damages to industrial sites, destruction of social infrastructures, and deterioration of roads, railways and power lines.[93]

[81] GoC 2024a.
[82] GoC 2019c.
[83] The PESETA VI study represents weather-influenced fire hazard quantitatively by exploiting a rating index, known as fire danger by weather, based on the Canadian FWI system.
[84] Costa, H., et al. 2020, Link.
[85] Based on analysis by CIMA Foundation for World Bank 2024a, which is an initial analysis considering climate change projections in risk modeling, combining social vulnerability and coping capacity, giving a basis for future analysis and refinements.
[86] European Commission (EC) 2024b, Link.
[87] GoC 2024a.
[88] GoC 2019e.
[89] Božiček, et al. 2023, Link.
[90] Ibid.
[91] Based on background analysis undertaken by the CIMA Foundation for World Bank 2024a.
[92] Including coniferous forests and broadleaves forests.
[93] Forzieri, G., et al. 2016, Link.

Intangible losses[94] due to wildfires are also expected to increase under future conditions, leading to negative societal and environmental impacts. With more frequent and intense wildfires and prolonged fire seasons, there will be more people affected by wildfires. Under the SSP585 scenario in 2041–2050, the number of people affected will increase, and these intangible impacts on people are generally hard to quantify, including long-term health impacts from wildfire air pollution or psychological impacts.[95] Croatia's National Adaptation Strategy (NAS) also suggests that there will be greater damage to forest ecosystems in the future as a result of increased frequency of forest fires and the occurrence of other disasters such as windbreaks, floods, and pest attacks, including a decrease in the value of wood assortments and the loss of non-market forest functions.[96] An increase in soil erosion and a decrease in water quality are expected as well.

Under climate effects, future wildfire events are expected to intensify, overwhelming response capacity, and leading to escalating impacts. Extreme meteorological conditions, such as strong winds, high air temperature, droughts, and lightning strikes, could lead to the development of several simultaneous vegetation fires over a larger area near settlements.[97] These extreme fire events can last for several days and overwhelm response capacities, requiring large-scale coordination across counties with varying levels of vulnerability and capacity (Table 2) or even international support. Nevertheless, concurrent crises in other Mediterranean countries may limit available assistance. As a result, these wildfires could have devastating consequences, threatening a large number of people and property, damaging critical infrastructure, and leading to massive social disruption and economic losses in key sectors such as tourism. This reveals the importance of enhancing capacity building in firefighting as well as addressing infrastructural deficiencies in wildfire resilience.

[94] Intangible losses refer to direct or indirect losses that are difficult to quantify, such as the psychological (post-traumatic stress), cultural, and environmental (contamination of drinking water, saltwater intrusion, and so on) impacts of disasters. See UNDRR 2024, Link.

[95] Based on background analysis undertaken by the CIMA Foundation for World Bank 2024a.

[96] GoC 2020.

[97] GoC 2019e.

Figure 7. Wildfire intensity in Croatia for different projected climate change scenarios (2023–2040)

Source: World Bank, 2024a. Note: The assessment uses the SSP-RCP ('SSPX-Y') scenarios, which are the most commonly used climate change scenarios. The SSP-RCP scenarios combine baseline socioeconomic narratives (the SSPs) with different emissions trajectories (based on the RCPs). There are five SSP-RCP ('SSPX-Y') scenarios (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5), and three of them (SSP1-2.6, SSP2-4.5, and SSP5-8.5) are considered for future wildfire risks and impacts in Croatia. See World Bank, 2024b; IPCC. 2023. Sixth Assessment Report. Link.

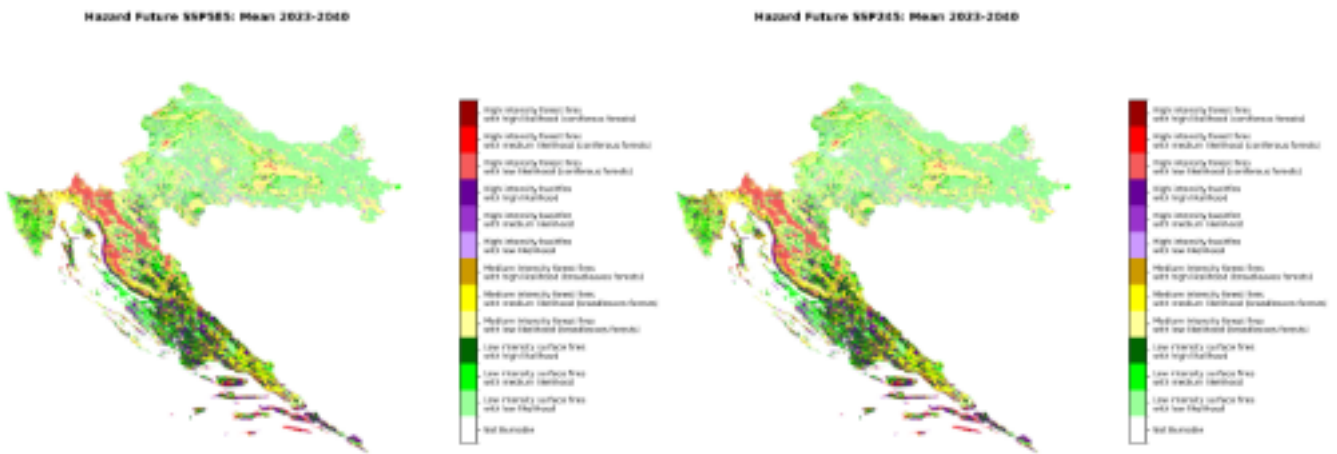


Figure 8. Projected AAL in Croatia for the future under SSP5RCP8.5

Source: Background analysis undertaken for World Bank, 2024a.

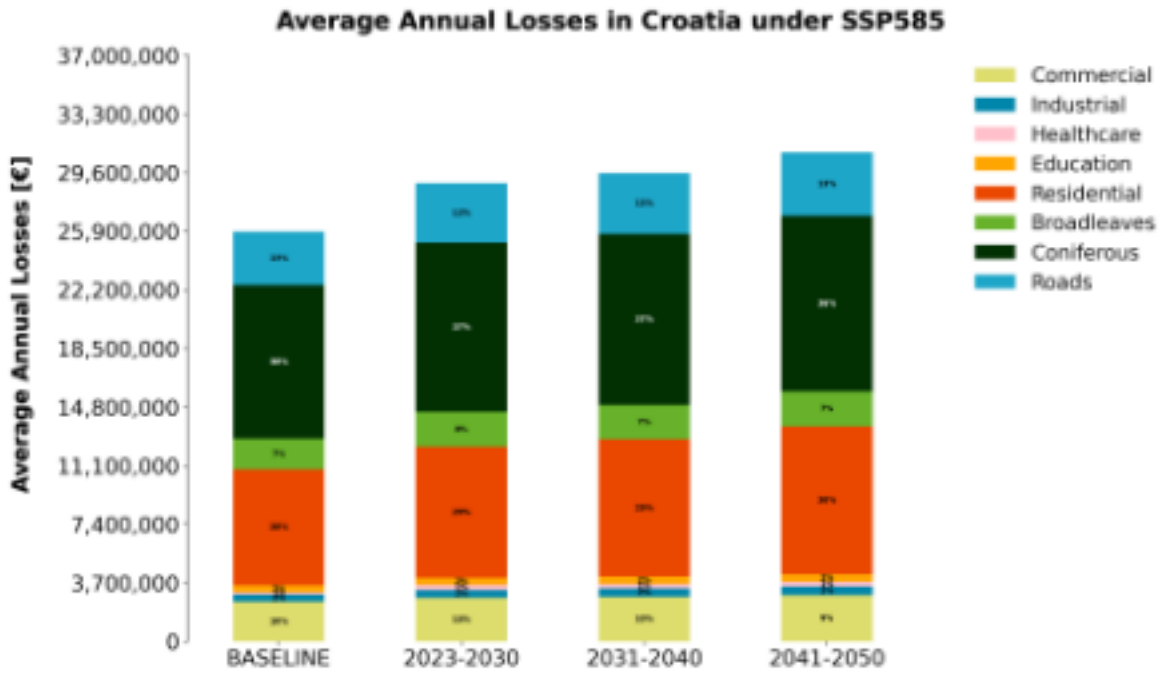


Table 2. Summary of wildfire risk by counties

Source: The 'wildfire risk' column is based on Civil Protection Directorate (2024) and the 'wildfire social risk' column is based on background analysis undertaken for World Bank (2024b). Note: Wildfire risk considers vulnerable areas where people and assets are exposed to fire danger, while wildfire social risk considers not only wildfire risk, but also the country's social vulnerability as well as coping capacity indicators related to wildfires (such as the number of fire stations).

County	Wildfire risk	Wildfire social risk
Bjelovar-Bilogora	Moderate	Very low
Brod-Posavina	Moderate	Very low
Dubrovnik-Neretva	High	Medium
Istria	High	Very low
Karlovac	Moderate	Very low
Koprivnica-Križevci	Moderate	Very low
Krapina-Zagorje	Moderate	Very low
Lika-Senj	Moderate	Very low
Međimurje	Moderate	Very low
Osijek-Baranja	Moderate	Very low
Požega-Slavonia	Low	Very low
Primorje-Gorski Kotar	Moderate	Extreme
Sisak-Moslavina	Moderate	Low
Split-Dalmatia	Very high	Extreme
Šibenik-Knin	High	Low
Varaždin	Moderate	Very low
Virovitica-Podravina	Moderate	Very low
Vukovar-Srijem	Moderate	Very low
Zadar	High	Extreme
Zagreb	Moderate	Low to very low
City of Zagreb	Low	Low to very low

WILDFIRE RISK MANAGEMENT AND INVESTMENT CAPACITY

The following chapters provide an overview of current arrangements and key challenges and opportunities in the existing wildfire risk management systems of Croatia, along with examples of successful strategies, investments, and approaches. It follows the PRAF and covers multiple aspects of wildfire risk management, including risk governance, assessment, prevention, early warning and awareness, preparedness and response, and recovery and reconstruction. It draws on publicly available information (such as national and local risk assessments, government reports, and studies) as well as information gathered during consultations.

Croatia has been enhancing its wildfire risk management and response capacity given the high fire risks and impacts. The country has established a solid legal basis for wildfire risk management that combines prevention, preparedness, and response measures at multiple levels, while aligning with EU policies to ensure an organized approach to wildfire risk. Fire risk assessments have been undertaken at the national and local levels to support the development of fire protection plans, with legislation outlining processes for data sharing, institutional coordination, and using standardized methodologies that ensure effective fire analytics and evaluations. For fire interventions, Croatia has been continuously enhancing its fire readiness and response to support firefighting plans, training, and operational measures to reduce impacts. The country's firefighting system relies on a structured command hierarchy that involves coordinated firefighting operations at the local level and support from the police and military forces, with clear responsibilities defined under the Firefighting Law and strategic intervention plans. Moreover, though Croatia has mainly focused on fire suppression in the past, the importance of risk reduction has been recognized in recent decades, leading to the implementation of various prevention measures in forests and key areas or critical assets exposed to high fire risks, such as fire protection roads and observation stations. Monitoring and warning systems, training, and information and awareness-raising campaigns have been implemented to enhance operational and public readiness. In addition to traditional measures, new innovative tools such as video surveillance, drones, robots, and satellite communication systems have also been developed to support risk management.

Despite progress, the current firefighting system could be further improved due to barriers such as coordination challenges, limited capacities, and improved prioritization in distribution of funding. Administrative and technical capacity building, enhanced data management and evaluation systems, public awareness raising, enhanced consideration of climate change, and more investments in innovative technological tools could help enhance effectiveness and efficiency of wildfire risk management in Croatia, leading to reduced fire impacts and losses and better protection of the population and assets.

Opportunities for improvement include the following:

- *Coordination and capacity gaps*: Administrative and technical constraints at local levels hinder effective risk management.
- *Data and risk assessment limitations*: Current risk assessments require harmonization, real-time updates, and climate impact modeling.
- *Funding and resource allocation issues*: Current funding distribution does not seem to address all gaps in preparedness and response, particularly in high-risk counties.
- *Public awareness and engagement*: While some education and outreach programs exist, broader community participation is needed, especially for vulnerable populations.
- *Post-fire recovery and reconstruction*: Limited legislation and strategic plans for recovery and reconstruction after a wildfire event and long-term recovery.
- *Financial resilience and insurance gaps*: Disaster financing mechanisms remain underdeveloped, and fire insurance uptake in households and agriculture is low.

GOVERNANCE OF WILDFIRE RISK MANAGEMENT

This chapter focuses on disaster risk governance, which includes the legislative, institutional, and strategic planning framework. The framework describes mandates, roles, and responsibilities as well as coordination arrangements among the different stakeholders, their policies, instruments, and investments. It is noted that this is a brief section that does not cover in detail all arrangements, some of which are covered in more detail in other sections.

DRM CONTEXT

Over the past decades, Croatia's DRM system has evolved to align with the global Sendai Framework for Disaster Risk Reduction (SFDRR) 2015–2030, emphasizing prevention and preparedness.[98] The core of this system is the Act on the Civil Protection System, involving policy makers at national, regional, and local levels.[99] The Croatian Platform for Disaster Risk Reduction, established in 2009, fosters knowledge transfer and solutions among various stakeholders.[100] The National Disaster Risk Management Strategy (NDRMS) until 2030, adopted in 2023, addresses unacceptable and tolerated risks, supporting international agreements like the SFDRR 2015–2030 and the Paris Agreement.[101] Croatia is addressing climate impacts with updated legislation like the Act on Climate Change and the Protection of the Ozone Layer, and the Climate Change Adaptation Strategy.[102] Under the National Recovery and Resilience Plan (NRRP), €1,978 million is allocated for energy efficiency and post-earthquake reconstruction, in line with Croatia's Long-term Strategy for the Reconstruction of the National Building Stock by 2050 supporting long-term EU CO_2 reduction goals to decrease emissions from the building sector by 80–95 percent by 2050, as well as the draft updated Integrated National Energy and Climate Plan (NECP) for 2021–2030 (draft update submitted to the European Commission (EC) in June 2023) and with the Strategy for Energy Development until 2030 with a view to 2050 (approved in 2020).[103]

CURRENT ARRANGEMENTS

In Croatia, efforts have been undertaken to align national legislation with ambitious regional goals, EU laws, and strategies. EU funds and programs for wildfire risk management and prevention have been utilized, primarily through projects and initiatives focusing on forest management and fire risk reduction. These efforts are often aligned with broader EU frameworks like the European Green Deal,[104] the EU Forest Strategy,[105] and the New EU Strategy on Adaptation to Climate Change,[106] which promote sustainable forest management and the integration of prevention and adaptation measures to reduce wildfire risks. Public stakeholders, such as the state-owned forest company Croatian Forests Ltd., have implemented wildfire protection measures in state-owned forests to align with these EU strategies, while the local fire departments have been receiving EU funding for firefighting activities and the purchase of equipment. In 2024, the Nature Restoration Regulation entered into force, aiming to significantly restore ecosystems in the EU. EU Member States, including Croatia, must develop national reconstruction plans within two years, defining priorities for reconstruction at the national level. By 2030, at least 20 percent of the EU's terrestrial and marine areas are planned to be

[98] Reforms in Croatia's DRM system reflect the legal requirements by the EU (such as the preparation of a national risk assessment [NRA]) and the opportunities for knowledge exchange and international cooperation facilitated by the UCPM. See Zvonko, Radujković, and Atalić 2022, Link. Croatia's DRM strategic documents are in line with the relevant national and EU regulations.

[99] The law stipulates the adoption of a National Disaster Risk Reduction Strategy, a Strategy for the Development of the Civil Protection System, and the State Civil Protection Action Plan, based on the National Risk Assessment. *See* GoC 2022, Link.

[100] For more information on disaster risk governance in Croatia, see Holcinger and Šimac 2021, Link.

[101] For the DRM Strategy, see GoC 2022. The strategy was drafted in accordance with the Act on the System of Strategic Planning and Development Management of the Republic of Croatia (Official Gazette, 123/17).

[102] GoC 2020, Link. The National Recovery and Resilience Plan is discussed further in section 3.2 (Box 5).

[103] EC 2023, Link.

[104] EC 2021c, Link.

[105] EC 2021b, Link.

[106] EC 2021a, Link.

restored, while by 2050, all ecosystems requiring restoration are expected to be restored. Moreover, for wildfire response, Croatia joined the EU UCPM[107] in 2009, adopting a joint approach to combat wildfires and mitigate their devastating impacts with other EU Member States and participating states

.

Multiple national laws and strategic plans apply to fire protection and suppression, particularly the Law on Firefighting and the National Fire Protection Strategy. The Law on Firefighting regulates the firefighting system in Croatia.[108] The law states the conditions and manner of establishing fire brigades and organizations at the national, regional, and local levels and the implementation, financing, and supervision of firefighting activities, which include the implementation of preventive measures for protection against fire, extinguishing fires, rescuing people and property threatened by fire and technological explosions, and providing technical assistance in accidents and dangerous situations. In addition, multiple strategic plans have been published to enhance fire protection and firefighting at the national level. The National Fire Protection Strategy[109] assesses the current state of firefighting in the country, including the main objectives, priorities, international obligations, legal framework and instruments, implementation measures, and responsible parties.[110] Other strategic documents include the firefighting plans, NDRMS until 2030,[111] and the Program of Activities in the Implementation of Special Fire Protection Measures of Interest to the Republic of Croatia for each year.[112] The Program of Activities is the basic executive document for the coordination and implementation of annual activities related to the implementation of fire protection measures. It states the responsibilities of public and private stakeholders[113] in fire protection and provides an overview of short-term measures, which will be systematically and continuously monitored throughout the year. In 2001, the Croatian government set up an intervention plan for large open-space fires in the territory of the Republic of Croatia.[114] The plan outlines different danger degrees for open-space fires and the corresponding firefighting forces and legal entities involved (see Figure 9 and the original table of the plan in Annex 3 for the Fire Protection Plan for all cities/municipalities).

Regarding forest fire prevention and risk management at the national level, one of the most important legislative documents is the Ordinance on Forest Fire Protection. Published in 2014, the Ordinance[115] prescribes technical, preventive-silvicultural, and other measures for forest fire protection, to reduce the risk of occurrence and rapid spread of wildfires, enable early detection and reporting of forest fires, and enhance timely action in extinguishing forest fires. According to the Ordinance, legal entities that manage forests and forest lands based on special regulations,[116] as well as counties, cities, and municipalities in whose territory forests and forest lands owned by forest owners are located, are obliged to take a series of actions in wildfire prevention. These measures include creating a list of forests according to forest fire risk level, establishing a video system or monitoring and reporting service for detecting forest fires, and implementing forest fire protection services. The ordinance also provides detailed guidance on the design and implementation of technical measures (such as the forest fire risk level map), the video system for detecting and monitoring forest fires, the observation and alarm service, and the training of intervention groups. A methodology for the evaluation of risks of forest fires is also included in the Ordinance.

[107] EC 2025, Link

[108] GoC 2019, Link.

[109] GoC 2013, Link.

[110] Note that the National Fire Protection Strategy (OG 68/13) was implemented from 2013 to 2022 and is now outdated. A new version of the strategy is planned to be adopted in 2025.

[111] MoI, Link.

[112] GoC 2024c, Link; GoC 2023, Link.

[113] Key authorities involved in fire protection include MoI, the Ministry of Agriculture (MoA), the Ministry of Defense, the Ministry of Tourism and Sports, The Ministry of Economy and Sustainable Development, public institutions of national and nature parks, as well as the local self-government units, and the county/City of Zagreb fire departments. Other key stakeholders include HVZ, the state-owned forestry company Croatian Forests Ltd., private forest owners, public and private carriers, and tourist companies.

[114] GoC 2001, Link.

[115] GoC 2014b, Link.

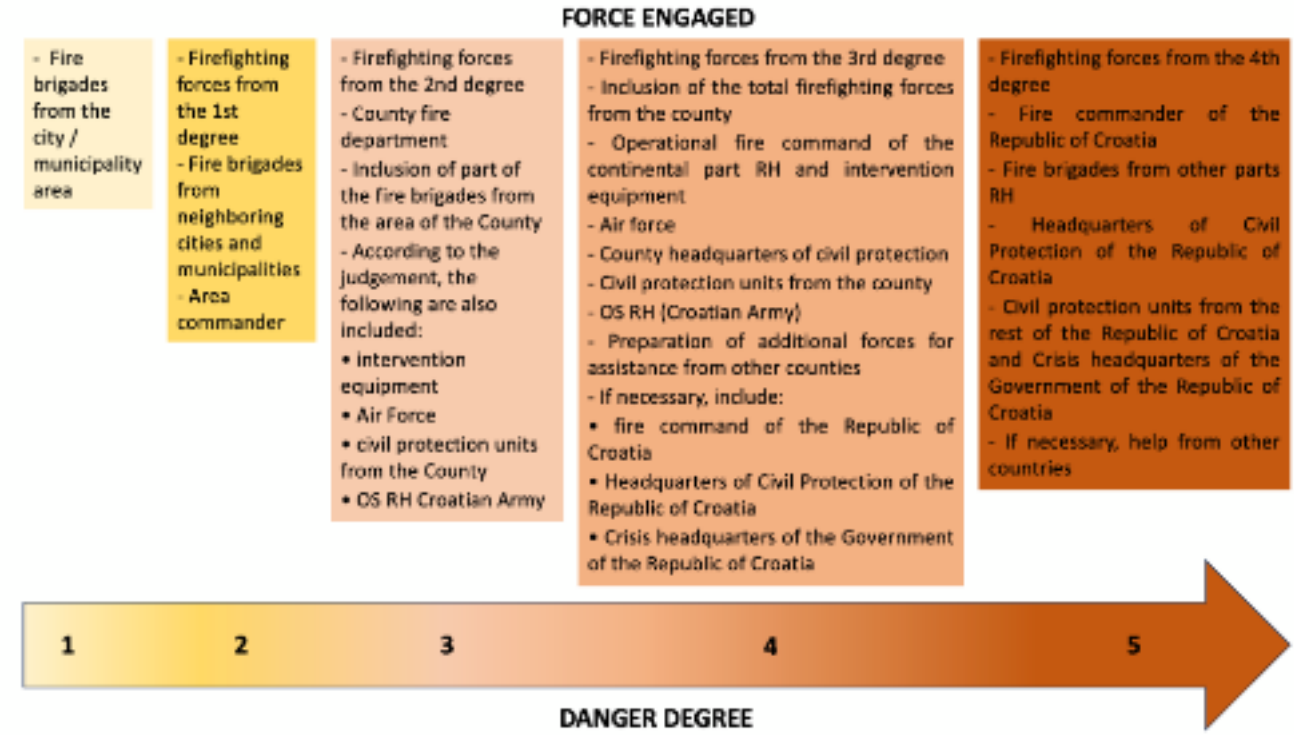
[116] Croatian Forests Ltd., private forest owners (Link), public institutions (Protected areas per the Nature Protection Act. Link).

For forest management and wildfire prevention, the Law on Forests provides legal regulations on the protection of forests from fires and other natural disasters. The law prescribes the obligation of managing an information and registry system for controlling and preventing forest fires; the responsibility of forest owners to restore burned areas within two years; and preventive silviculture works that counties, cities, and municipalities should take for wildfire risk reduction, early detection and alarms, and suppression.[117] The Forest Management Ordinance was set up in 2018 and contains the adoption and methods of preparation of forest management plans as well as the conditions for the preparation of extraordinary revisions of forest management plans. Based on the Law on Forests, in 2019, the Ministry of Agriculture, Forestry, and Fisheries issued a regulation on the method of data collection, content, and maintenance of the register and conditions for the use of data on forest fires.[118] The register is maintained and edited by Croatian Forests Ltd. and the ministry. For forest planning, Croatian Forests Ltd. has adopted a Forest Management Basis for 2016-2025.[119]

[117] Articles 41 to 45 in GoC. 2019b. *OG 68/18, 115/18, 98/19: Law on Forests*. Croatian Parliament: Zagreb, Croatia.
[118] GoC 2019f, Link.
[119] GoC 2016, Link.

Figure 9. Fire danger degree and corresponding fire brigades and legal entities involved in firefighting activities from the Intervention plan for large open-space fires in Croatia

Source: Based on Table in the Intervention plan for large open-space fires in the territory of the Republic of Croatia. Link (also included as Table 7 in Annex 2).



Danger degree:
1 = small-scale outdoor fires, danger index very low to low
2 = smaller forest areas, larger areas of grass and low vegetation, danger index low to moderate
3 = larger forest areas, large areas of grass and low vegetation, danger index low to moderate
4 = valuable forest areas, very large areas of grass and low vegetation, endangerment of buildings and settlements, possible more simultaneous events in a wider area (of different intensity), danger index moderate to high
5 = particularly valuable forest areas, extremely large areas of open space, more simultaneous events of greater intensity, endangerment of settlements and/or other contents or facilities, danger index high to very high

In accordance with national laws, local authorities are responsible for regulating fire protection and suppression in their areas and are obliged to undertake fire risk assessments and establish fire protection plans and firefighting brigades. Fire risk assessments are undertaken at county levels, which provide an overview of forest areas by type, age, flammability, and degree of fire danger as well as the status of the implementation of fire protection measures in the forests. For instance, the fire danger assessment for Varazdin County describes the location of fire bans, warning signs, and fire-extinguishing equipment.[120] Nevertheless, it also states that there is no firefighting pumping station or fire monitoring and reporting stations in the forest.[121] The fire protection plan of Split-Dalmatia County indicates six public fire brigades and 52 voluntary fire departments for fire suppression. It contains a divided system of patrolling, monitoring, and reporting in the case of a fire hazard.[122] The fire protection plan of Zadar County has a described system for reporting fires and involving fire departments and other participants in firefighting operations. Zadar City is divided into eight fire areas and 33 fire zones.[123] Based on the fire risk assessments, fire protection plans are developed at county levels as well as at city, area, or municipality levels. According to the Law on Firefighting, the fire plan must include a firefighting network and describe the principles of actions of fire organizations and fire departments in the implementation and coordination of firefighting activities and measures and the management of the firefighting system. Under the 2001 Croatia Intervention Plan for large open-space fires, fire departments and fire brigades are also established at county levels, and they are the first responders during a fire suppression operation.[124]

Prevention and suppression of wildfires require collaboration between different government authorities and stakeholders at national and local levels. Collaboration between national and local authorities is crucial, with MoI and State Inspectorates leading preventive measures, conducting post-fire evaluations, and refining protection strategies. The state-owned forest company Croatian Forests Ltd.[125] manages fire risks in state-owned forests, while private landowners are legally required to implement preventive measures in private forests. In terms of preparedness, during tourist seasons, MoI intensifies oversight of high-risk areas through its Police Directorate and the Directorate of Civil Protection. The Croatian Meteorological and Hydrological Service (DHMZ) provides critical weather and fire forecasts and fire risk warnings to HVZ, enabling proactive response planning.[126] In terms of readiness and response, the Firefighting Law establishes a command hierarchy, with the Chief Fire Commander issuing all regulations and the Fire Inspectorate ensuring compliance related to firefighting. Local governments handle firefighting operations, supported by HVZ as the central coordinating body.[127]

Firefighting and wildfire protection and recovery activities are financed through the approved funds in the state and county budgets. According to the Firefighting Law, the counties are responsible for equipping and financing firefighting activities of their fire departments, while HVZ is funded by the state budget. Other funding for firefighting includes the fire insurance premiums and fees for the use of general forest functions. In Croatia, 5 percent of the funds collected by insurance companies are allocated to the fire insurance premium, of which 30 percent are paid to HVZ, 30 percent to the county firefighting association (that is, the City of Zagreb in the area where the insured property is located), and 40 percent to the firefighting association of the municipality or city in the area where the insured property is located. Meanwhile, compensation funds for general utility functions of forests are provided for the needs of firefighting in a minimum amount of 20 percent. In addition, the state budget provides financing for planning and operational costs related to wildfire protection, with the largest share under the Ministry of Defense for firefighting aircraft and helicopters. Under the Law on Forests, the fee for non-wood forest functions (green tax) is paid in the amount of 0.024 percent of a total income of more

[120] Davor Kraš et al. 2020.
[121] Ibid.
[122] Split-Dalmatia County, GoC 2024, Link.
[123] Zadar County, GoC 2024, Link.
[124] GoC 2001, Link.
[125] Hrvatske šume 2024, Link.
[126] Kozarić, T. 2024, Link.
[127] Croatian Firefighting Association 2024.

than €1 million for defined taxpayers. Funds collected from the fee are spent on fire protection, remediation, and restoration of forests in the country. Annually, about €22 million is collected under the green tax, which is distributed according to the regulations to the firefighters, demining initiatives, private forest owners, and the state forest company.[128]

CHALLENGES AND OPPORTUNITIES

Strengthening Croatia's wildfire protection system and legal framework and addressing disparities in local capacities is essential for enhancing overall resilience. Croatia has made significant progress in establishing a robust legal foundation for wildfire protection and forest management through the adoption of national laws and strategic plans. Although the fundamental elements are aligned with EU and PRAF guidelines, the documents are primarily based on Croatian laws and regulations, while the integration of the latest European practices and innovations may be possible through future revisions or alignment of national legislation. The current legal framework focuses more on fire suppression and less on prevention and preparedness, and there are no specific laws regulating wildfire recovery and reconstruction in place. Therefore, it is crucial to enhance the legal framework so that it covers all aspects of wildfire management, with local circumstances and wildfire hot spots taken into account. In addition, while national laws provide a framework for fire interventions, there are challenges in achieving a nationwide cohesive and efficient fire protection network, as well as ensuring the full implementation of the legislation at local levels. Strengthening coordination between national lawmakers, local governments, and fire departments could improve the implementation of fire risk assessments and protection measures at local levels. Additionally, disparities in local government capacities and funding for fire protection create an uneven ability to respond effectively to fire risks, with some counties experiencing resource shortages while others are comparatively overfunded. Addressing these gaps by enhancing administrative and technical capabilities, improving risk assessment systems, and ensuring that funding is allocated based on wildfire risk assessments would strengthen fire protection at all levels. Improved coordination among national and local authorities and between fire departments, particularly during cross-county operations in wildfire seasons, would further enhance the country's preparedness and response capabilities.

Incorporating climate change considerations into wildfire management is crucial for mitigating future risks and impacts. Evidence suggests that wildfire risks and impacts are likely to intensify under future scenarios, increasing potential damage and losses. While the 2024 NRA identifies wildfires as a significant future threat, the current legal framework could better incorporate climate considerations into risk assessments and wildfire protection measures. Local governments have an opportunity to address both current and projected wildfire risks by implementing forward-looking risk reduction measures and adaptation strategies. Additionally, promoting climate-smart forestry practices, such as planting mixed tree species, implementing thinning and harvesting operations to manage tree density, and fostering sustainable forest growth, could significantly enhance forest resilience. Encouraging these practices, particularly through the efforts of Croatian Forests Ltd. and private forest owners, would support sustainable forestry management and strengthen the country's resilience to intensifying wildfire risks. Furthermore, policy fragmentation poses a significant barrier, as fire prevention is often insufficiently integrated into spatial planning, forest management policies, agriculture, and tourism, which hinders the implementation of a holistic approach to risk management. There is a space for solutions that connect multiple sectors and take into account the interplay of climatic and non-climatic factors (e.g., urbanization, land-use changes/repurposing).

Increasing government measures for more efficient and sustainable land use can reduce fire risks. Investing in abandoned rural areas, measures for improving agricultural land potential, and developing extensive crops and livestock farming should additionally reduce the risk of uncontrolled spread of fire. Agroforestry was developed in rural areas; however, this type of management was abandoned due to the relocation of a large part of the population to cities. This system includes a combination of tree cultivation and agricultural crops or livestock in the same production area, which reduces flammable fuel and unkempt land. Carrying out mandatory silvicultural care and restoration techniques in state-owned and especially private forests (where

[128] Posavec et al. 2023.

they are often not carried out) should be analyzed and monitored at a higher level.[129] So far, the application of individual post-fire recovery and rehabilitation measures has not been included in the governance framework. Post-fire regeneration mainly refers to the cleaning of burned areas and the removal of burned and partially burned remains in two years. Encouraging adapted agricultural production together with proper silviculture in fire-prone areas should be adopted.[130] Increment of favorable state instruments and support financial programs together with commercialization of preventive and post-fire restoration measures can create a more resilient and less suitable environment for the occurrence of catastrophic fires.

[129] Kisić, I., I. Bogunović, D. Delač, D. Barčić. 2023, Link.
[130] Pagadala 2024, Link.

UNDERSTANDING WILDFIRE RISK AND USE OF RISK DATA

This chapter focuses on current understanding of wildfire risks and impacts in Croatia and examines the country's wildfire risk assessment framework. It emphasizes the legislative, institutional, and methodological aspects to analyze and address wildfire risks at various administrative levels and examines the roles of key stakeholders in wildfire risk analytics. Additionally, challenges and opportunities for enhancing the quality of wildfire risk assessments are identified.

DRM CONTEXT

The NRA process in Croatia, governed by the Civil Protection System Act, requires ministries and government institutions to develop risk assessments at the national, regional, and local levels. The process adheres to EU and ISO guidelines and has produced NRAs in 2015, 2019, and 2024. The risk assessment framework involves a main working group and hazard-specific working groups composed of scientific and academic experts. The assessments include hazard identification, scenario analysis (most probable and worst-case), risk matrix evaluations, and capacity assessments for prevention and response. Key hazards include earthquakes, floods, forest fires, extreme temperatures, and industrial accidents. Risks are categorized as unacceptable, tolerated, or acceptable based on likelihood, impact, and mitigation capacity. The 2022 risk assessment introduces updated guidelines emphasizing economic and social vulnerability, direct damage, and broader considerations like public infrastructure and critical services. Vulnerability metrics such as poverty, unemployment, and literacy rates are factored into evaluations. Hazard-specific risk maps and matrices are developed by ministries in collaboration with scientific institutions, supported by the National Platform.

CURRENT ARRANGEMENTS

Understanding wildfire risk in Croatia is supported by local, national, and international risk knowledge. Understanding risk more generally to inform wildfire risk management in Croatia is based on several different reports and knowledge products, including EFFIS annual reports[131] published by the EU. However, in terms of national documents adopted under national legislation and formally meant to inform DRR activities, including wildfire risk management, in the country, the NRA is the central document.[132] For wildfire disaster cases, each year a Program of Activities for the fire season is brought where planning, preventive, operational, and supervisory activities are adopted.[133] Several Croatian laws encompass and elaborate wildfire risk management. The Ordinance on Forest Fire Protection gives criteria for assessing forest fire risk, including several measurements of parameters to estimate fire danger.[134] It relates to forest management plans of economic units. The Law on the Civil Protection System provides the role and establishes measures and activities to regulate the rights and obligations of all parts of the civil protection system.[135] Each county and big city has existing fire protection plans and fire danger assessments.

Croatia's NRA serves as a cornerstone for understanding wildfire risk, emphasizing cross-sectoral collaboration and standardized methodologies. The NRA, first established in 2015 and updated in 2019 and 2024, is central to Croatia's DRM strategy. It is designed to enhance the understanding of risks and vulnerabilities, inform planning and investment decisions, and provide a standardized framework for risk assessments across all levels and sectors to ease updates. The

[131] EFFIS, Link.

[132] The 2019 Disaster Risk Assessment for the Republic of Croatia was adopted under Article 10(1) of the Code of Art, Law on the Civil Protection System (Official Gazette, Nos. 82/15 and 118/18). The 2024 NRA was adopted under Law on the Civil Protection System ('Official Gazette', No. 82/15, 118/18, 31/20, 20/21 and 114/22.).

[133] GoC 2024c.

[134] GoC 2014b.

[135] GoC 2015.

2024 NRA reflects Croatia's evolving risk landscape, analyzing 16 natural and technological hazards—compared to 11 in 2019—and incorporates updated methodologies, including considerations for compound risks. It adheres to international, national, and EU standards, including ISO 31000,[136] IEC 31010,[137] UNDRR Guidelines for national disaster risk assessment,[138] and EU methodological guidelines,[139] categorizing risks as acceptable, tolerable, or unacceptable based on current and projected scenarios. The risk assessment quantifies the effects of wildfires on three social categories (human life and health, economy, and social stability and politics) and considers complex aspects such as cross-border impacts and cascading effects.

Compared to 2019, the 2024 NRA considers the effect in a more systematic approach and classifies the impact of climate change on disaster risk into four categories: extremely negative impact, negative impact, no or negligible impact, and positive impact.[140] Projections indicate possible increase of disaster risk by revealing the occurrence and intensity of natural threats, showing vulnerability and changed areas of exposure. Based on projections, Croatian parliament establish Climate Change Adaptation Strategy by 2040 with a view to 2070.[141] In forest sector, the trend in the number of wildfires shows that there were significantly more of them in dry years and in the Mediterranean area, while projections show that the risk of wildfires will be greater in the future in the entire Croatia. The Adaptation Strategy proposes a total of 83 measures, of which three measures can be considered general (modeling, strengthening knowledge and capacity, and development of indicators of the effects of implementing the Adaptation Strategy).

In addition, the Ordinance on Forest Fire Protection outlines the criteria for forest fire assessment, which allows the classification of all forests in Croatia into four levels of fire danger and the identification of forests prone to high wildfire risks.[142] The criteria are based on six key parameters that determine forest fire risks, including vegetation cover, anthropogenic factors, climate, habitat, orography, and maintenance of forest stand. The influence of all built-in factors is converted to a sum of points with a value between 115 and 580 points. Depending on the total number of points, all forests in Croatia are classified into four levels according to the risk of forest fires: very big (>480 points), big (381–480 points), moderate (281–380 points), and small (<280 points). The criteria are used by legal entities that manage forests and forest lands on the basis of special regulations, as well as counties, cities, and municipalities in whose territory forests and forest lands owned by forest owners are located, to classify forests in their respective areas according to forest fire risk levels.

A framework is in place mandating fire risk assessments for specific assets at building, municipality, and county levels. The Regulation on the Preparation of Fire and Technological Explosion Risk Assessments outlines the content and methodologies to prepare fire and technological explosion hazard assessments to inform prevention and firefighting measures and to be used for the development of fire protection plans.[143] According to the regulation, these assessments should include an analysis of the current state, quantitative analysis of fire risk, expert evaluations on risk and current fire protection systems, and recommendations for reducing risks. The recommendations for reducing risk can be of varied nature, including prevention measures, change of purposes of buildings/zones, improvement or resilience upgrades, enhanced fire extinguishing or alarm installations, or other firefighting capacity improvements, among others. The regulation also outlines the necessary content of vulnerability assessments of assets and data required, including, among others, on population, buildings, critical services, firefighting equipment and capacity, and inspection results from dangerous zones and activities and analysis of fires that have

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[136] ISO 31000 is an international standard that provides principles and guidelines for risk management. It outlines a comprehensive approach to identifying, analyzing, evaluating, treating, monitoring, and communicating risks across an organization. *See* ISO. 2018. Link.

[137] IEC 31010:2019 is a double logo standard with ISO that provides guidance on the selection and application of techniques for assessing risk in a wide range of situations. The techniques are used to assist in making decisions where there is uncertainty, to provide information about particular risks and as part of a process for managing risk. *See* ISO. 2019. Link.

[138] UNDRR. 2017, Link.

[139] Including the EC Guidelines for risk assessment and risk mapping for the purpose of disaster management (SEC(2010) 1626 final version, 21 December 2010), Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks, and JRC/EC Recommendations for national risk assessments for disaster risk management.

[140] *See* 2024 NRA Chapter 7 Climate Traffic Light.

[141] Climate Change Adaptation Strategy of the Republic of Croatia, Link.

occurred in the last decade.[144] The data and information gathered during the risk assessment process are treated confidentially. The regulation also prescribes the use of either Croatian nationally recognized methods or internationally recognized methodologies (TRVB 100, Euralarm, Gretener, DOW Index, and similar) for the risk assessments to ensure standardization.

The wildfire risk assessment process is notable for its cross-sectoral and cross-institutional approach. For the development of the NRA, coordination involves the assignment of specific threats to competent authorities and the development of preliminary disaster scenarios.[145] These threats are then evaluated by a cross-institutional group against several impact metrics: loss and damage with a focus on lives lost and people affected, economic impacts including financial damage, and extended societal damage including impacts on infrastructure and basic service delivery. This analysis helps determine the 16 key risks to be further analyzed in the NRA. This structured approach fosters collaboration and information sharing, enhances the continuity of data sharing and transparency among local and national institutions, and creates a strong foundation for future updates and analytical projects by harmonizing methodological approaches. The NRA also emphasizes the importance of improving risk factor analyses, harmonizing data collection methodologies, and bolstering intersectoral cooperation through platforms such as the Croatian Platform for Disaster Risk Reduction. So far, through the activities of the Platform, key strategic and planning documents related to disaster risk reduction have been prepared, which are coordinated by MoI. As well, for Platform, it is necessary to intensify activities on collecting data on vulnerabilities and damages in order to fulfill the obligations from the SFDRR, and to monitor the implementation of the NDRMS until 2030.

Multiple institutions play a critical role in wildfire risk monitoring and assessments. There are notable contributions from DHMZ, HVZ, the MoA, and Croatian Forest Ltd., the MoI's Directorate for Civil Protection, and the Ministry of Defense special operational fire unit.[146] DHMZ is responsible for monitoring daily real fire index threats across 40 key stations indicating fire ignition and spreading and then submitting these for the April-October season to the other key institutions. The MoA and Croatian Forests Ltd. provide continuous access to HVZ to data recorded in the Forest Fire Register on the number of fires, location, type, cause, size, damage reports, and interventions. Based on information from DHMZ and others, the MoA develops annual reports on the fire season with an assessment of wildfires considering fire intensity and distribution at the national level (spatial distribution of monthly and seasonal intensity - Monthly Severity Ratings (MSRs) and SSRs, comparison with multi-year averages, and analysis of consecutive dry days and period depending on fuel types). NRAs are also informed by fire risk assessments undertaken at county levels. The Government of the Republic of Croatia determines coordinators of individual risks. For fire risk, the coordinator is HVZ, and executors are MoI and Civil Protection, HVZ, MoA, Croatian Forests Ltd., DHMZ, and Faculty of Forestry and Wood Technology.[147] For fire risk, a working group of various experts from different fields and sectors is determined.

[142] Official Gazette, Ministry of Interior 2024.

[143] GoC 1994, Link.

[144] The current situation for buildings should be evaluated using the following data on assets: surface, occupancy, type of building and key structural features, substances stored and used in the building, results from inspections and analysis of dangerous zones, reliability of assets functionality, analysis of reliability of basic services (roads and accessibility for fire trucks, water supply status and backup sources, power supply, IT and telecom systems and so on), trained employees and surrounding fire units for firefighting, fire load of buildings, state of first aid services and overview of registered fires and impacts in the last 10 years. At the municipality/city level, the data would be equivalent but at the city scale (surface; population; legal entities in the economy with increased fire hazard; inspection results of industrial zones, power plants, locations with hazardous content or activities, fire stations, buildings with a large number of occasional or permanent residents - schools, hospitals, cultural facilities and so on), settlements that are inaccessible to fire trucks or with insufficient fire-extinguishing equipment, overview of road/railway routes, tourist resorts, settlements where fire hydrant networks are installed, agricultural and forest areas, review of natural water sources usable for extinguishing, telecom systems, state of first aid services and overview of registered fires and impacts in the last 10 years. The data to be collected at the county level are equivalent to the municipal/city level.

[145] Each threat first identified (35) is assigned a coordinator and competent authority of the state administration to create preliminary scenarios (descriptions of events that can be declared a disaster).

[146] Posavec et al. 2023.

[147] GoC 2014, Link

Croatia is advancing fire risk and monitoring data from various sectors. The 2024 Program of Activities in implementing special fire protection measures includes several requirements for institutional stakeholders on monitoring and data sharing.[148] DHMZ is responsible, as stated above, for sharing weather and meteorological data and wildfire hazard data on a regular basis and in structured comprehensive weekly, monthly, and annual reports. The Croatian Forests Ltd. and MoA are obliged to provide HVZ and territorially competent fire brigades of the counties and City of Zagreb with free up-to-date data on categories of wildfire risk and other important underlying information in digital georeferenced form respectively for publicly and privately owned forests.[149] The transport public institution agency Croatian Roads Ltd. also needs to share with HVZ data on public roads in georeferenced form. MoI and the Civil Protection Directorate need to record ignition causes and damage caused by fires in open areas. Competent services within MoI, HVZ, MoA, and Croatian Forests Ltd. are also required under the program to develop a single analytical methodology to ensure better quality statistical data management, analysis of wildfires, and inform DRR planning, with MoA being specifically responsible for improving methods to calculate hazard index for vegetation fires in open spaces. Additionally, during fire seasons and periods of high fire risk, several entities must provide round-the-clock monitoring and alert services, supported by georeferenced data shared with HVZ. This data-driven, preventive approach is reinforced by the integration of GISs for real-time information sharing among firefighting and forestry services via MoI, the Civil Protection Directorate, and HVZ for operational and strategic planning purposes. VATROnet is the central database of the HVZ members, employees, equipment, vehicles, and activities.[150]

The Firefighting Center for Education and Technological Development Split–Vučevica (V.A.C.E.T.R.A.S.) was established by the Firefighting Association of the Split-Dalmatia County as a public institution to serve the educational needs of the firefighting system.[151] The center's mission is to ensure a high standard of training for firefighters and rescue teams, preparing them for a wide range of challenges and intervention scenarios. This hub serves as a key administrative and logistical base for specialized firefighting units, acting as a center of excellence for wildland fires and maritime incident response. It comprises various facilities and training grounds that enable firefighters and rescue teams to receive top-tier training and preparation for diverse scenarios.

CHALLENGES AND OPPORTUNITIES

Strengthening fire risk assessment processes and cross-sectoral collaboration is critical to improving wildfire risk management in Croatia. Risk and vulnerability assessments are regularly updated; however, the treatment of wildfires within these evaluations remains underdeveloped. There is a clear need to develop dedicated assessments specifically addressing wildfires in open areas, as well as tailored evaluations for counties situated in the continental regions of Croatia. Achieving this will require amendments to the existing legal framework. While Croatia has a strong foundation for wildfire risk assessment through the NRA and regulated fire risk evaluations at various administrative levels, challenges remain in ensuring comprehensive, standardized, and actionable outputs through scientific approaches. Implementation of regulations and frameworks could be strengthened by enhancing the consistent application of standardized methodologies and technical guidelines and standards to allow fully comparable results across counties and seamless data sharing among stakeholders. Addressing these gaps through enhanced frameworks for collaboration, more frequent updates to risk assessments, and the integration of real-time data-sharing systems can strengthen the country's preparedness. The requirement in the 2024 Program of Activities to develop a single analytical methodology for wildfire analysis can unify disparate data sources, help integrate datasets into GIS and improve real-time monitoring and forecasting for risk decision-making. Opportunities also lie in leveraging existing platforms such as the Croatian Platform for Disaster Risk Reduction to further harmonize risk analyses, enhance information sharing, and ensure consistency across institutions and regions. However, challenges in collecting reliable data may impact the accuracy of

[148] GoC 2024, Link.

[149] Other data include forest communities, forest area boundaries (economic division - management units, departments and sections), forest roads, monitoring stations, and averages, categorized forest values (.shp, Feature Class format).

[150] GoC VATROnet, Link.

[151] VACETRAS, Link.

risk assessments. An accurate, innovative methodology is needed for risk management to generate precise and comprehensive data.

The NRA's recommendations further emphasize strengthening intersectoral cooperation and integrating scientific expertise into DRR strategies. Recommendations in the NRA encourage progress particularly regarding four aspects related to wildfire risk assessments: (a) improving analysis of risk factors and harmonizing methodologies for data collection, processing, and impact assessments, (b) further strengthening intersectoral cooperation for comprehensive risk management, with the Croatian Platform for DRR playing a significant role as an exchange and coordination platform, (c) facilitating and improving the involvement of scientists in the development and implementation of DRR solutions, and (d) strengthening institutional stakeholders responsible for education, capacity building, and knowledge transfer for DRR. These coordinated efforts encourage a unified approach to addressing wildfire risks and help ensure that both prevention and suppression measures are informed by robust data and shared knowledge.

Improving capacity building and compliance can address gaps in local implementation and firefighting readiness. Despite a robust regulatory framework, variations in local implementation remain a challenge, with some counties lacking the capacity to obtain all necessary data and information to conduct thorough risk assessments or effectively implement recommendations. Compliance with fire risk assessment guidelines, enforced through inspections and fines, can be bolstered by expanding training programs for local fire departments and administrations. Opportunities also exist to enhance firefighting readiness by increasing investments in fire detection systems and providing targeted support to counties with high fire risks but limited resources. Improving, maintaining, and regularly updating an online database of all fire cases and information should be recommended for monitoring and understanding fires, while developing tools and scenario modeling to assess the effect of climate change on wildfire risks and impacts is also crucial to inform better decision-making and allocation of resources and fundings for wildfire prevention. Technology can play a significant role in improving the ability to assess and manage wildfire risks. Continuous investment in knowledge, sharing of good practice examples, and education will help in the development and maintenance of these necessary capacities. Strengthening these capacities at the local level will help ensure the consistent and effective application of national standards while boosting overall wildfire resilience.

WILDFIRE RISK PREVENTION, REDUCTION, AND MITIGATION

This chapter focuses on Croatia's efforts in wildfire risk prevention, reduction, and mitigation. It presents the various prevention measures and activities implemented in forests and other endangered areas by public and private stakeholders in accordance with national laws, including traditional preventive measures as well as new, innovative tools. Additionally, challenges and opportunities for enhancing the effectiveness and efficiency of wildfire prevention and risk reduction are discussed.

DRM CONTEXT

In line with the governance framework, planning and prevention activities in Croatia fall under the jurisdiction of the Ministry of the Interior (MoI), relevant line ministries (depending on the hazard), and sub-national authorities. In 2023, Croatia approved the NDRMS for 2030, which provides a comprehensive strategic framework for enhancing disaster resilience across all hazards identified in the NRA. The strategy reinforces the principle that "disasters are everyone's business" and underscores the importance of a collaborative approach to risk reduction. On the other hand, DRM funding in Croatia is sourced primarily from the state budget and local budgets, complemented by EU and other international funding. These funding resources have been utilized for various purposes, including enhancing operational readiness and capacity, raising public disaster risk awareness, and, more recently, integrating energy efficiency measures and seismic retrofitting. While a comprehensive overview of existing public and private, national and international funding opportunities and synergies is not available, it is estimated that between 2014 and 2024, Croatia has made several investments in DRM through national programs funded by the state budget, alongside various programs from EU investments, including from Cohesion Funds, NRRP, and UCPM, among others.

CURRENT ARRANGEMENTS

In Croatia, prevention measures regarding fire protection are defined by national laws and strategic plans and implemented by public stakeholders and private forest owners. Based on the risk assessments and fire protection plans, local self-government units, public institutions of national parks and parks of nature, Croatian Forests Ltd., and private forest owners are obliged to implement fire prevention measures in forests, endangered areas, and buildings and areas along railway and road routes in their areas of responsibility.[152] A list of prevention measures is provided in the Ordinance of Forest Fire Protection, including fuel management, the establishment and maintenance of firebreaks and forest tracks, observation stations in special elevated places in fire-prone areas, the establishment of water supply points.[153] Moreover, additional fire protection measures will be implemented every year according to the Program of Activities in the Implementation of Special Fire Protection Measures of Interest.[154] Some of these measures are implemented from a cross-sectoral perspective in key relevant sectors (for example, agriculture, forestry, transportation, waste management), such as measures for landfill regulation, the rehabilitation of uncontrolled 'wild' landfills, or clearing and thinning of forests near campsites.[155] The program also provides funding for the implementation of the measures. In recent years, fire prevention has been mainstreamed in spatial plans, landscape protection plans, and sectoral plans in the country. Examples include the revitalization of old olive groves and the implementation of new bike paths with firebreaks and evacuation exits.[156]

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[152] National laws and strategic plans: the Fire Protection Act, the Firefighting Act, the Program of Activities in the Implementation of Special Fire Protection Measures of Interest to the Republic of Croatia, and the Ordinance on Forest-Fire Protection; GoC 2024c.

[153] GoC 2014b.

[154] GoC 2024c.

[155] Delač, D., I. Kisić, Ž. Zgorelec, A. Perčin, P. Pereira. 2022a, Link.

[156] Interreg Italy-Croatia 2022, Link.

For state-owned forests, prevention measures are implemented by the state-owned forest management company Croatia Forests Ltd. The company has made efforts to reduce forest fire risks by implementing various types of forest protection measures and emphasizing on preventive activities, especially during the forest fire season. In 2023, a total of €12.9 million was spent on the implementation of wildfire protection measures, such as fire protection of roads and openings, observation stations, warning signs, forest guarding, and video surveillance systems.[157] For traditional, physical prevention measures, 50 km of new fire protection roads are built annually in the forests managed by Croatia Forests Ltd. on average, and around 800 km of roads are maintained every year. An observation and report service has also been established, with around 500 forest guards employed and regular observations on foot and by vehicles organized. In addition to the implementation of prevention measures, sustainable and climate-smart forest management practices have also been considered, such as forestry and silvicultural works for the purpose of increasing wildfire resilience of forests.[158] During the wildfire season, which start each year on June 1st, additional efforts have been made, such as enhanced forest guarding during the spring and summer. The company has also been collaborating with local fire departments on wildfire prevention.

In addition to the implementation of technical prevention measures, efforts have also been made in the supervision and surveillance of critical locations at potential fire risks. According to the Program of Activities in implementing special fire protection measures, the Police Directorate and the Civil Protection Directorate under MoI carry out regular surveillance in locations that are at potential risks of wildfire occurrence and spread, such as legal and/or illegal waste dumps, high-risk forests, neglected agricultural lands, and other risky open areas.[159] Areas along all types of roads (state and local roads and motorways) are also monitored. People in the high-risk areas are recorded, while the use of flammable and explosive substances is controlled. Before and during the summer fire season, inspections and surveillance are increased, primarily of open spaces and tourist facilities on the coast. Croatian Forests Ltd. has also established an observation and reporting system, with around 500 forest guards carrying out regular surveillance in 2023 and an additional 320 temporary employees to support observations during the fire.[160] The service operates from June 1st to September 30th, and longer if necessary. It is active 24 hours a day in forest areas categorized as Level 1 fire risk. It includes lookouts stationed at permanent observation points (watchtowers), as well as patrols that monitor the terrain by vehicle and on foot. During the tourist season in summer, Croatian Forests Ltd., following special instructions and orders, maintain and remove vegetation around tourist areas such as campsites.

Croatia has also been consistently investing in innovative solutions for wildfire monitoring and forest surveillance, which are effective in terms of wildfire reduction. This includes different tools that monitor and provide warnings about fires in real-time conditions, both at large scales based on satellite imagery and fire information systems and at local levels based on cameras or drones.[161] According to the 2014 Ordinance on Forest Fire Protection, it is necessary to carry out fire detection and monitoring through video surveillance systems, which include information technologies for preventive and optimal operational actions while minimizing the damage caused by forest fires.[162] Nevertheless, it was only after the devastating 2017 wildfire season that the development of video surveillance of forests for wildfire protection was prioritized and promoted.[163] With cross-sectoral collaboration and administrative and technical support from multiple stakeholders and government authorities, Croatia has developed its own Integral Forest Fire Monitoring System, the IPNAS, which is an integrated and intelligent forest fire monitoring and observation system based on video cameras, a combination of different data types (video signals, weather data, and GIS information), and AI technologies.[164] Croatian Forests Ltd. has also developed a video surveillance system for forests in Dalmatia, Istria, Primorje, and Lika.[165] Until the end of 2023, 138 cameras were installed at 69 locations, and the application for EU funding is under way for 41 new locations in 2024. The surveillance systems have proved to be efficient in Croatia, as evidence suggests that the number of fires has been considerably reduced.[166]

[157] Musa 2024.
[158] Ibid.
[159] GoC 2024d.
[160] Musa 2024.
[161] Interreg Italy-Croatia 2022.
[162] Official Gazette, Ministry of Interior 2024.
[163] Musa 2024.
[164] Božović, D., M. Knežević, M. Aleksić, O. Iker, and L. Gostimirović. 2022.
[165] Musa 2024.
[166] Ibid.

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[167] Interreg Italy-Croatia 2022.
[168] Official Gazette, Ministry of Interior 2024.
[169] Musa 2024.
[170] Božović, et al 2022.
[171] Musa 2024.
[172] Ibid.

Table 3. Forest fire protection measures implemented by Croatian Forests Ltd in 2023
Source: Croatian Forests Ltd.

Measure	Quality	Cost (€)
Construction of fire protection roads (km)	114.74	108,819.17
Observation service (ha)	1,139,142.86	2,866,290.35
Construction of observation stations (pc)	1	9,900.00
Maintenance of observation stations (pc)	4	9,397.74
Construction of fire protection openings (km)	5.33	6,843.75
Maintenance of fire protection openings (km)	2,168.63	479,527.08
Construction of fire protection openings with road el.(km)	51.76	1,188,969.88
Maintenance of fire protection openings with road el. (km)	818.76	3,550,778.14
Setting up of warning signs (pc)	2.611	11,189.19
Cleaning of stands, low pruning (ha)	185.68	450,924.13
Forest guarding (wd)	503,789.64	3,354,670.11
Firefighter advertisement (TV/radio spots, commercials and similar)		163,107.20
Video surveillance, basic contract (in Dalmatia, 2022-2025)	49.00	528,110.50
Expansion of video surveillance (in Dalmatia, 2023-2025)	4	42,126.08
Video surveillance (in Istra, Primorje, and Lika, 2023–2025)	16	174,477.02
Total		12,945,130.34

CHALLENGES AND OPPORTUNITIES

By promoting sustainable management activities, integrated fire management can help to preserve forest ecosystems and related ecosystem services. In Croatia an integrated approach links the four steps of crisis management: mitigation, preparedness, response and recovery. However, when it comes to disaster preparedness, in Croatia only 2 percent of funds are invested in prevention, while 98 percent are spent on operational disaster response capacities. Integrated fire management highlights the importance of shifting the focus from fire suppression to fire prevention and terrain recovery, suggesting the integration of pre- and post-fire management to reduce fire risk and impacts. The costs of replanting and restoring damaged forests far exceed the investment required by fire prevention initiatives. In this regard, although prevention programs have a smaller budget compared to fire suppression, the FAO considers forest fire prevention "the most cost-effective and efficient mitigation program that a competent authority or community can implement." However, in Croatia, the greatest threat in the Mediterranean region comes from neglected and abandoned private properties, which often have unclear or unresolved ownership issues. According to the laws, such properties should be maintained by their owners, but due to abandonment, they are often left neglected and become sources of highly flammable vegetation, especially during the summer period. These areas are frequently the origin and starting points of large and catastrophic wildfires during the summer.

Although Croatia has been mainly focusing on fire suppression in the past, the importance of shifting from suppression to prevention has been recognized in recent decades, leading to the [173] at state and local levels. Nevertheless, variations in local implementation remain a challenge, with some counties lacking the technical capacity and funding to implement effective prevention measures. Enhanced capacity building, financing, monitoring and evaluation could help wildfire prevention in counties with high fire risks but low capacity. In addition, there is also lack of clarity on the responsibility for maintenance of firebreaks and roads between the Croatian Forests Ltd. and private forest owners. Enhancing collaboration between national and local authorities and between public and private stakeholders could help address this situation and improve fire prevention. International knowledge exchange is also crucial, especially with fire-prone countries in the Mediterranean areas and neighboring Western Balkan countries facing cross-border fire risks. Moreover, a common methodology and clear criteria (for example, cost-benefit analyses, cost-efficiency, multi-criteria analysis) could also be helpful in prioritizing specific investments or actions.[174]

Continuous investments in innovative, digital information and monitoring systems could help enhance wildfire prevention and risk reduction. Technology for fire monitoring and detection has greatly improved in the past decade and has proven effective in reducing the number of wildfires in the country. Therefore, it is crucial for the country to continue to support the development of more advanced technology for fire monitoring and detection and the expansion of the surveillance network, while EU and innovative projects could also be further explored. A few initiatives have been launched. For instance, Croatian Forest Ltd. will extend its video surveillance system to the continental part of the country, in areas under wildfire risks such as Karlovac and Vinkovci.[175] Moreover, as stated in the Program of Activities in implementing special fire protection measures, an Expert Conference on 'the Development and Introduction of New Methods, Techniques, and Technologies in Fire Protection' will be held at least once every two years, organized by the HVZ, MoI, and the Ministry of Science and Education, while a Plan for the Scientific and Technical Improvement of Fire Protection in the Republic of Croatia will be developed annually.[176]

[173] Interreg Italy-Croatia 2022.

[174] 'The new Union Strategy on Adaptation to Climate Change (COM/2021/82) instructs Member States to step up their action to make climate change adaptation faster, more systematic and knowledge based. Regulation (EU) 2021/1119 obliges Member States to ensure continuous progress in adaptive capacity, increasing resilience and reducing vulnerability'; 'The guidelines for the climate [risk analytics to undertake as a basis for the definition of climate adaptation measures] shall be adopted by the minister responsible for climate change by decision with the prior consent of the minister in charge of coordination of the strategic planning system. [...] The Ministry shall publish on its website the guidelines for the climate risk analytics." *See* N1 Zagreb, Hina. 2025 Government introduces bill on climate change to parliament. Link.

[175] EU fundings and innovative projects could also be further explored.

[176] GoC 2024d.

Enhancing the fire resilience of critical infrastructure and networks is also crucial given the high exposure to wildfire risks. Given the high exposure of emergency response-related assets to wildfire, it is necessary for Croatia to enhance the fire resilience of critical infrastructures through the implementation of building standards and guidelines and retrofitting programs. Building regulations and construction guidelines should be in place to promote the use of fire-resilient materials and the implementation of smoke infiltration and water supply protection. More investments in retrofitting programs for public buildings should be made based on results from exposure assessments. Such retrofitting could also be combined with seismic resilience and energy efficiency measures to achieve additional co-benefits. A few projects have been launched under national or EU initiatives. For instance, the ongoing project 'Resilience and Protection of Critical Entities in Europe' is implemented by the MoI's Civil Protection Directorate under the EU Directive 2022/2557.[177] The project focuses on enhancing resilience and reducing the vulnerabilities of critical infrastructure in 11 key sectors to better prevent and mitigate incidents disrupting the provision of essential services.

Mainstreaming wildfire prevention into sectoral planning and promoting climate-smart forest management (especially in WUIs and counties with high wildfire risks) can help Croatia further enhance fire risk reduction under future conditions. Currently, Croatia focuses mostly on the implementation of traditional prevention measures, such as the construction of fire breaks and observation stations. Nevertheless, with increased climate impacts, more sustainable and climate-smart forest management practices should be introduced in fire-prone areas to enhance the resistance and resilience of forests to fires. These practices include mixed tree species and reduced tree density in new woodland creation. Proper land management, such as regular farming, diverse cultivation, agroforestry, grazing, and silviculture, can enhance the resilience of landscapes to wildfires.[178]

Prescribed burning is an effective way to reduce wildfire risks and should be promoted, with regular training programs and rural campaigns for prescribed burning implemented on a regular basis. Examples from European countries, such as the five-year LIFE Taiga project in Sweden and the 2019 prescribed burning TREX in Andalucia, have shown how prescribed fires help enhance land use, ecosystem restoration, and wildfire resilience by removing fuel load.[179] These early prevention measures could reduce wildfire risks while generating environmental and biodiversity co-benefits. A pilot project called Dinara back to LIFE was implemented in Croatia, where controlled burning was tested on 7 hectares of overgrown grasslands as part of efforts to restore habitats and prevent ecological succession (i.e., the spread of shrubs and forest).

Meanwhile, the inclusion of fire prevention in spatial planning in fire-prone areas (such as the WUI), as well as in rural and forest land use planning, is crucial to address wildfire causes and reduce fire risks. This includes promoting measures such as the establishment of buffer zones in WUI areas and planting of vegetation characterized by high moisture content, low flammability, and combustibility. It is reported that most of the budget is spent on firefighting and less on prevention. Prevention strategies should include management of land and the environment as key points for wildfire hazards. Creating a mosaic landscape with different habitat types and vegetation can lead to more effective fuel load management and fire prevention. In Ireland, sustainable farming and integrated vegetable and habitat management measures have been implemented in upland areas to reduce wildfire risks, while the EU GrazeLIFE project supports efficient fuel load management through grazing for wildfire prevention while generating co-benefits in promoting adaptation and biodiversity-rich ecosystems.[180]

[177] EC 2024a, Link.
[178] Delač et al. 2022b.
[179] Nuijten, D., Onida, M. and Lelouvier, R.. 2021, Link.
[180] Nuijten et al 2021.

WILDFIRE EARLY WARNING AND PUBLIC AWARENESS

This section focuses on wildfire early warning and awareness raising in Croatia. It presents the various measures and activities to provide timely warning and enhance public awareness in accordance with national laws, such as wildfire forecasting and warning, communication systems, and public awareness-raising programs. Additionally, challenges and opportunities for promoting awareness and enhancing the effectiveness of wildfire monitoring and early warning are discussed.

DRM CONTEXT

Croatia's risk communication and awareness initiatives are implemented at the national and local levels, focusing on continuous DRM education and practical skills for all age groups, from kindergarten to university. Through the National Platform geared by Civil Protection Directorate, awareness-raising activities include workshops, seminars, evacuation exercises, and creative initiatives like literary and art projects. They also include a specific 'action' brochure for every hazard that might affect Croatia, explaining the hazard and how to respond to it. Additionally, they provide different learning materials for children, such as animated videos explaining how to reduce disaster risk and how to respond to different catastrophes.[12] Online resources, such as dashboards with hazard and risk assessment data, complement these activities. Furthermore, DRR workshops and training events, often in collaboration with the Disaster Preparedness and Prevention Initiative for South-Eastern Europe (DPPI SEE) and UNDRR, promote a holistic, regional approach to resilience building and provide tailored education for school principals and local governments, fostering capacity development at all levels. Also, in August 2023, Croatia established the SRUUK EWS, co-financed by the EU, to notify citizens and civil protection participants about imminent dangers like natural disasters, epidemics, or other crises. Moreover, in Croatia, public alerts are issued through sirens, public address systems, electronic media, and mobile device messages. Each warning signal is accompanied by public communication that provides timely and essential information for effective protective action. Residents and visitors in specific areas of Croatia receive warning messages on their mobile devices in cases of extraordinary events that pose potential threats to life, health, property, or the environment. Such events include natural disasters, technological accidents, or human-induced incidents, such as floods, fires, hazardous material accidents, dam failures, or epidemics. Finally, surveys have been conducted in Croatia to assess citizens' disaster awareness. A 2024 report by the EC revealed that Croatian citizens feel most vulnerable to extreme weather events (43 percent), followed by geological disasters (39 percent) and human health emergencies (33 percent).[181]

CURRENT ARRANGEMENTS

In Croatia, DHMZ is responsible for providing wildfire forecasting and sending daily fire weather warnings to HVZ.[182] DHMZ provides long (seasonal and monthly), medium (weekly and half-weekly), and short (daily) range forecasts of wildfire risks, with the short-range, daily forecasts as the primary and most important activity. The daily forecast provides actual and prognostic fire danger classes based on the calculation and dissemination of the FWI, which relates to the state of fuels and weather conditions. Based on the fire danger classes, as well as three other criteria, wind speed, turbulence (TKE), and vertical instability (Haines index - HI), warnings on weather conditions particularly dangerous for the development and spread of extreme wildfires will be generated and categorized into one of three warning levels: yellow, orange, and red (Table 4). When the criteria are fulfilled, text documents and graphical products will be disseminated to HVZ for regions prone to wildfires. These reports integrate data from advanced forecasting models, ensuring that firefighting units are equipped with

[181] Disaster risk awareness and preparedness of the EU population: Croatia, EC Link.
[182] Kozarić 2024.

actionable insights for preemptive and reactive measures. The collaborative efforts of DHMZ, the MoA, and Croatian Forests Ltd. ensure that all wildfire monitoring systems are interconnected, facilitating effective responses to emerging threats during a wildfire event.[183]

In addition, fire warning and evacuation plans are set up at local levels and in key sectors or areas prone to fire risks. The local governments are responsible for issuing warnings and notifications on wildfire risks to the public through different local media, such as newspapers, radio stations, television, social networks, and the internet.[184] In addition, for fire-prone areas such as forests and nature reserves, fire monitoring and alert services are developed by relevant stakeholders, such as Croatian Forests Ltd. and public institutions of national parks. Moreover, for the tourism sector, county tourist departments need to identify tourist facilities (such as hotels and campsites) particularly at risk of fire and inform tourism companies. Tourist companies are required to develop evacuation and disposal plans that are aligned with national or local protection action plans as well as designate responsible persons and provide training for organizing and implementing activities at tourist facilities particularly at risk of fire. An expert conference focusing on the topic 'Fire Protection of Particularly Fire-Endangered Tourist Facilities' will also be held at least once every two years to enhance fire preparedness and awareness in the tourism sector.

To enhance public awareness and understanding of wildfire risks, information campaigns and awareness-raising programs have been developed, especially for targeted groups such as tourists and school children. Usually arranged at local levels by the county fire brigades and supported by leaflets and visual materials, these programs aim to educate communities about legal regulations and safe practices to mitigate fire risks. Some of the programs focus on special target groups such as local residents or tourists, while others provide special outreach campaigns during the summer when there is a higher wildfire risk. In addition, special attention must be paid to educating the public about the legal regulations prohibiting the burning of waste in open spaces.[185] The state-owned forest management company Croatian Forest Ltd. has also implemented a series of advertising and communication activities (both independently and in cooperation with the firefighting community) through different media and platforms, such as TV and radio spots, billboards along roads, warning signs, and information boards.[186] Moreover, Croatia has also made efforts in educating children and students about the importance of fire prevention for nature protection and firefighting for society. According to the 2024 Program of Activities in the Implementation of Special Fire Protection Measures, the Ministry of Science and Education needs to develop a proposal for a preventive curriculum and organize workshops to introduce school students to the dangers and consequences of fires and natural disasters while also raising the level of general awareness about them.[187] Education and awareness programs have also been developed by communities and organizations. For instance, the Croatian Agrometeorological Society has developed a fire education program 'Little School on Forest Fires' and an accompanying animated film 'Fire Is No Joke', which educates children in kindergartens and primary schools on fire danger and forest protection.[188]

CHALLENGES AND OPPORTUNITIES

Actions could be undertaken to enhance wildfire early warning and public education, especially at local levels. The 2024 fire season planning highlighted the significance of monitoring and forecasting and resource mobilization during high-risk periods.[189] A few measures and activities could be improved. For instance, the wildfire EWS could be enhanced so that it adopts an inclusive, community-based approach to providing timely warnings and is more connected to the local or sectoral contingency plans. The needs of vulnerable groups (such as the elderly, children, and low-income populations) could be further considered, such as providing special outreach and support during a wildfire event. Public education and communication activities on early wildfire warning could also be further promoted so that people know what to do and how to react more effectively when they receive a warning message. In addition, education and awareness programs could be held more regularly to enhance the overall level of awareness, with more engagement of the population and private sectors (especially key groups such as the vulnerable population, young people, and tourists) to enhance understanding of early warning signals, evacuation procedures, and fire prevention measures.

[183] GoC 2024c.
[184] GoC 2024c.
[185] GoC 2024c.
[186] Musa 2024.
[187] GoC 2024c.
[188] Croatian Agrometeorological Society 2024, Link.
[189] GoC 2024c.

New technologies have been developed to enhance fire monitoring and forecasting and public communication under national and EU initiatives. The Program of Activities in the Implementation of Special Fire Protection Measures has listed the development and introduction of new systems, techniques, and technologies as one of the key areas of action for fire protection and preparedness and requires joint efforts of different stakeholders at multiple levels.[190] Some of the actions include establishing a unified geo-information management system, holding regular expert conferences and seminars on the introduction of new methodologies and technologies for fire protection, improving interdepartmental cooperation, and promoting international knowledge exchange. In addition, multiple EU projects have been launched in Croatia, with the objective of enhancing awareness and understanding of wildfire risks to firefighters and the public through the implementation of new, innovative tools, such as video surveillance, wildfire risk visualization panels, satellite communication systems, and firefighting drones for the detection of wildfire incidents (see Box 1).

[190] Ibid.

Table 4. DHMZ fire weather warning levels

Source: Kozarić 2024. Note: Turbulence kinetic energy (TKE) is the mean kinetic energy per unit mass associated with eddies in turbulent flow, which is a measure of the intensity of turbulence in the atmosphere; Haines Index (HI) is a fire weather index based on the stability and moisture content of the lower atmosphere that estimates the likelihood of large wildfires.

Warning level	Yellow		Orange	Red
Fire danger class	Moderate	High and/or very high	High and/or very high	High and/or very high
Wind speed (ms^{-1})	>9 (5 hours or more)	6 to 9 (5 hours or more)	>9 (2–3 hours or more)	>9 (18 hours or more)
TKE (M^2S^{-2})		3 to 5 (5 hours or more)	>5 (2–3 hours or more)	>5 (18 hours or more)
HI		6 (5 hours or more)		

Box 1. Innovative EU projects on wildfire early warning and awareness-raising in Croatia

EU projects and initiative have been implemented in Croatia to enhance wildfire monitoring, early warning, and awareness-raising through new technologies and innovative approaches.

Funded by the EU Horizon 2020 Green Deal program, the SILVANUS Project aims to develop an integrated technological and information platform for climate-resilient forest management and wildfire prevention. In 2023, SILVANUS initiated a two-phase pilot project in Croatia, with Phase A focusing on public education and awareness raising and Phase B on firefighting exercises supported by new innovative tools.[191] During Phase A, an educational poster exhibition was organized in the city of Rijeka, featuring 10 two-sided bilingual (Croatian and English) posters that presented the main activities and objectives of SILVANUS, as well as messages and advice for citizens on wildfire prevention and response. For Phase B, a pilot exercise of wildfire suppression was organized by HVZ. The exercise was executed with the help of new technological tools, including video surveillance, Unmanned Aerial Vehicles (drones), ground robots, and modern satellite communication systems. The goal of the exercise was to test the effectiveness of firefighting operations in open spaces and various tactical approaches for fire suppression, as well as checking the road network and its interconnectivity and the well-functioning of the connection systems.

Through the EU scientific research project HOLISTIC (Adriatic Holistic Forest Fire Protection), a video surveillance system for wildfire monitoring and warning was installed to enhance wildfire operational and public preparedness. The system consists of multiple cameras set up in strategic locations, which automatically detect smoke and fires and send images to operational centers in Zagreb and Split.[192] Through image processing systems and fire propagation prediction software, the system enhances preparedness by allowing the operational center to quickly organize and disperse firefighting forces to the georeferenced fires. In addition, an automatic panel for wildfire risk visualization was implemented in nature reserves, with the objective of informing the public and raising awareness about the potential risk of wildfires for the given area.[193]

[191] SILVANUS 2023a, Link.
[192] Casartelli and Mysiak 2023.
[193] Holistic, Link.

WILDFIRE PREPAREDNESS AND EMERGENCY RESPONSE

This section focuses on wildfire preparedness and emergency response, which encompasses firefighting plans, training, and operational measures to reduce impacts, as well as improvement of operational preparedness to wildfire events. It provides an overview of Croatia's firefighting system by outlining the structure, roles, and responsibilities of professional and voluntary firefighters and key resources and measures for firefighting. The section also highlights coordination mechanisms across national, local, and international levels as well as the challenges and opportunities for enhancing wildfire preparedness and response.

DRM CONTEXT

The Civil Protection Headquarters functions as both an operational and coordinating body, and its Civil Protection Directorate aims to minimize risks, prevent consequences of risks, organize activities related to DRM, oversee the civil protection operational forces, and ensure smooth coordination among all the participants within the civil protection system. In times of disaster, it is responsible for overseeing and coordinating the activities of civil protection operational forces, both during the preparatory phase and throughout the implementation of civil protection measures. The headquarters operates at both the national level and within units of local and county (regional) self-governments. It is composed of representatives from relevant public administration bodies, operational forces of the civil protection system, and other key legal entities that play an important role in civil protection in Croatia. At the regional level, a total of 21 county civil protection headquarters have been established, representing 20 counties and the City of Zagreb.[194] In the Ready2Respond[195] Diagnostic conducted in 2022, emergency response, specifically search and rescue, was an area identified as very strong for Croatia.[196]

CURRENT ARRANGEMENTS

Croatia's dual-force firefighting system is structured to integrate centralized oversight with local implementation for effective wildfire management. Fire response and firefighting activities are regulated by HVZ[197] at the state level and operated by fire departments at local levels (see Figure 10 for the organizational structure of the firefighting system in Croatia). HVZ, funded by the state budget, shapes the firefighting system and coordinates the activities of local brigades in firefighting operations. It also carries out wildfire prevention activities such as the construction and maintenance of fire roads and monitoring of forests through a video surveillance system. The Chief Fire Commander of HVZ ensures the legality of operations of the Croatian Fire Brigades, equipment readiness, organization and readiness, and firefighter training. Meanwhile, local governments establish county firefighting departments and brigades, carrying out firefighting operations aligned with fire protection plans. The local fire brigades are under the jurisdiction of HVZ in operational and implementation terms.

Croatia's firefighting system is generally robust in terms of national and local setup for firefighting. Local governments are responsible for establishing county firefighting departments and brigades and carrying out firefighting operations in accordance with firefighting protection plans and with sufficient resources and equipment. There are currently 20 county fire departments in addition to the Fire Department of the City of Zagreb, 140,000 members of fire departments, and 62,000 operational and enforcement firefighters, which include both professional and voluntary firefighters (see Box 2).[198] The number of firefighters has been increasing since 2000 due to the introduction of new national legislation in alignment with the EU acquis and the

[194] GoC 2019g; GoC 2023a. Link.; GoC 2015a; GoC 2023a.

[195] The Ready2Respond (R2R) framework is a methodology that provides an understanding of existing EP&R capacities in a municipality, country or region and assesses 360 data points related to facilities, personnel, equipment, information and legal frameworks. See GFDRR and World Bank 2017, Link.

[196] A brief summary of the results is included in World Bank 2024b.

[197] Croatian Firefighting Association (Hrvatska Vatrogasna Zajednica) 2024, Link.

[198] Ibid.

expansion of protection criteria.[199] In terms of firefighting vehicles, there are 5,712 fire trucks currently in use, along with six Canadair CL 415 planes, six Air Tractors AT-802 A Fire Boss, one Mi-117-Sh helicopter, one PC-9 M aircraft (reconnaissance and other tasks), and BZS "Orbiter 3" under the jurisdiction of the Ministry of Defense.[200] Local governments are also the main source of funding for firefighting activities within their areas, including expenditures on regular operations, equipment and training, and capital investments. EU funding resources for enhanced wildfire responses, such as EU-subsidized purchase of firefighting equipment, are also distributed to the fire departments through local budgets.

[199] Fabac, R., D. Đalog, V. Zebić. 2015, Link.
[200] Croatian Firefighting Association 2024.

Box 2. Professional and voluntary firefighters in Croatia

Croatia has a dual-force firefighting system that relies on joint efforts of professional and voluntary firefighters and robust coordination between stakeholders at multiple levels.

The dual-force system of professional and voluntary firefighters enhances Croatia's capacity to respond to wildfire risks. Professional firefighters are regulated under the Law of Public Institutions, while voluntary firefighters follow the Law of Associations of Citizens.[201] The Law on Firefighting outlines the requirements and responsibilities of professional and voluntary firefighters. Both groups collaborate closely in fulfilling firefighting duties. For instance, professional firefighters meet specific qualifications, while voluntary firefighters, who often serve as supplementary forces during fire seasons, undergo training to ensure readiness. There are currently 3,500 professional firefighters in Croatia, employed in public fire departments, professional fire departments in the economy, voluntary fire companies, fire departments of municipalities, cities, regions, counties, the City of Zagreb, the Croatian Fire Department, or other legal entities.[202] Voluntary firefighters serve as an additional force in firefighting operations, as professional firefighters have limited capacity to cope with all fire events throughout the country. Both professional and voluntary firefighters are financed by local governments, which provide funding for firefighting activities, equipment, and training in their areas.

Effective wildfire management in Croatia relies on robust coordination between stakeholders at the national, local, and international levels. Wildfire response in Croatia necessitates joint efforts between various firefighting forces and stakeholders. When a wildfire occurs, HVZ receives early warnings issued by DHMZ, which include detailed text and graphical forecasts. HVZ then directs firefighting operations based on this warning and coordinates county fire departments to deploy both professional and voluntary brigades, as well as civil protection units, police, and ambulance services. Civil protection participates in coordination, unification, and provision of information during readiness. Civil protection is included when a major accident or disaster, or special circumstance, is declared, in accordance with the Law on the Civil Protection System.[203] In high-risk coastal areas or during fire seasons, the Ministry of Defense supplements local firefighting efforts with ground and air support, including specialized aircraft. This multi-agency coordination ensures a timely and efficient response to wildfires.

[201] Fire Department of Croatia 2024, Link.
[202] Croatian Firefighting Association 2024.
[203] Law on the Civil Protection System, Link.

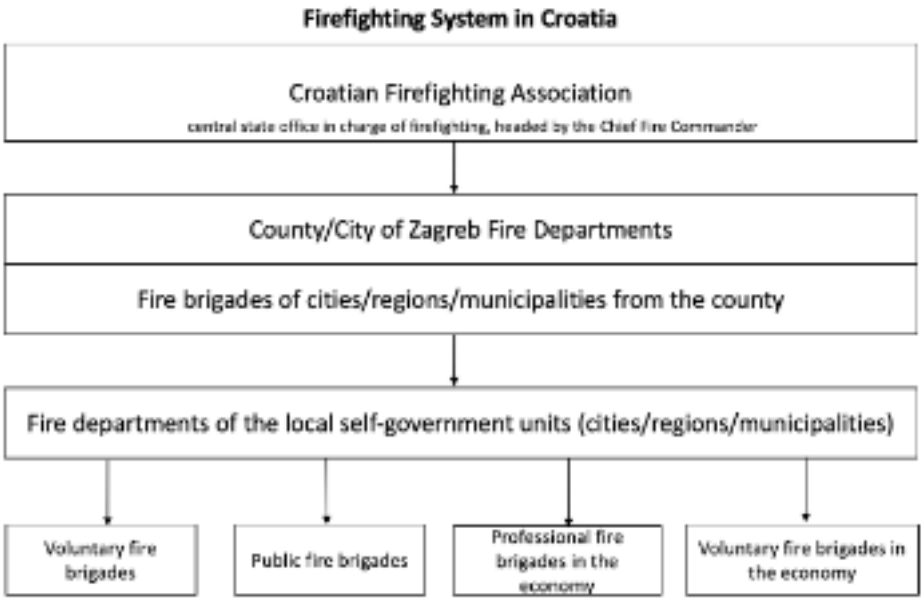

Figure 10. Organizational structure of the firefighting system in Croatia

Source: Based on Croatian Firefighting Association (2024).

An alert and communication system has been used by HVZ and county fire departments for timely and effective firefighting operations. The state emergency number 193, as well as the Europe-wide 112 emergency number, can be used anytime to contact HVZ and county fire departments for fire interventions and rescues. A common IT system has been used for the Croatian firefighting system, which includes innovative tools to support fire interventions, such as the Fire Database Vatronet, the Fire Vehicle Tracking System, and GIS tools for wildfire mapping and analysis. Moreover, a unique firefighting communications system is currently being developed through the company Odašiljači i veze.[204] Odašiljači i veze implemented a specialized video surveillance system using Axis cameras to monitor critical areas for early wildfire detection and prevention. This system, named OIV Fire Detect AI, integrates high-resolution pan-tilt-zoom (PTZ) cameras, GISs, and real-time monitoring to enhance fire detection capabilities. Cameras have been installed at 110 locations and will be expanded to other locations in the future. In 2023, the Civil Protection Directorate established an Early Warning and Crisis Management System (SRUUK).[205] It is a tool that aims, through messages via mobile phones, to quickly and effectively inform citizens and civil protection participants about impending dangers and measures that need to be taken to reduce human casualties and material damage.

Croatia enhances wildfire readiness through comprehensive training and operational preparation before and during fire seasons. Before each fire season, Croatia invests in additional training and equipment to bolster its response capabilities.[206] Firefighters participate in advanced programs, such as aircraft guidance and helicopter rescue training, to prepare for wildfire suppression. Seasonal and volunteer firefighters augment professional teams, while land, air, and naval forces are assigned in readiness for rapid intervention.[207] For instance, during the severe 2017 fire season, coordinated efforts from the National Protection and Rescue Directorate[208] - Fire Operations Center, Air Force Command, and Ministry of Defense were deployed across the coast and were instrumental in containing widespread fires.[209] In addition, the national firefighting command and coordination center is set up every year from June to September during the

[204] Odašiljači i veze (OIV), Fire Detect AI, early fire detection system. Link
[205] Early Warning and Crisis Management System (SRUUK), Link.
[206] Grančić, J. 2024, Link.
[207] Ibid.
[208] The National Protection and Rescue Directorate was responsible for the planning, managing, and coordinating firefighting operations before 2019.
[209] San-Miguel-Ayanz et al. 2018.

firefighting season.[210] The coordination center includes representatives of HVZ, the Croatian Armed Forces, the police, and the Civil Protection Directorate. It further strengthens decision-making and coordination by enabling real-time information collection and distribution, knowledge exchange, and bringing together representatives from key agencies. Civil Protection monitors conditions for wildfires across the entire territory and participates in preparations for the readiness of public and state fire departments, standardization of detection and alarm systems, and approval of the deployment of aerial firefighting forces.

In addition to HVZ, the Civil Protection Directorate also has an important role in wildfire readiness and response. Under the National Civil Protection Action Plan, the civil protection system includes measures and activities (preventive, planning, organizational, operational, supervisory, and financial) that regulate the rights and obligations of participants, the organization and operation of the system, and the method of connecting the institutional and functional resources of participants.[211] During preparedness, Civil Protection follows conditions for open-space wildfires across the entire territory of the Republic of Croatia, maintains special measures to raise the level of the early fire detection system and alerting of fire brigades, takes strategic measures and activities for timely and effective preparation for the protection of society, material, cultural, and natural assets, and the environment, makes decisions on the evacuation of the endangered population, and seeks information. In the response phase, Civil Protection follows and monitors wildfires, determines the cause of wildfires, organizes evacuation, care, search and rescue, traffic regulation, human sanitation, accepts financial assistance, informs the public, and maintains management in the case of a disaster declaration.[212]

International collaboration and knowledge exchange are crucial to strengthen Croatia's wildfire response system. Croatia has been actively engaged in international exchanges and learning from best practices on wildfire suppression and response. The country has also been actively engaged in cross-border agreements and international exercises to improve its firefighting capabilities and provide mutual assistance during emergencies.[213] Standard operating procedures signed with neighboring countries such as Bosnia and Herzegovina, Montenegro, and Slovenia enable seamless deployment of land and air forces in border areas during large-scale fires.[214]

Moreover, since joining the EU UCPM in 2009, Croatia has the option to seek assistance when a wildfire event occurs, while participating in collaborative efforts with Mediterranean nations on firefighting and providing assistance during international wildfire crises.[215] In September 2024, Croatia, along with other EU Member States and UCPM participating states, sent out firefighting planes and firefighters to assist when Greece activated the UCPM for support in combating wildfires. When fires broke out in Slovenia in July 2022, Croatia sent out firefighting planes from the rescEU reserve stationed in the country to help extinguishing the flames.[216] Another notable example is the 2019 'MODEX CRES 2019' exercise held on the Croatian island of Cres, where over 300 participants from 10 European countries demonstrated how to coordinate large-scale firefighting operations.[217] It was the first international exercise in forest fire fighting in the history of the EU, with the objective of demonstrating how international forces can coordinate and act together in large forest firefighting operations. These efforts highlight Croatia's commitment to adopting global best practices and fostering international cooperation in wildfire management.

[210] Grančić, J. 2024, Link.
[211] Law on the Civil Protection System, Link.
[212] GoC 2021, Link.
[213] San-Miguel-Ayanz et al. 2018.
[214] San-Miguel-Ayanz et al. 2018.
[215] Posavec et al. 2023.
[216] EC 2022b.
[217] Vatrogasna Zajednica Pgž 2019, Link.

CHALLENGES AND OPPORTUNITIES

In the past few decades, Croatia has made efforts to enhance its firefighting capacity, which led to effective firefighting operations and reduced wildfire impacts. HVZ has been consistently investing in excellence and education of its firefighters through the application of new technologies and acquaintance with new tools (such as the implementation of the EU SILVANUS Project[218] that focuses on innovative, technological solutions to wildfire detection and suppression).[219] In addition, good practices in wildfire prevention and suppression, such as the training of firefighters, the construction and maintenance of fire roads, and the installation of video surveillance systems, have been pursued.[220] As a result, the 2023 fire season was viewed as one of the most successful in the last 15 years.[221] The firefighting system functioned efficiently and tackled each fire with all forces available, leading to a significant decrease in the number of wildfires and burned areas. In addition, Croatia will also continue investing in firefighting equipment. From 2019 to 2023, 350 new firefighting vehicles were purchased. In 2024, a €105 million contract was signed by the Minister of the Interior for the purchase of two new Canadair firefighting planes, which will be delivered in about five years.[222]

Strengthening coordination, capacity, and information systems is essential to enhance Croatia's wildfire readiness and response capabilities. Firefighting operations in Croatia involve multiple stakeholders at the national and local levels. As a result, interoperability and coordination challenges exist, leading to a duplication of efforts and confusion in responsibilities and mechanisms over operations and logistic support. Therefore, improvements in the legal framework and organizational structure would allow better coordination, interoperability, and communication and help enhance the efficiency of firefighting operations. More advanced information systems can also be introduced to speed up information flow and enhance cooperation and coordination during operations. Capacity building is also crucial to enhance wildfire readiness at the local level. The 2024 NRA has identified eight Croatian counties (Bjelovar-Bilogora, Karlovac, Koprivnica-Krizevci, Krapina-Zagorje, Lika-Senj, Medimurje, Sisak-Moslavina, and Varazdin) as having low operational readiness for fires.[223] Therefore, it is crucial to establish training and capacity-building programs in these counties to ensure adequate administrative and technical skills of relevant stakeholders as well as sufficient, well-trained human resources for response operations. Good practices and well-established training systems from counties with high operational readiness, such as the city of Zagreb, should be promoted nationwide to address disparities in local capacities. Moreover, continued knowledge exchange and cooperation with stakeholders at all levels (local, national, and international) is also important to promote swift and efficient intervention.

Improving the financing system for fire readiness and response can help ensure adequate and proper allocation of funding for firefighting operations in areas prone to high fire risk and with low coping capacities. Currently, Croatia has a decentralized grant system with local governments as the main source of financing fire readiness and response. Some counties do not have adequate funding to purchase even the basic needs for firefighting equipment, while others have sufficient fundings for not only firefighting operations but also social outreach events and information campaigns. Therefore, it is crucial to provide funding based on actual needs in the field, such as fire risk level and the type of fire brigade at the local level. This can improve coping capacity and enhance fire responses at the local level. The new firefighting network called "Vatrogasna mreza" intends to enable easier monitoring of reports of fires, a more equitable distribution of finance to volunteer fire departments, and the distribution of forces in the field.[224] In Croatia, annual reports and financial plans are published each year by HVZ. It stated that for 2023, one of the improvements has been initiated.[225]

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[218] SILVANUS 2023b, Link.
[219] Vatrogasna Zajednica Pgž 2019.
[220] Grančić, J. 2024, Link.
[221] Ibid.
[222] Croatia Week 2024, Link.
[223] GoC 2024a.
[224] Vatrogasna mreža *(eng. Firefighting network)*, Link.
[225] GoC website, Link.

By the Law on Civil Protection System, when a major accident and/or disaster exceeds the capabilities of all participants and operational forces of the civil protection system of the Republic of Croatia, the government may seek external assistance.[226] When necessary, Croatia seeks and may receive assistance from UCPM.

Moreover, improvements in data and information management for the firefighting system and further exploration of crowdsourcing and social media data are also crucial. The Croatian Fire Service has recently prioritized the development of a unified system for receiving, monitoring, and managing data on firefighting resources and interventions. Known as the VATROnet,[227] the central database of the HVZ stores data on firefighting organizations, their members, employees, equipment, vehicles, and activities. It aims to streamline data processing at all operational levels and serve as a basis for various activities, such as generating reports and administering firefighting training and competitions. By integrating existing fire and burned area mapping technologies such as GIS and ZeOS,[228] these tools enhance statistical and analytical capabilities for real-time decision-making. Furthermore, regional fire brigades and Croatian Fire Brigade headquarters are mandated to ensure interoperability and data sharing, enabling better coordination during wildfire events. Moreover, the potential of using crowdsourcing and social media in crisis mapping and improving situational awareness could be further explored. An analysis of the use of georeferenced social media data in the 2017 Split wildfire illustrated how crowdsourcing can fill in gaps in authoritative data and provide valuable information to be incorporated into disaster management decision-making.[229]

[226] Law on Civil Protection System, Link.
[227] HVZ. VATROnet, Link
[228] Implemented by the Croatian Protection and Rescue directorate since 2013.
[229] Tavra, M., I. Racetin, and J. Peroš. 2021, Link.

WILDFIRE RECOVERY, RECONSTRUCTION, AND POST-DISASTER FINANCING

This chapter covers wildfire recovery, reconstruction, and post-disaster financing. It refers to actions taken after the response phase when priorities shift toward post-fire reforestation, the restoration of burned areas, and helping communities return to normal.

DRM CONTEXT

Assistance after a disaster is regulated by the Act on Mitigation and Elimination of Consequences of Natural Disasters and the Ordinance on the Register of Damages of Natural Disasters. Also, the Ministry of Finance uses budget reallocations to finance unplanned needs, as the Amendment of the Public Financial Management Act (Articles 58 and 59) removes restrictions on the use of budget reallocations after a disaster. Budget reallocations, including identification of the original account and the redesignated account, are reported twice a year. Additionally, Croatia is advancing its efforts to enhance damage and loss assessment as a critical component of post-disaster recovery and reconstruction planning. A key initiative involves the development of a bottom-up disaster loss data (DLD) collection and damage and loss assessment system. This system will be created through collaboration with local and national stakeholders, who will also receive targeted education and training to ensure effective implementation. The renewed disaster loss and damage assessment system will establish clear roles for responsible stakeholders and a coordinating body to oversee its operation. The collected data will not only guide recovery and reconstruction efforts but also be integrated into localized awareness-raising activities and materials to make the information more relevant and relatable for citizens in the pilot areas. Additionally, a dedicated law is being planned to formalize and institutionalize the DLD collection and assessment process. On the other hand, banks currently recommend that those seeking a home loan should purchase a household insurance policy. However, insurance is only required to cover fire risks and not natural hazards in general. For multi-apartement buildings, all owners have to pay for a reserve fund called *pričuva*. The reserve is used for general repairs but can also be used for repairs resulting from natural hazards. A new law is being introduced in Croatia that requires landlords to have property catastrophe insurance for their buildings. This step will help ensure protection against disasters.

CURRENT ARRANGEMENTS

Croatia has implemented national programs and strategic plans for post-disaster recovery that include elements related to fireproofing and wildfire resilience. The Law on mitigation and relief of natural disasters regulates assistance and damage assessments after a disaster, including wildfires.[230] In addition, the Recovery and Resilience Plan 2021–2026 highlights several measures to improve post-disaster recovery, reconstruction, and resilience related to fires and wildfires.[231] Central to these efforts is the comprehensive renovation of buildings, particularly those damaged by earthquakes, to improve fire safety alongside seismic resistance and energy efficiency. Renovations will include fire protection measures, enhancement of mechanical stability, and creation of healthy indoor climates, with a focus on public infrastructure, cultural heritage sites, and residential buildings. The plan also emphasizes the modernization of fire protection systems, technical upgrades, and risk reduction measures, especially for older buildings that fail to meet current fire safety standards. Coordination among ministries and stakeholders will be enhanced to ensure timely implementation of fire protection and safety measures. Additionally, data-driven approaches such as GIS integration and strengthened

[230] GoC 2019c, Link

[231] EC page Link.; GoC page Link.; Recovery and Resilience Plan Link.; Review of achievements Recovery and Resilience Plan Link.

monitoring systems will support resilience-building efforts, while financial mechanisms, including grants and co-financing, will be utilized to fund these comprehensive renovations. These initiatives align with broader goals of decarbonization, adaptation, and reducing risks associated with fires and other natural disasters.

Restoration of forests and other burned areas is guided by EU and national laws and regulations for wildfire recovery and nature and ecosystem resilience. In 2024, the EU Nature Restoration Law was published, with the objective of ensuring the recovery of biodiverse and resilient nature while contributing to the EU's climate commitments.[232] According to the Nature Restoration Law, EU Member States should implement necessary restoration measures to enhance biodiversity of forest ecosystems, while taking into account the risks of wildfires. The law also promotes sustainable afforestation, reforestation, and tree planting to fulfill the objective of planting at least three billion additional trees by 2030 at the EU level. Meanwhile, at the national level, the Forest Law requires forest owners to restore burned areas due to wildfires and other deforested areas within two years, if that period is not determined by the forest management plan.[233] The Forest Management Regulation states the removal of fire-damaged wood as a measure of rehabilitation and restoration of forests damaged by biotic and abiotic factors.[234]

In accordance with the Law on Forest Reproductive Material, the seed reserve is established and operates within the Croatian Forest Research Institute, which is responsible for professional supervision of the formation, preservation, and use of seed material reserves.[235] The institute is also accountable for assessing the quality and genetic identity of this material. The seed reserve and seed bank serve, among other purposes, to ensure seed reserves for forest regeneration, afforestation, and the preservation of the genetic diversity of forest tree species. In line with the above, it can be stated that the Republic of Croatia has established basic framework plans and tools for the long-term management of forest regeneration, including fire-affected areas. Although the forest regeneration strategy in the context of climate change is still being aligned with European guidelines, there is currently no unified plan or national strategy specifically focused on the restoration of fire-damaged areas with such considerations. Restoration of these areas is usually carried out in accordance with approved forest management programs, with possible extraordinary revisions when necessary.

Organizations and local communities have also been making efforts to restore forests. Organized primarily by the Scout Association of Croatia, Croatian Forests Ltd., the Croatian Mountain Rescue Service (HGSS), and the Civil Protection Directorate, the Boranka campaign is the largest voluntary post-fire reforestation effort in Croatia.[236] Since its launch, Boranka has mobilized over 11,800 volunteers from across Croatia and abroad, planting more than 135,000 new trees, seeds, and acorns at fire sites around Split, Solin, Makarska, Trogir, Zadar, and Sibenik.[237] For restoration, Boranka considers the geographical and climate context of forests in Croatia and carefully selects native species such as downy oak, black and maritime pine, stone pine, cypress, and various species of bushes.[238] With the support of the Ministry of Foreign and European Affairs of Croatia, the campaign has even expanded to neighboring countries in recent years, restoring forests in North Macedonia, Montenegro, and Bosnia and Herzegovina.[239] The Forest Management Basis 2016–2025 issued by Croatian Forests Ltd. states the need for restoration of forest stands damaged by fires and drying, where individual forest stands are mentioned and the need for recovery after wildfires. Restoration can be carried out in two ways, natural regeneration, when the forest ecosystem has retained its capacity for self-renewal through seeds, stumps, or roots, artificial regeneration (reforestation), when natural regeneration is not possible, particularly in cases of severe soil degradation or increased risk of erosion.

In Croatia, post-fire recovery is financed through the state budget under national legislations. According to the Law on Mitigation and Relief of Natural Disasters, aid funds for mitigating and partially removing the consequences of natural disasters, including wildfires, are distributed according to the percentage of damage to the value of the confirmed final damage assessment, based on data from the Register of Damages and other

[232] EC 2024d, Link.
[233] Such as areas where illegal logging and forest degradation occurred.
[234] Forest Management Regulation, Link.
[235] Law on Forest Reproductive Material, Link.
[236] Boranka 2025, Link.
[237] Croatia Week 2024.

documentation.[240] The aid can be used to compensate damages and rehabilitation costs in key sectors such as agriculture, forestry, and fishing as well as other types of damage (for example, damage to buildings, equipment, and land and the associated reconstruction costs), especially for damage caused to public infrastructure and/or assistance to local self-government units for the costs of recovery and reconstruction in the affected area. Nevertheless, the compensation is restrictive, as the amount of funding cannot exceed 5 percent of the amount of the final confirmed damage to the property of the individual victim.[241] The resources and other types of assistance can also be provided through EU funds, such as the EU Solidarity Fund (EUSF)[242], which are carried out according to special regulations governing the use, and donations.

For forest restoration, one crucial source of funding is the fee for non-wood forest functions (green tax). The fee is paid in the amount of 0.02 percent of a total income of more than €1 million for defined taxpayers under the Law on Forests.[243] A part of the funds collected from the fee is spent on fire protection and restoration of forests on islands, coasts, and mountainous areas. In the continental part of Croatia, these funds are mostly spent on the remediation and restoration of decaying forests, forest protection, development of forest management plans, afforestation and restoration of forest stands, reconstruction and conversion of forests, forest protection, and construction of forest infrastructure. The funds of the green tax fee have been paid into a special account of the State Budget since 2014, and they are controlled and distributed to various relevant stakeholders by the MoA in accordance with the Law on Forests, including firefighters, demining initiatives, private forest owners, and the state forest company.[244]

An insurance protection gap for wildfire exists in Croatia, as household and agriculture insurance policies are in place, but the penetration rate is low. Wildfire risk is included in household fire policies, which means there is no specific exclusion from wildfires.[245] Therefore, it is expected that household fire policies would include damage from wildfires in most EU Member States. In Croatia, approximately 25 percent of homeowners have household insurance that covers wildfire.[246] For the agricultural sector, Croatia has a government-subsidized agriculture insurance scheme, but the penetration rate is low.[247] The consensus among insurers on the low penetration is that local governments are expected and tend to provide citizens with financial support when a large disaster such as wildfire occurs, which leads to a lack of willingness to purchase insurance. As a result, the country has a relatively high insurance protection gap for wildfire compared to other EU Member States.[248] For example, the MoA periodically implements measures under the rural development roadmap program for agricultural production assurance.[249]

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238 Boranka 2025.

239 Croatia Week 2024.

240 GoC 2019g, Link.

241 In the agriculture, forestry, and fishing sectors, the amount of the funding for damage can be exceptionally increased to a max. of 70 percent of the total funds that are intended to be used for partial rehabilitation of damage caused by natural disasters.

242 From 2014 to 2025, Croatia requested EUSF support seven times for flooding and, earthquake recovery. From 2010 to 2014, it requested support five times for ice storms and flooding. In 2020, it submitted two requests: for the Zagreb earthquake (March) and another one for Petrinja earthquake (December). For the March earthquake Croatia was provided €684 million in EUSF funds, and for the December earthquake €319 million in EUSF funds. In total, Croatia received €1,025,69 million in EUSF funds.

243 OG 68/18, 115/18, 98/19; Law on Forests. Official Gazette of the Republic of Croatia, Croatian Parliament, Croatia, 2019.

244 Posavec et al. 2023.

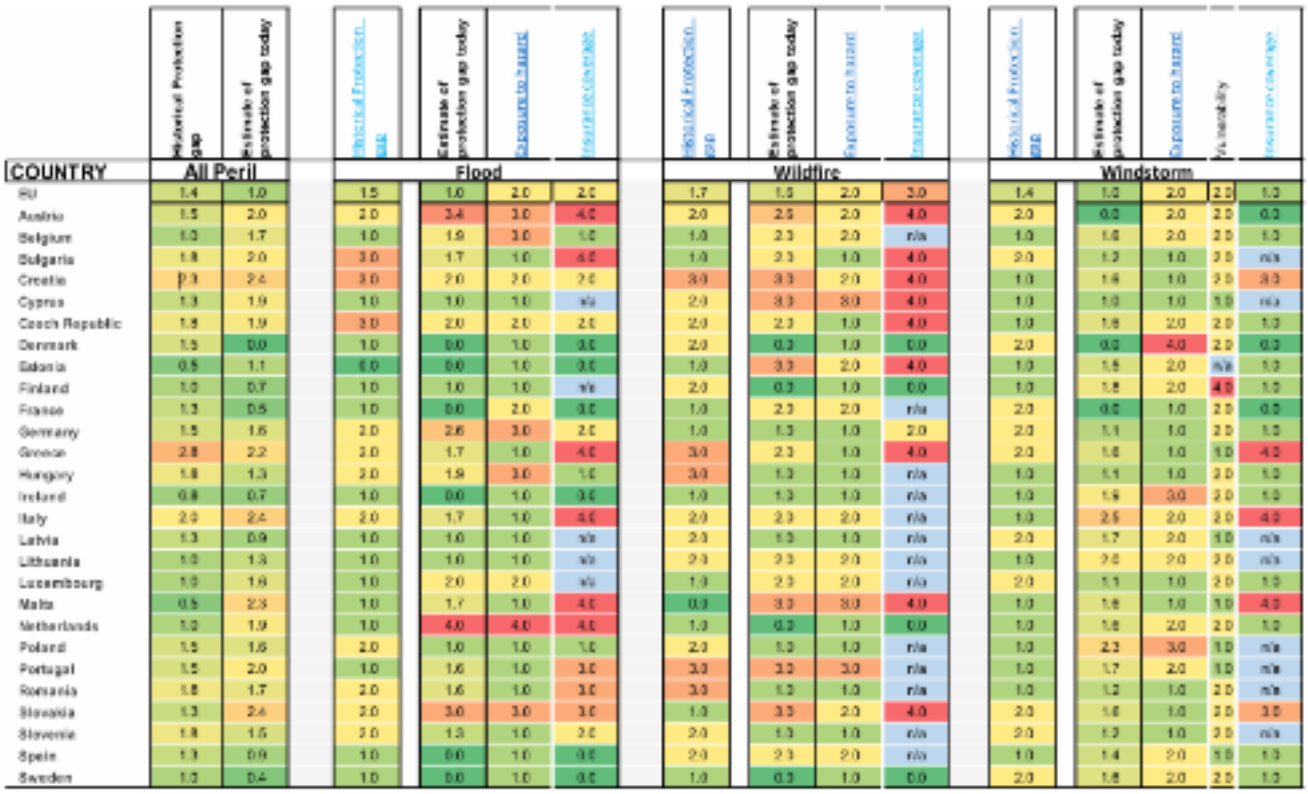
245 Confirmed by private insurance companies in Croatia.

246 World Bank 2024d, Link.

247 World Bank 2025, Link.

248 Radu, Diana. 2022, Link; EIOPA 2020, Link.

249 Rural development measure under MoA, Link.



COUNTRY	All Peril		Flood				Wildfire				Windstorm				
EU	1.4	1.0	1.5	1.0	2.0	2.0	1.7	1.5	2.0	3.0	1.4	1.0	2.0	2.0	1.0
Austria	1.5	2.0	2.0	3.4	3.0	4.0	2.0	2.5	2.0	4.0	2.0	0.0	2.0	2.0	0.0
Belgium	1.0	1.7	1.0	1.9	3.0	1.0	1.0	2.3	2.0	n/a	1.0	1.6	2.0	2.0	1.0
Bulgaria	1.8	2.0	3.0	1.7	1.0	4.0	1.0	2.3	1.0	4.0	2.0	1.3	1.0	3.0	n/a
Croatia	2.3	2.6	3.0	2.0	2.0	2.0	3.0	3.3	2.0	4.0	1.0	1.6	1.0	2.0	3.0
Cyprus	1.3	1.9	1.0	1.0	1.0	n/a	2.0	3.3	3.0	4.0	1.0	1.0	1.0	1.0	n/a
Czech Republic	1.8	1.9	3.0	2.0	2.0	2.0	2.0	2.3	1.0	4.0	1.0	1.6	2.0	2.0	1.0
Denmark	1.5	0.0	1.0	0.0	1.0	0.0	2.0	0.3	1.0	0.0	2.0	0.0	4.0	2.0	0.0
Estonia	0.5	1.1	0.0	0.0	1.0	0.0	1.0	3.3	2.0	4.0	1.0	1.5	2.0	n/a	1.0
Finland	1.0	0.7	1.0	1.0	1.0	n/a	2.0	0.3	1.0	0.0	1.0	1.6	2.0	4.0	1.0
France	1.3	0.5	1.0	0.0	2.0	0.0	1.0	2.3	2.0	n/a	2.0	0.0	1.0	2.0	0.0
Germany	1.5	1.6	2.0	2.6	3.0	2.0	1.0	1.3	1.0	2.0	2.0	1.1	1.0	2.0	1.0
Greece	2.8	2.2	3.0	1.7	1.0	4.0	3.0	2.3	1.0	4.0	2.0	1.6	1.0	1.0	4.0
Hungary	1.8	1.3	2.0	1.9	3.0	1.0	3.0	1.3	1.0	n/a	1.0	1.1	1.0	2.0	1.0
Ireland	0.8	0.7	1.0	0.0	1.0	0.0	1.0	1.3	1.0	n/a	1.0	1.6	3.0	2.0	1.0
Italy	2.0	2.4	2.0	1.7	1.0	4.0	2.0	2.3	2.0	n/a	1.0	2.5	2.0	2.0	4.0
Latvia	1.3	0.9	1.0	1.0	1.0	n/a	2.0	1.3	1.0	n/a	2.0	1.7	2.0	1.0	n/a
Lithuania	1.0	1.3	1.0	1.0	1.0	n/a	2.0	2.3	2.0	n/a	1.0	2.0	2.0	2.0	n/a
Luxembourg	1.0	1.6	1.0	2.0	2.0	n/a	1.0	2.3	2.0	n/a	2.0	1.1	1.0	2.0	1.0
Malta	0.5	2.3	1.0	1.7	1.0	4.0	0.0	3.3	3.0	4.0	1.0	1.6	1.0	1.0	4.0
Netherlands	1.0	1.9	1.0	4.0	4.0	4.0	1.0	0.3	1.0	0.0	1.0	1.6	2.0	2.0	1.0
Poland	1.5	1.6	2.0	1.0	1.0	1.0	2.0	1.3	1.0	n/a	1.0	2.3	3.0	1.0	n/a
Portugal	1.5	2.0	1.0	1.6	1.0	3.0	3.0	3.3	3.0	n/a	1.0	1.7	2.0	1.0	n/a
Romania	1.8	1.7	2.0	1.6	1.0	3.0	3.0	1.3	1.0	n/a	1.0	1.2	1.0	2.0	n/a
Slovakia	1.3	2.4	2.0	3.0	3.0	3.0	1.0	3.3	2.0	4.0	2.0	1.6	1.0	2.0	3.0
Slovenia	1.8	1.5	2.0	1.3	1.0	2.0	2.0	1.3	1.0	n/a	2.0	1.3	1.0	2.0	n/a
Spain	1.3	0.9	1.0	0.0	1.0	0.0	2.0	2.3	2.0	n/a	1.0	1.4	2.0	1.0	1.0
Sweden	1.0	0.4	1.0	0.0	1.0	0.0	1.0	0.3	1.0	0.0	2.0	1.6	2.0	2.0	1.0

Figure 11. Insurance coverage across the EU

Source: Radu 2022 based on EIOPA 2020.

CHALLENGES AND OPPORTUNITIES

Several actions could be taken to enhance post-fire recovery and restoration, starting with the development of wildfire recovery plans, especially for hotspot areas. Following a military approach and based on a decades-old regulatory framework, the country's current DRM system is mainly oriented toward disaster response.[250] Though laws and strategic plans (such as the Law on Mitigation and Relief of Natural Disasters and the NRRP) have been developed to enhance post-disaster recovery in general, there is no wildfire-specific recovery plan in place. Therefore, the development of a post-fire recovery plan can ensure a systematic approach to wildfire recovery and reconstruction and help society return to normal quickly. The recovery plan should be based on post-disaster needs and impact assessments. Priority actions should be defined to reduce social impacts, such as the reconstruction of critical infrastructures and networks, the recovery of essential services, and special outreach and care for vulnerable groups. In addition to direct damages and impacts, indirect and intangible effects should also be considered, such as providing psychological support for those in need and implementing protection measures to prevent secondary effects of wildfires (such as flash floods, landslides, and water pollution).[251] Climate aspects should also be considered in the recovery process, with climate-smart restoration measures implemented to support long-term resilience of ecosystems and reduce future fire risks. Forest restoration should also be encouraged in accordance with the EU Nature Restoration Law,[252] with the objective to reduce soil erosion and enhance resilience and forest connectivity and biodiversity. Learning from successful practices from other European countries, such as the forest restoration projects in Italy and Cyprus under EU initiatives,[253] could help Croatia to advance in forest conservation and achieve long-term resilience.

Capacity building and review processes for wildfire recovery, and lessons learned are needed. Training programs and workshops on how to build back after a wildfire event should be implemented on a regular basis, especially in counties with high wildfire risks or low coping capacities. A review process in the aftermath of major wildfires should be in place to identify good and bad practices. This allows the identification of 'lessons learned' and areas for

[250] Sigmund, et al. 2022, Link.
[251] Delač et al. 2022b.
[252] EC 2024d
[253] EC 2022a.

systemic improvement, which can help the development of future wildfire risk management plans and fire response and recovery training programs. Meanwhile, good practices could be shared between stakeholders in knowledge exchanges to enhance capacity in counties with low capacity as well as shared with the public to enhance awareness and better preparedness against future fire events. International knowledge exchange on wildfire recovery and reconstruction should also be encouraged, with good practices from other fire-prone countries being considered, such as the reforestation of communal land with native, fire-resistant species and the restoration of waterlines in the aftermath of the devastating 2017 wildfires of Greece.[254]

In addition, financial resilience against wildfires needs to be strengthened through enhanced insurance systems and post-fire financing schemes. In Croatia, a huge protection gap for wildfire exists due to restrictive public damage compensation and low penetration of insurance. Therefore, it is necessary to have a thorough understanding of the potential post-fire financing gaps and needs and develop an overarching strategy on disaster risk financing and insurance in line with a risk-layering approach. New financing mechanisms, such as contingent loans, could also be promoted to ensure faster disaster responses and incentivize pre-disaster investments. In Croatia, a new law that mandates landlords to have property catastrophe insurance for buildings is being introduced, which is a good step to ensure protection against disasters, including wildfires.

[254] Soares, F., Schmidt, L. and A. Delicado. 2025, Link.

CROSS-CUTTING TOPICS

This chapter focuses on two cross-cutting topics related to wildfire risks and management. The first topic considers social resilience and inclusion in the context of wildfires, while the second focuses on the private sector's involvement and contribution to wildfire risk reduction.

In Croatia, the management of wildfire risks involves not only the public sector but also the private sector as well as socially vulnerable groups. Wildfires do not affect all members of society equally. Socially vulnerable and marginalized groups, such as children, the elderly, persons with disabilities, racial minorities, and low-income households, tend to face higher health impacts and economic losses due to wildfires. In addition, counties with high social vulnerability and low fire coping capacities are more likely to be affected by wildfire events. Therefore, understanding social vulnerabilities is critical for an inclusive emergency response. Government actions, such as capacity building and increased DRM investments, can be a useful mechanism to support these vulnerable counties and communities most in need, which enhance social resilience and inclusion and thus reduce wildfire losses. In addition to public efforts, the private sector plays a crucial role in wildfire management and can contribute to fire risk reduction. Prevention measures have been implemented by private stakeholders in key vulnerable sectors such as forestry, tourism, and transportation, while private technology companies also have the potential to develop innovative solutions to support more effective wildfire risk management.

CROSS-CUTTING TOPIC: SOCIAL RESILIENCE AND INCLUSION

This chapter covers social resilience and inclusion in the context of wildfires. Wildfires have a disproportionate effect on socially vulnerable groups, such as children, the elderly, persons with disabilities, racial minorities, and low-income households. Additionally, wildfires tend to lead to higher impacts and losses in counties with high social vulnerability and low fire coping capacities.

Wildfires have a bigger impact on socially vulnerable populations and lead to higher risk exposures and losses, as these groups often do not have the resources necessary to prepare for and recover from wildfires. For instance, small and low-income farmers and forest owners in Croatia are less likely to implement protection measures or have their assets insured. As a result, they will experience greater losses if a wildfire event occurs. Meanwhile, wildfire impacts tend to be bigger in counties with high social vulnerability and low fire coping capacities. Therefore, it is crucial for the government to invest in risk reduction and emergency social protection measures to enhance social resilience and inclusion and mitigate wildfire impacts on vulnerable groups. Capacity building and increased funding for counties with low operational readiness are also needed to enhance effectiveness and efficiency of fire suppression and thus reduce human and asset losses.

CURRENT ARRANGEMENTS

As with other disasters, wildfires disproportionately affect socially vulnerable households (such as children, the elderly, persons with disabilities, migrants, minorities, and low-income households), leading to higher risk exposures and losses. Global evidence suggests that socially marginalized communities are particularly vulnerable to wildfire effects because they often lack access to the resources necessary to prepare for and recover from wildfires and are frequently underrepresented in the wildfire planning process.[255] With a lower income, poorer households are less likely to purchase health and household insurances and have limited access to health care resources or protections for their assets. Therefore, they will face bigger health impacts and financial losses if a wildfire event occurs. In Croatia, small private forest owners are more likely to lack the ability and knowledge to implement management programs or protection measures.[256] This makes their forests more exposed to wildfire risks. While insured crops and agricultural infrastructures will be partially compensated if they are

[255] Lambrou, et al. 2023, Link; Baker, B., et al. 2024, Link.
[256] Ilakova, B. 2024, Link.

damaged during a wildfire event,[257] poor households are often less likely to have their farms and groves insured and thus face higher losses.

Wildfires cause more catastrophic losses if an area has more vulnerable communities and low firefighting capacity.[258] Quantitative analysis shows extremely high wildfire social risks in three coastal counties (Split-Dalmatia, Primorje-Gorski Kotar, and Zadar), indicating high levels of wildfire risks and social impacts and low levels of fire resilience and coping capacities in these regions (see Table 2).[259] In addition, the 2024 NRA has identified eight counties with low operational readiness and capacity to cope with fire (see Table 5).[260] Wildfires are likely to cause higher losses in these counties due to untimely and ineffective fire responses.

CHALLENGES AND OPPORTUNITIES

Given the disproportional impact of wildfires on socially vulnerable households, it is crucial for authorities to invest in risk reduction and emergency social protection measures to enhance social resilience and inclusive emergency response. Funding should be allocated for retrofitting critical infrastructure networks and buildings in fire-prone areas, with a focus on protecting the assets of low-income groups. Special consideration should be provided to vulnerable groups for wildfire planning, such as the development of special evacuation plans or the establishment of support call and emergency service centers for special outreach and support during a wildfire event. Rapid restoration of essential services (such as health, education, and social welfare services) in affected areas after a fire is also crucial, as this ensures that everyone can access these services and get necessary support, including socially marginalized groups. The post-fire financing schemes could also be enhanced by increasing the coverage of the government disaster fund so that a higher portion of the damaged assets can be compensated, and households will suffer fewer financial losses. Awareness raising and training could also be arranged in vulnerable communities so that they can be more prepared when a wildfire event occurs.

Capacity building is needed in counties with low fire coping capacities to enhance public and operational readiness. Exercises and training programs for firefighters and rescue teams should be implemented on a regular basis, with the support of innovative digital tools such as VR technologies. This can enhance the effectiveness and efficiency of fire suppression and rescue during a wildfire event so that there will be fewer human and asset losses. Knowledge exchange between local fire departments should also be encouraged so that good practices from counties with high coping capacities can be shared. In addition, more funding should be allocated to counties with low coping capacities, as currently some counties do not have sufficient funding to purchase even basic firefighting equipment. Therefore, increasing the annual budget for firefighting could not only enable these counties to purchase necessary equipment and enhance fire suppression capacity but also provide the funding to develop information campaigns and awareness programs, which can enhance public preparedness for wildfires, especially for vulnerable communities.

[257] Jusup, N. 2022, Link.

[258] Chas-Amil, et al. 2022, Link; Coughlan, 2019.

[259] The wildfire social risk considers the country's social vulnerability as well as coping capacity indicators related to wildfires (such as the number of fire stations) and the information on wildfire hazard. See World Bank, 2024b.

[260] GoC 2024a.

Table 5. Wildfire capacity gaps at the county level

Source: Croatia NRA 2024.

County	Wildfire operational readiness and capacity
Bjelovar-Bilogora	Low
Brod-Posavina	**High**
City of Zagreb	**High**
Dubrovnik-Neretva	**High**
Istria	**High**
Karlovac	Low
Koprivnica-Križevci	Low
Krapina-Zagorje	Low
Lika-Senj	Low
Međimurje	Low
Osijek-Baranja	**High**
Požega-Slavonia	**High**
Primorje-Gorski Kotar	**High**
Sisak-Moslavina	Low
Split-Dalmatia	**High**
Šibenik-Knin	**High**
Varaždin	Low
Virovitica-Podravina	**High**
Vukovar-Srijem	**High**
Zadar	**High**
Zagreb	**High**

CROSS-CUTTING TOPIC: PRIVATE SECTOR

This section covers private sector involvement in the context of wildfire risk management. Relevant stakeholders might include forest and landowners, insurance companies, business owners, tourist agencies and companies, transport carriers, technology companies, organizations, and non-profits.

In Croatia, the private sector plays an important role in wildfire risk management and prevention in addition to efforts by public agencies. National legislation and guidelines have been published to ensure fire prevention and risk reduction in key vulnerable sectors, such as forestry, tourism, and transportation. For the forestry sector, private forest owners are obliged to take actions to protect their forests from fire and implement prevention measures, though their potential could be further explored given that, in reality, private forests are often not managed effectively and sustainably. In addition, private technologies can also contribute to more precise decision-making and more effective fire risk reduction, which will face a growing market in the future with intensified wildfire risks.

CURRENT ARRANGEMENTS

In Croatia, private forest owners play a crucial role in wildfire protection and sustainable forestry management. Though the majority of the forests are owned by the state, around 23 percent (593,027 ha) of the total forest area is privately owned.[261] The distribution of private forest ownership in Croatia is heterogeneous, diverging from 1 percent of privately owned forests in some regions to 57 percent in others. These private forest owners need to undergo a licensing process established in 2007 with the foundation of the Croatian Chamber of Forest and Wood Technology Engineers and the adoption of necessary regulations.[262] The licensing process represents the inclusion of private forest owners in the unconditional contingency of sustainable forest management.[263] According to the Ordinance on Forest Fire Protection, legal entities, including private forest owners, are obliged to take actions to protect their forests from fire, such as implementing fire protection measures and establishing video systems for wildfire detection and monitoring.[264] The adoption of the EU Biodiversity Strategy and the resulting Forest Strategy also lead to increased protection requirements in private forests. Nevertheless, in reality, private forests are often not managed efficiently due to a number of challenges.[265] Moreover, though forest owners in Croatia accept the concept of sustainable land management, very often is difficult to implement management programs, or protection measures due to unclear ownership, carelessness and fragmented holdings.[266]

National legislation and guidelines have been published to ensure fire prevention and risk reduction in key vulnerable sectors (such as tourism and transportation) and relevant private stakeholders. For the tourism sector, tourist companies that own or manage hotels, campsites, and resorts exposed to fire danger are required to develop evacuation plans that are aligned with national or local civil protection action plans as well as designate responsible people at tourist facilities particularly at fire risk.[267] Given the high exposure to wildfire risks of the road and railway networks, stakeholders from the transportation sector are required to take actions to reduce fire risks. The railway infrastructure company HŽ Infrastruktura needs to clean and maintain the railway tracks from flammable substances, while rail freight carriers such as HŽ Cargo and ENNA Transport are required to implement fire protection measures for towing and towed vehicles.[268]

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[261] Confederation of European Forest Owners. Croatia, Link.
[262] Šporčić et al. 2017, Link.
[263] Ibid.
[264] GoC 2014b.
[265] Ilakova. 2024.
[266] Ibid.
[267] GoC 2024c
[268] Ibid.

CHALLENGES AND OPPORTUNITIES

The potential of private forest owners' role in fire protection and sustainable forestry management could be further explored with the support of public policies. European evidence suggests that public policy is the critical enabler of private investments in biodiversity and forest conservation by creating commodification mechanisms that underpin markets and providing public funding that catalyze market opportunities.[269] In Croatia, the national legal framework on forests treats all forest owners equally regardless of the size of their forests or their abilities or willingness to take actions in wildfire protection. However, small and dispersed ownership of private forests often makes it difficult to manage forests in a sustainable way and implement prevention measures. Therefore, the existing legal framework could be enhanced to take the size of the forests into consideration and provide guidelines and financial subsidies to incentivize small forest owners to implement and adopt sustainable forestry management practices. Establishing and supporting a balance between fire protection and the silvicultural needs of forests is also crucial, as the majority of private forest ownerships are centered on economic activities and less motivated by recreation and conservation.[270] Education and information campaigns should also be regularly carried out to enhance private forest owners' awareness of the importance of wildfire prevention.

Private sector technologies, such as intelligence and surveillance systems, can be promoted to support more precise decision-making and more effective fire management. In Croatia, innovative solutions to wildfire detection and management have been implemented under EU and national initiatives and by state-owned companies such as OIV Fire Detect AI, which is a smart and integrated system for monitoring remote areas to detect the early start of wildfires.[271] One example of private sector engagement is the SILVANUS project, which brings together interdisciplinary experts from several countries, including Croatia. The project is developing an integrated technological and information platform for wildfire prevention and suppression, which has been tested in Croatia and other nations.[272] In addition to public efforts, private technology companies should be encouraged to develop innovative solutions to enhance efficiency and effectiveness of fire protection and suppression, such as the development of camera surveillance systems for forest monitoring and early wildfire detection, or drones and unmanned robots for prescribed burnings and firefighting operations. With intensified wildfire risks and impacts, there will be a growing market for these businesses. These companies represent private sector solutions in addition to fire protection efforts by government agencies.

[269] zu Ermgassen, S.O., Hawkins, I., Lundhede, T. et al. 2025, Link.
[270] Ilakova 2024.
[271] OIV 2025, Link.
[272] EC: Research and Innovation, Combatting forest fires through technological innovation, Link.

INVESTMENT NEEDS AND RECOMMENDATIONS

This section proposes targeted reforms, key investment priorities, and areas requiring technical assistance to be addressed through EU instruments. It is informed by desk research, consultations with stakeholders, and comprehensive analysis.

Several steps can be taken by Croatia to enhance its wildfire risk management system. In the past two decades, Croatia has been making efforts to develop a solid legal framework for fire prevention and suppression and implement fire protection measures. Nevertheless, a few key investments could be made to support more effective and efficient fire risk reduction and post-fire recovery and response. These recommendations promote a standardized, science-driven approach and climate-smart and innovative solutions to wildfire risk management. The objective is to help inform better decision-making and enhance wildfire and resilience in the country.

A summary of recommendations is provided in Table 6**,** with additional information below the table.

Table 6. Key investment recommendations for Croatia in wildfire risk management across sectors

Governance	• Establish a cohesive and efficient fire protection network by enhancing administrative and technical capabilities, improving risk assessment systems, and ensuring that funding is allocated based on fire risks and coping needs. • Strengthen coordination between national lawmakers, local governments, and fire departments to improve the implementation of fire risk assessments and protection measures at local levels. • Incorporate wildfire risk reduction and climate change considerations into legislation for key sectors such as forestry, agriculture, tourism, and spatial planning. • Increase government regulations and measures for more efficient and sustainable land use. • Enhance monitoring and evaluation systems to ensure full and effective implementation of fire protection laws and strategic plans.
Understanding risk	• Create consistent, standardized methodologies for fire risk and impact assessments to allow fully comparable results across counties and seamless data sharing among stakeholders and incorporate these into fire protection laws. • Promote digitalization of risk assessments by using digital tools and processes to identify, assess, and manage risks and improve data sharing. • Ensure more frequent updates to risk assessments, integrating real-time data, local knowledge, and climate aspects. • Leverage existing platforms such as the Croatian Platform for Disaster Risk Reduction to further harmonize risk analyses, enhance information sharing, and ensure consistency across institutions and regions. • Integrate results of risk assessments into landscape and spatial planning (especially in WUI areas) and emergency management documentation. • Enhance risk assessments to provide quantitative analysis of wildfire impacts and cover critical infrastructure and networks. • Develop tools and scenario modeling to assess the effect of climate change on wildfire risks and impacts, as well as compounding and secondary effects of wildfires, and include the results in national and local risk assessments. • Allocate resources, secure funding, and provide staff training to build capacity in public administration for risk assessment and management, especially at local levels. • Strengthen intersectoral cooperation and integrate scientific expertise into wildfire risk reduction strategies. • Ensure funding and allocate resources for establishing data collection and information management systems.
Risk prevention, reduction and mitigation	• Define a common methodology and clear criteria (for example, cost-benefit analyses, cost-efficiency, multi-criteria analyses) for the selection and prioritization of prevention measures. • Support the implementation of low-regret and win-win fire prevention measures as well as measures with environmental or climate co-benefits. • Invest in innovative, digital information and monitoring systems. • Enhance fire resilience of critical infrastructure and networks through the implementation of building standards and guidelines and retrofitting programs. • Mainstream wildfire prevention into sectoral planning and promoting climate-smart and sustainable forest management. • Enhance administrative and technical capacity building, financing, monitoring and evaluation to support wildfire prevention in counties with high fire risks and low capacity. • Enhance collaboration between national and local authorities as well as international knowledge exchange (especially with countries in the Mediterranean areas) on wildfire prevention.

Preparedness, EWS, awareness	• Improve the fire warning system at the local level by adopting an inclusive, community-based approach to provide timely warnings that are more connected to local or sectoral contingency plans. Integrate local sirens into a national system. • Address the needs of vulnerable groups by providing special outreach and support during a wildfire event. • Promote education and information campaigns to enhance public awareness of wildfire risks and preparedness, especially for vulnerable groups such as children and tourists. • Improve the data and information system and adopt a unified approach for fire warning, response, and communication. • Allocate funds and train preparedness personnel to deliver inclusive and nationwide wildfire preparedness workshops and materials, especially for key sectors such as forestry and tourism.
Readiness and response	• Improve the legal framework and organizational structure for firefighting to allow better coordination, interoperability, and communication. • Enhance the information and communication system to speed up information flow and enhance cooperation and coordination during operations. • Enhance response capacity and allocate funds for new technology and resources for interventions, especially in counties with low operational readiness. • Develop a new financing system for the Croatian firefighting network to provide funding based on actual needs in the field, such as fire risk level and the type of fire brigade at the local level. • Enhance firefighting training programs with the use of modern IT tools like virtual reality and online courses to increase effectiveness and reach.
Recovery and reconstruction, post-disaster financing	• Develop wildfire recovery frameworks/plans, especially for potential hotspot areas, taking into Recovery and reconstruction, post-disaster financingccount post-disaster needs and impact assessments • Strengthen financial resilience against wildfires by identifying potential gaps and needs, developing a comprehensive strategy for disaster risk financing and insurance in line with a risk-layering approach, and updating/establishing new instruments as relevant. • Create guidelines for implementing 'build back better' and 'build back smarter' concepts for wildfires, with climate aspects and adaptation taken into account. • Establish capacity building, review processes, and knowledge exchange for wildfire recovery and lessons learned after a wildfire event. • Support the implementation of climate-smart and sustainable practices and measures in long-term forest restoration plans. • Enhance the capacity of public authorities to understand and utilize available funds to support the planning, monitoring, and implementation of DRR investments, including through online training.
Social resilience, social protec-tion and inclusion	• Update intervention procedures to accommodate the diverse communication and functional needs of various groups. • Invest in retrofitting critical infrastructure networks and buildings in fire-prone areas, with a focus on protecting the assets of low-income groups. • Develop inclusive training programs and awareness campaigns for the population to enhance awareness and preparedness. • Enhance accessibility and post-fire recovery of emergency facilities and services and provide special outreach and health care for vulnerable groups during and after a wildfire event. • Increase the coverage of the government disaster fund to compensate for a higher portion of the asset losses due to a wildfire event. • Enhance capacity building and increase the annual budget for firefighting in counties with low fire coping capacity.
Private sector	• Strengthen the fire resilience of private forests by providing guidelines and subsidies to incentivize small forest owners to implement and adopt sustainable forestry management practices. • Provide financial incentives for private technology companies to invest in innovative tools for wildfire risk prevention.

GOVERNANCE OF WILDFIRE RISK MANAGEMENT

Croatia's wildfire risk management is founded on a comprehensive legal framework that integrates prevention, preparedness, and response at the national and local levels, aligning with EU policies and strategies such as the European Green Deal and the EU Forest Strategy. The Law on Firefighting and the National Fire Protection Strategy define the roles and responsibilities for managing wildfire risk, with local governments responsible for fire risk assessments, protection plans, and firefighting operations. Strategic documents such as the NDRMS (until 2030) and the Program of Activities for Fire Protection provide guidance on short- and long-term wildfire risk reduction measures. Fire response relies on a structured command hierarchy, with local fire brigades, HVZ, police, and military forces playing key roles. Forest fire prevention is regulated under the Ordinance on Forest Fire Protection and the Law on Forests, which mandate fire risk reduction measures in both state-owned and private forests. Croatia also participates in EU-wide initiatives such as the UCPM to enhance cross-border cooperation on wildfire suppression. Despite significant progress in governance and institutional coordination, challenges remain in ensuring effective risk reduction, response capacity, and long-term resilience to increasing wildfire threats.

Opportunities for improvement include the following:

- *Policy integration and coordination*: Strengthening collaboration between national and local authorities to ensure that wildfire prevention and response strategies are consistently applied across different regions.
- *Risk assessment and planning*: Improving standardized methodologies for wildfire risk mapping and ensuring climate change considerations are fully integrated into fire protection laws and local planning.
- *Funding and resource allocation*: Addressing gaps in financing mechanisms to ensure that fire protection funding is allocated based on risk levels rather than administrative divisions.
- *Data and information management*: Enhancing real-time data collection and sharing systems to improve fire forecasting, early warning, and response coordination.
- *Technological innovation*: Increasing investment in advanced wildfire monitoring and suppression technologies, including drones, remote sensing, and early detection systems.
- *Public awareness and community preparedness*: Expanding wildfire education campaigns, particularly targeting tourists, rural communities, and high-risk regions.
- *Post-fire recovery framework*: Developing a comprehensive recovery strategy that integrates build back better (BBB) principles to ensure sustainable forest restoration and community resilience.

UNDERSTANDING RISK FOR WILDFIRE RISK MANAGEMENT

Croatia has developed a comprehensive wildfire risk assessment framework that integrates legislative, institutional, and methodological approaches to enhance disaster risk management. The NRA serves as the primary document for wildfire risk evaluation, incorporating standardized methodologies, data-sharing protocols, and cross-sectoral collaboration. Updated in 2015, 2019, and 2024, the NRA aligns with international and EU standards (ISO 31000, United Nations Office for Disaster Risk Reduction [UNDRR], and EU methodological guidelines), categorizing wildfire risks based on their severity and projected impacts. The Ordinance on Forest Fire Protection further refines wildfire risk assessments by classifying all forests into four fire danger levels based on key parameters such as vegetation cover, climate, and anthropogenic influences. Local authorities are mandated to develop fire danger assessments and protection plans, supported by fire and explosion risk assessments that outline prevention strategies, vulnerability assessments, and risk mitigation recommendations. DHMZ plays a critical role in providing daily fire risk forecasts, while institutions such as HVZ, MoI, MoA, and Croatian Forests Ltd. contribute to real-time data collection and wildfire monitoring. The 2024 Program of Activities emphasizes improved geographic information system (GIS) integration, real-time data sharing, and methodological consistency, yet challenges remain in ensuring harmonized data collection, inter-institutional coordination, and standardized and digitalized risk assessments.

Opportunities for improvement include the following:

- *Standardization and digitalization of risk assessments*: Strengthen the consistent application of standardized methodologies across all counties to allow for comparable results and use digital tools and processes to identify, assess, and manage risks and improve data sharing.
- *Integration of real-time data*: Enhance fire risk assessments with real-time weather monitoring, remote sensing, and GIS tools to improve early warning and preparedness.
- *Intersectoral cooperation*: Expand the role of the Croatian Platform for Disaster Risk Reduction (DRR) to improve cross-institutional collaboration and knowledge exchange.
- *Scientific expertise in risk modeling*: Increase engagement with scientific institutions to improve risk factor analysis, projections, and impact assessments.
- *Capacity building at local levels:* Address disparities in data collection capabilities by providing technical support and training to county and municipal authorities.
- *Compliance and enforcement*: Strengthen enforcement of fire risk assessment regulations, ensuring that local authorities and landowners adhere to fire prevention and protection measures.
- *Investment in fire monitoring systems*: Expand fire detection technologies such as drones, satellite monitoring, and automated surveillance to enhance wildfire tracking and response.
- *Improved wildfire data management*: Develop and maintain an online centralized database to store detailed wildfire incident reports, damage assessments, and long-term trend analyses.

WILDFIRE RISK PREVENTION, RISK REDUCTION AND MITIGATION

Croatia has increasingly prioritized wildfire prevention, risk reduction, and mitigation alongside traditional fire suppression measures, integrating them into national laws, strategic plans, and cross-sectoral initiatives. Public authorities, Croatian Forests Ltd., and private landowners play crucial roles in implementing preventive actions, including fuel management, firebreak construction, fire surveillance, and video monitoring systems. The Ordinance on Forest Fire Protection outlines specific fire prevention measures for the forestry sector, while the Program of Activities for Fire Protection sets out annual priorities and funding for additional prevention efforts. Innovative technologies such as real-time surveillance systems, AI-powered fire detection, and remote sensing have significantly improved fire monitoring capabilities. In state-owned forests, extensive fire prevention investments have been made, including the construction of 100 km of fire protection roads annually and the deployment of 500 forest guards. Additional efforts have been made during the summer tourist seasons to reduce potential fire risks. Additionally, fire resilience strategies are being incorporated into spatial, agricultural, and forest management planning, with projects such as the revitalization of olive groves and wildfire-resilient infrastructure. However, gaps remain in technical capacity, financial resources, and strategic coordination, particularly at the county and municipal levels, which could hinder the effective implementation of fire prevention measures.

Opportunities for improvement include the following:

- *Strengthening local capacity and funding*: Increase financial and technical support for counties with high wildfire risks but limited resources to ensure consistent implementation of prevention measures.
- *Defining standardized prevention criteria*: Develop clear methodologies for prioritizing cost-effective, low-regret wildfire prevention measures with environmental and climate co-benefits.
- *Expanding investments in fire monitoring technology*: Continue enhancing fire detection and surveillance systems, leveraging EU funding and public-private partnerships to extend video monitoring networks and remote sensing capabilities.
- *Enhancing wildfire resilience of critical infrastructure*: Develop and implement fire-resilient building standards, retrofit public infrastructure, and integrate wildfire protection into energy and transportation networks.
- *Mainstreaming wildfire prevention in land use planning*: Strengthen climate-smart forestry practices, promote sustainable land management, and integrate wildfire prevention measures into spatial and rural planning frameworks.
- *Increasing prescribed burning initiatives*: Expand the use of controlled burning as a preventive tool, supported by training programs and community outreach efforts.
- *Balancing prevention and suppression budgets*: Reallocate funding to ensure that long-term wildfire risk reduction strategies receive adequate investment, rather than prioritizing suppression efforts alone.
- *Enhancing national and international knowledge exchange*: Collaborate with Mediterranean and EU partners, as well as neighboring countries, to adopt best practices in wildfire prevention, adaptive forest management, and resilience strategies.

WILDFIRE EARLY WARNING AND AWARENESS

Croatia has established a comprehensive framework to enhance wildfire early warning and public awareness, integrating forecasting, EWSs, emergency communication, and public education/ outreach initiatives. DHMZ provides daily, medium-term, and seasonal wildfire risk forecasts, disseminating real-time fire weather warnings to HVZ and local fire departments. Emergency communication systems, including the national 193 and European 112 emergency numbers, support rapid response coordination, while IT platforms like the Fire Database Vatronet and GIS-based fire mapping tools enhance operational decision-making. Public preparedness efforts include fire warning and evacuation plans at the local level, targeted public awareness campaigns, and specialized training for high-risk sectors such as tourism. Investments in advanced early warning and crisis management systems, such as OIV Fire Detect AI and Early Warning and Crisis Management System (SRUUK), have improved Croatia's ability to detect and communicate fire risks. Additionally, education programs for schoolchildren, tourists, and local communities—such as the 'Little School on Forest Fires' and the Ministry of Science and Education's wildfire prevention curriculum—aim to increase public understanding of fire risks and prevention measures. Despite these advancements, challenges remain in establishing inclusive local warning systems, ensuring special outreach and awareness programs for vulnerable groups, and fully leveraging digital technologies and data management.

Opportunities for improvement include the following:

- *Enhancing local EWSs:* Develop inclusive, community-based wildfire alert systems that integrate sectoral contingency plans and ensure accessibility for vulnerable populations (for example, elderly, children, low-income communities).
- *Strengthening public awareness campaigns*: Expand targeted education and communication programs to ensure that citizens understand early warning signals, evacuation procedures, and fire prevention measures.
- *Investing in digital fire monitoring and crisis management*: Expand the use of real-time monitoring tools, AI-based fire detection systems, and data-driven risk visualization platforms to improve fire response efficiency.
- *Leveraging EU-supported innovation*: Promote cross-sectoral and international knowledge exchange on emerging fire monitoring and forecasting solutions, including the expansion of surveillance networks, remote sensing applications, and crowdsourced wildfire data collection.
- *Improving wildfire preparedness in high-risk industries*: Strengthen fire protection measures in tourism, ensuring that evacuation and safety plans are well-integrated with national and local response frameworks.
- *Exploring social media and crowdsourced data for fire management*: Utilize georeferenced public data from social platforms to enhance situational awareness, risk assessments, and real-time crisis response strategies.

WILDFIRE PREPAREDNESS AND EMERGENCY RESPONSE

Croatia has developed a structured and well-coordinated wildfire response system, integrating national, regional, and local firefighting forces under the leadership of HVZ, the national body responsible for firefighting. The Firefighting Law and strategic intervention plans define roles and responsibilities, ensuring effective coordination among professional and voluntary firefighters, local fire brigades, civil protection units, police, and the Croatian Armed Forces. At the beginning of each fire season, a special program of activities is established as per the decision of Chief Firefighting Commander and Minister of Defense to enhance fire risk prevention, inspections, and surveillance. In addition, a national coordination center was established to facilitate real-time decision-making, resource allocation, and emergency response coordination. The Civil Protection Directorate plays a crucial role in evacuations, traffic control, search and rescue, and public information during major wildfire events with the support of Mountain Rescue Service and Red Cross. International cooperation, including cross-border agreements and participation in the EU UCPM, enhances Croatia's fire response capacity. While recent investments in firefighter training, new equipment, and AI-powered fire detection systems have improved wildfire readiness, challenges remain in ensuring equitable resource distribution, local operational capacity, and interoperability among multiple firefighting entities. Opportunities lie in improving interoperability, addressing readiness gaps in certain counties, and implementing a new financing model based on fire risk assessments.

Opportunities for improvement include the following:

- *Strengthening inter-agency coordination*: Enhance legal frameworks and communication protocols to improve interoperability and efficiency in wildfire response.
- *Expanding firefighter training programs*: Increase targeted capacity-building initiatives in counties with low operational readiness, ensuring adequate human resources, technical skills, and equipment.
- *Improving emergency information systems*: Invest in real-time data integration, GIS-based tracking, and AI-powered fire detection tools to speed up wildfire response and decision-making.
- *Increasing wildfire training and simulations*: Conduct regular fire response drills and implement a lessons-learned approach to enhance preparedness among local authorities, businesses, and the general public.
- *Optimizing resource allocation*: Develop a risk-based funding model for firefighting operations, ensuring equitable financial distribution based on local fire risk levels and response needs.
- *Enhancing international cooperation*: Continue engaging in joint wildfire exercises, cross-border fire suppression agreements, and EU-led initiatives to strengthen regional response capacity.
- *Investing in new, innovative firefighting technologies*: Expand the use of AI-driven surveillance, unmanned aerial vehicles (drones), and smart firefighting equipment to improve early wildfire containment efforts.
- *Developing a sustainable firefighting network*: Implement 'Vatrogasna mreža' (Firefighting Network) for better tracking, reporting, and field resource distribution, ensuring efficient deployment of forces.

WILDFIRE RECOVERY, RECONSTRUCTION, AND POST-DISASTER FINANCING

In Croatia, although there is no comprehensive post-fire recovery plan at the national level, a few actions have been undertaken to support wildfire recovery and resilience under national laws and strategic plans, focusing on forest restoration, infrastructure resilience, and disaster relief support. These efforts include the restoration of forests and burned areas and the renovation of buildings to improve fire safety alongside seismic resistance. The Forest Law mandates the restoration of burned areas within two years, while the EU Nature Restoration Law (2024) emphasizes sustainable reforestation and biodiversity restoration. Community-led initiatives like the Boranka campaign have played a crucial role in post-fire forest rehabilitation, mobilizing over 11,800 volunteers to plant 135,000 trees in wildfire-affected areas. The Recovery and Resilience Plan (2021–2026) integrates fireproofing measures into post-earthquake building renovations, improving fire safety, mechanical stability, and energy efficiency. In Croatia, post-fire recovery is financed through the state budget under national legislation, while one of the crucial sources of funding for forest restoration is the fee for non-wood forest functions (green tax), controlled and distributed to various relevant stakeholders by the MoA in accordance with the Law on Forests. Financial resilience in Croatia remains an area of improvement, as public compensation for disaster damages is restrictive, while the penetration rate is low for household and agriculture insurance against fire. Gaps remain in ensuring sufficient post-fire financing and systematic recovery planning.

Opportunities for improvement include the following:

- *Developing wildfire recovery plans*: Establish a dedicated post-fire recovery strategy (especially for potential hotspot areas), integrating impact assessments, infrastructure reconstruction, ecosystem restoration, and social recovery measures.

- *Enhancing financial resilience through improved insurance mechanisms*: Increase household and agricultural wildfire insurance coverage, expand government-backed disaster relief funds, and explore contingent loan mechanisms for faster recovery financing.

- *Strengthening local and community-driven recovery efforts*: Provide capacity-building programs and funding support for local governments and civil society initiatives engaged in forest and infrastructure restoration.

- *Integrating climate-smart restoration measures*: Promote nature-based solutions, sustainable reforestation practices, and adaptive land management to enhance resilience and prevent secondary disaster risks (for example, landslides, soil degradation).

- *Institutionalizing post-disaster reviews and lessons-learned programs:* Implement training workshops, systematic reviews of major wildfire events, and knowledge-sharing platforms to refine future wildfire response and recovery efforts.

- *Expanding EU and international funding opportunities:* Strengthen partnerships for accessing post-disaster financing, leveraging EU grants, public-private investments, and cross-border collaboration on forest restoration and resilient infrastructure projects.

CROSS-CUTTING: SOCIAL RESILIENCE AND INCLUSION AND PRIVATE SECTOR

In Croatia, the management of wildfire risks involves not only the public sector but also the private sector and socially vulnerable groups. Wildfires do not affect all members of society equally. Socially vulnerable and marginalized groups, such as children, the elderly, persons with disabilities, minorities, and low-income households, tend to face higher health impacts and economic losses due to wildfires. In addition, counties with high social vulnerability and low fire coping capacities are more likely to be severely affected by wildfire events. Therefore, government actions, such as capacity building and increased disaster risk management (DRM) investments, are essential for these vulnerable counties and communities to enhance social resilience and inclusion, thereby reducing wildfire losses. In addition to public efforts, the private sector also plays a crucial role in wildfire management and can contribute to fire risk reduction. Prevention measures have been implemented by private stakeholders in key vulnerable sectors such as forestry, tourism, and transportation, while private technology companies have the potential to develop innovative solutions to support more effective wildfire risk management.

Opportunities for improvement include the following:

- *Enhancing fire resilience of critical assets*: Retrofit critical infrastructure networks and buildings in fire-prone areas, with a focus on protecting the assets of low-income groups.
- *Enhancing functionality of emergency facilities and essential services*: Enhance accessibility and rapid recovery of emergency facilities and services after a wildfire event.
- *Increasing consideration of the vulnerable group in wildfire planning*: Design special evacuation plans and provide special outreach and health care for vulnerable groups during and after a wildfire event.
- *Capacity building for counties with low operational readiness*: Implement training programs, promote knowledge exchange, and increase firefighting budgets to improve the effectiveness and efficacy of firefighting operations.
- *Strengthening fire resilience of private forests*: Provide strategic guidelines and subsidies to incentivize small forest owners to implement and adopt sustainable forestry management practices.
- *Promoting private technology to support fire risk management*: Provide financial incentives for private technology companies to invest in innovative tools for fire risk reduction and prevention.
- *Promoting private sector engagement*: Continue dialogue with the private sector to enhance their resilience, business continuity planning, and participation in prevention and preparedness investments.

ANNEX 1. REFERENCES

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ANNEX 2. ADDITIONAL MATERIALS

Table 7. Wildfire danger matrix used to classify wildfire hazard in the critical infrastructure exposure analysis

Source: World Bank. 2024b.

		Danger by fire weather				
Danger by thermal anomalies	%	0-20	21-40	41-60	61-80	81-100
	0-20	VL	VL	L	L	M
	21-40	VL	L	L	M	H
	41-60	L	L	M	H	H
	61-80	L	M	H	H	VH
	81-100	M	H	H	VH	VH

Table 8. Open-space fire danger degree and corresponding fire brigades and legal entities involved in firefighting activities from the Intervention plan for large open-space fires in the territory of Croatia

Source: Republic of Croatia 2001.

Danger degree	Threat	Force engaged
1	• Small-scale outdoor fires • Danger index very low to low	• Fire brigades from the city/municipality area
2	• Smaller forest areas • Larger areas of grass and low vegetation • Danger index low to moderate	• Firefighting forces from the 1st degree • Fire brigades from neighboring cities and municipalities • Area commander
3	• Larger forest areas • Large areas of grass and low vegetation • Danger index low to moderate	• Firefighting forces from the 2nd degree • County fire department • Inclusion of part of the fire brigades from the area of the county • According to the judgment, the following are also included: o Intervention equipment o Air force o Civil protection units from the County o The Armed Forces of the Republic of Croatia (OSRH)
4	• Valuable forest areas • Very large areas of grass and low vegetation • Endangerment of buildings and settlements • Possible more simultaneous events in a wider area (of different intensity) • Danger index moderate to high	• Firefighting forces from the 3rd degree • Inclusion of the total firefighting forces from the county • Operational fire command of the continental part RH and intervention equipment • Air force • County headquarters of civil protection • Civil protection units from the county • OS RH (Croatian Army) • Preparation of additional forces for assistance from other counties • If necessary, include the following: o Fire command of the Republic of Croatia o Headquarters of Civil Protection of the Republic of Croatia o Crisis headquarters of the Government of the Republic of Croatia.
5	• Particularly valuable forest areas • Extremely large areas of open space • More simultaneous events of greater intensity • Endangerment of settlements and/or other contents or facilities • Danger index high to very high	• Firefighting forces from the 4th degree • Fire commander of the Republic of Croatia • Fire brigades from other parts of RH • Headquarters of Civil Protection of the Republic of Croatia • Civil protection units from the rest of the Republic of Croatia and Crisis headquarters of the Government of the Republic of Croatia • If necessary, help from other countries

Table 9. Open-space fire danger degree and corresponding fire brigades and legal entities involved in firefighting activities from the Fire Protection Plan for the City of Zabok

Source: Republika Hrvatska Krapinsko-zagorska Županija 2022[273]

Danger degree	Threat	Force engaged
1	• Small-scale outdoor fires • Danger index very low to low	• Fire brigades from the city of Zabok
2	• Smaller forest areas • Larger areas of grass and low vegetation • Danger index low to moderate	• Firefighting forces from the 1st degree • Fire brigades from neighboring cities and municipalities • Area commander
3	• Larger forest areas • Large areas of grass and low vegetation • Danger index low to moderate	• Firefighting forces from the 2nd degree • County fire department • Inclusion of part of the fire brigades from the area of the County • According to the judgment, the following are also included: o Intervention equipment o Air force o Civil protection units from the County o OS RH Croatian Army.
4	• Valuable forest areas • Very large areas of grass and low vegetation • Endangerment of buildings and settlements • Possible more simultaneous events in a wider area (of different intensity) • Danger index moderate to high	• Firefighting forces from the 3rd degree • Inclusion of the total firefighting forces from the county • Operational fire command of the continental part RH ÿ intervention equipment • Air force • County headquarters of civil protection • Civil protection units from the county • OS RH (Croatian Army) • Preparation of additional forces for assistance from other counties • If necessary, include the following: o Fire command of the Republic of Croatia o Headquarters of Civil Protection of the Republic of Croatia o Crisis headquarters of the Government of the Republic of Croatia.
5	• Particularly valuable forest areas • Extremely large areas of open space • More simultaneous events of greater intensity • Endangerment of settlements and/or other contents or facilities • Danger index high to very high	• Firefighting forces from the 4th degree • • Fire commander of the Republic of Croatia • • Fire brigades from other parts of RH • • Headquarters of Civil Protection of the Republic of Croatia • • Civil protection units from the rest of the Republic of Croatia ÿ Crisis headquarters of the Government of the Republic of Croatia • • If necessary, help from other countries

[273] Republika Hrvatska Krapinsko-zagorska Županija, 2022. Grad Zabok Plan Zaštite Od Požara. Zabok, ožujak 2022.

Table 10. Critical infrastructure affected by wildfires by sector

Source: Based on Republic of Croatia (2019d).

Impact	Sector
X	Energy
	Communication and information technology (electronic communications, data transfer, information systems, provision of audio and audiovisual media services)
X	Transportation (road, rail, air, sea, and inland waterway transport)
	Health care (health care, production, circulation and supervision of medicines)
	Water management (regulatory and protective water structures and communal water structures)
X	Food (food production and supply chain, food safety system, commodity stocks)
	Finance (banking, stock exchanges, investments, insurance, and payment systems)
	Production, storage, and transportation of dangerous substances (chemical, biological, radiological, and nuclear materials)
X	Public service (ensuring public order and peace, protection and rescuing services, emergency medical assistance)
X	National cultural and natural heritages

Table 11. Wildfire losses and impacts for the most likely scenario

Source: Based on Republic of Croatia 2019.

Life and human health			
Category	**Consequences**	**Criteria (no. of citizens)**	**Selected**
1	Insignificant	<50	
2	Small	50-200	
3	Moderate	201-500	**X**
4	Significant	501-1,500	
5	Catastrophic	>1,500	
Economy			
Category	**Consequences**	**Criteria (million kn)**	**Selected**
1	Insignificant	<250	
2	Small	250-700	**X**
3	Moderate	700-1,500	
4	Significant	1,500-7,000	
5	Catastrophic	>7,000	
Social Stability and Politics			
Damage to Critical Infrastructure			
Category	**Consequences**	**Criteria (million kn)**	**Selected**
1	Insignificant	<250	**X**
2	Small	250-700	
3	Moderate	700-1,500	
4	Significant	1,500-7,000	
5	Catastrophic	>7,000	
Damage to Public Buildings			
Category	**Consequences**	**Criteria (million kn)**	**Selected**
1	Insignificant	<250	**X**
2	Small	250-700	
3	Moderate	700-1,500	
4	Significant	1,500-7,000	
5	Catastrophic	>7,000	
Social Disruption due to Termination of Operation of Critical Infrastructure (>10 days)			
Category	**Consequences**	**Criteria (no. of citizens)**	**Selected**
1	Insignificant	<5,000	**X**
2	Small	5,000-15,000	
3	Moderate	15,000-50,000	
4	Significant	50,000-250,000	
5	Catastrophic	>250,000	

Table 12. Wildfire losses and impacts for the worst possible scenario

Source: Based on Republic of Croatia (2019).

Life and human health			
Category	**Consequences**	**Criteria (no. of citizens)**	**Selected**
1	Insignificant	<50	
2	Small	50–200	
3	Moderate	201–500	
4	Significant	501–1,500	
5	Catastrophic	>1,500	**X**
Economy			
Category	**Consequences**	**Criteria (million kn)**	**Selected**
1	Insignificant	<250	
2	Small	250–700	**X**
3	Moderate	700–1,500	
4	Significant	1,500–7,000	
5	Catastrophic	>7,000	
Social Stability and Politics			
Damage to Critical Infrastructure			
Category	**Consequences**	**Criteria (million kn)**	**Selected**
1	Insignificant	<250	**X**
2	Small	250–700	
3	Moderate	700–1,500	
4	Significant	1,500–7,000	
5	Catastrophic	>7,000	
Damage to Public Buildings			
Category	**Consequences**	**Criteria (million kn)**	**Selected**
1	Insignificant	<250	**X**
2	Small	250–700	
3	Moderate	700–1,500	
4	Significant	1,500–7,000	
5	Catastrophic	>7,000	
Social Disruption due to Termination of Operation of Critical Infrastructure (>10 days)			
Category	**Consequences**	**Criteria (no. of citizens)**	**Selected**
1	Insignificant	<5,000	**X**
2	Small	5,000–15,000	
3	Moderate	15,000–50,000	
4	Significant	50,000–250,000	
5	Catastrophic	>250,000	

Table 13. Exposure of critical assets to hazards in Croatia

Source: World Bank.

Total # assets	% EDU	% HLTH	% FIRE	% POLICE	# EDU	# HLTH	# FIRE	# POLICE	All assets
Total assets					**Assets exposed to High and Very High wildfire**				
1,329	34%	13%	35%	18%	315 (69%)	95 (57%)	373 (79%)	181 (76%)	964 (73%)
					Assets exposed to H and VH Landslide susceptibility				
					29 (6%)	12 (7%)	27 (6%)	20 (8%)	88 (7%)
					Assets exposed to high seismic hazard (>=MMI VI)				
					414 (91%)	156 (93%)	418 (89%)	212 (89%)	1,200 (90%)

Table 14. Road and power line assets exposed to high and very high hazards in Croatia

Source: World Bank.

Total km of road exposed	% ROADS	Total km of power lines exposed	% POWER LINES
Roads exposed to high and very high wildfire hazard		**Power lines exposed to high and very high wildfire hazard**	
2,811	97%	8,148	94%
Roads exposed to high and very high landslide susceptibility		**Power lines exposed to high and very high landslide susceptibility**	
1,944	67%	4,773	55%
Roads exposed to VI+ seismic shaking intensity		**Power lines exposed to VI+ seismic shaking intensity**	
2,625	91%	8,061	93%

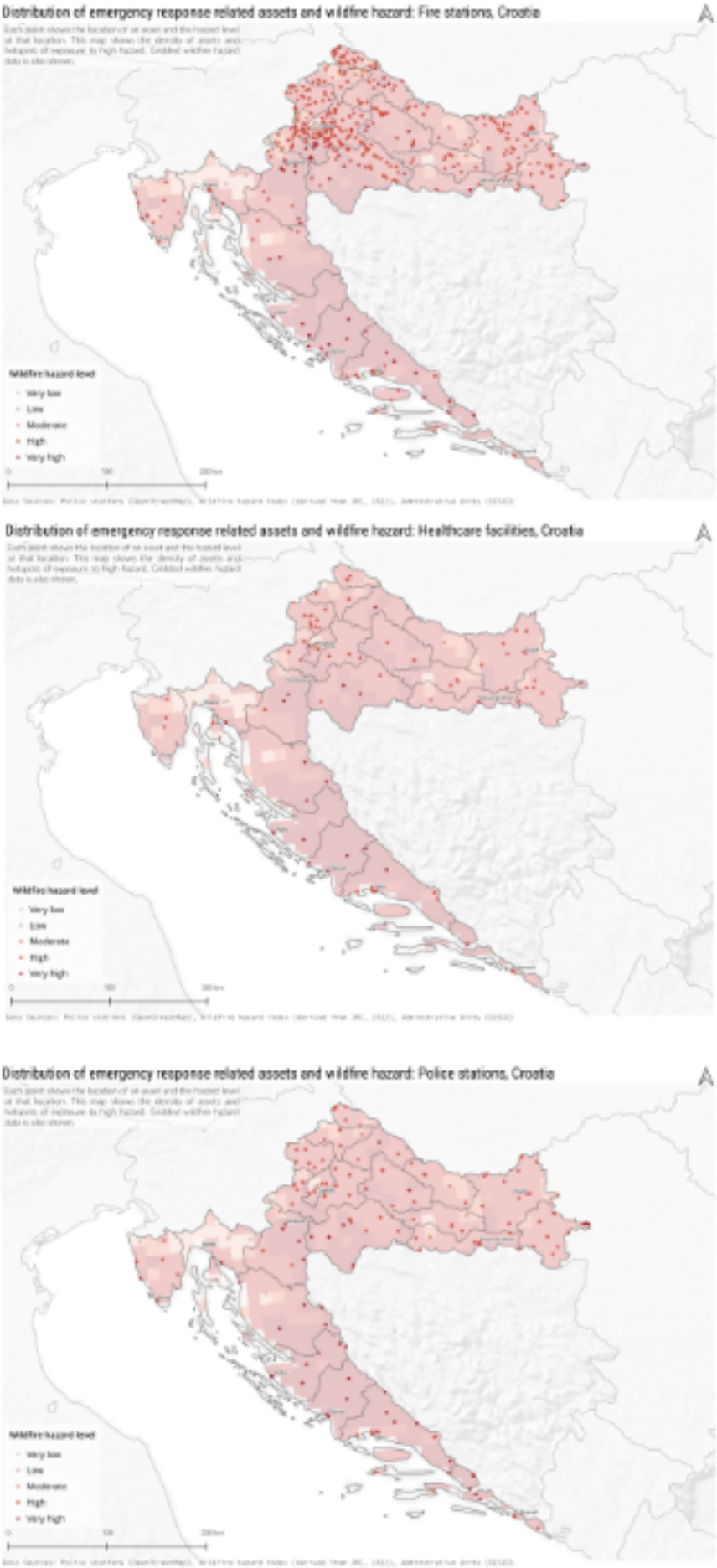
Table 15. Wildfire risk and social vulnerability vs. Capacity gaps at county level

Source: The 'wildfire risk' is based on Civil Protection Directorate (2024); 'wildfire social risk' is based on background analysis undertaken for World Bank (2024b); 'wildfire risk operational readiness and capacity' is based on Croatia NRA (2024).

County	Wildfire risk	Wildfire social risk	Wildfire operational readiness and capacity
Bjelovar-Bilogora	Moderate	Very low	Low
Brod-Posavina	Moderate	Very low	High
City of Zagreb	Low	Low to very low	High
Dubrovnik-Neretva	High	Medium	High
Istria	High	Very low	High
Karlovac	Moderate	Very low	Low
Koprivnica-Križevci	Moderate	Very low	Low
Krapina-Zagorje	Moderate	Very low	Low
Lika-Senj	Moderate	Very low	Low
Međimurje	Moderate	Very low	Low
Osijek-Baranja	Moderate	Very low	High
Požega-Slavonia	Low	Very low	High
Primorje-Gorski Kotar	Moderate	Extreme	High
Sisak-Moslavina	Moderate	Low	Low
Split-Dalmatia	Very high	Extreme	High
Šibenik-Knin	High	Low	High
Varaždin	Moderate	Very low	Low
Virovitica-Podravina	Moderate	Very low	High
Vukovar-Srijem	Moderate	Very low	High
Zadar	High	Extreme	High
Zagreb	Moderate	Low to very low	High

Figure 12. Exposure map of critical assets to wildfire hazards in Croatia

Source: World Bank (2024b).



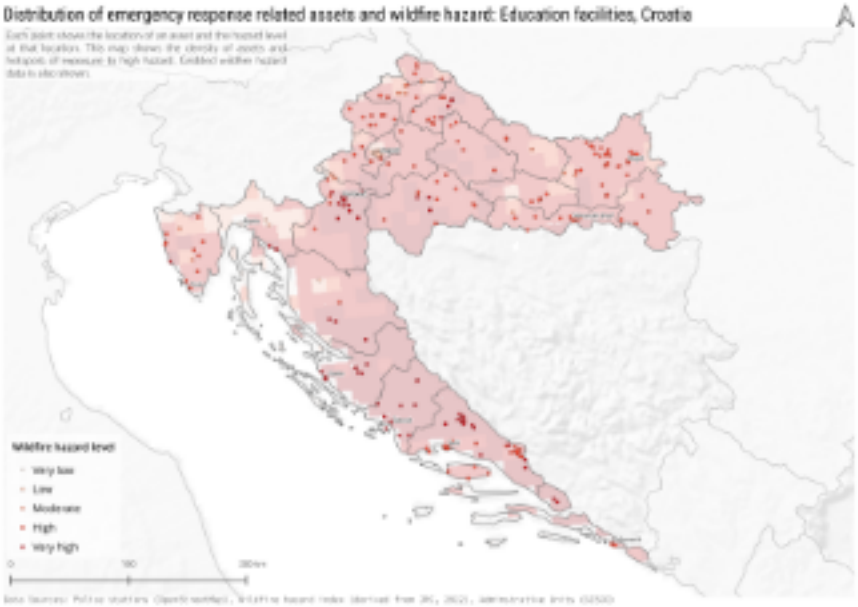
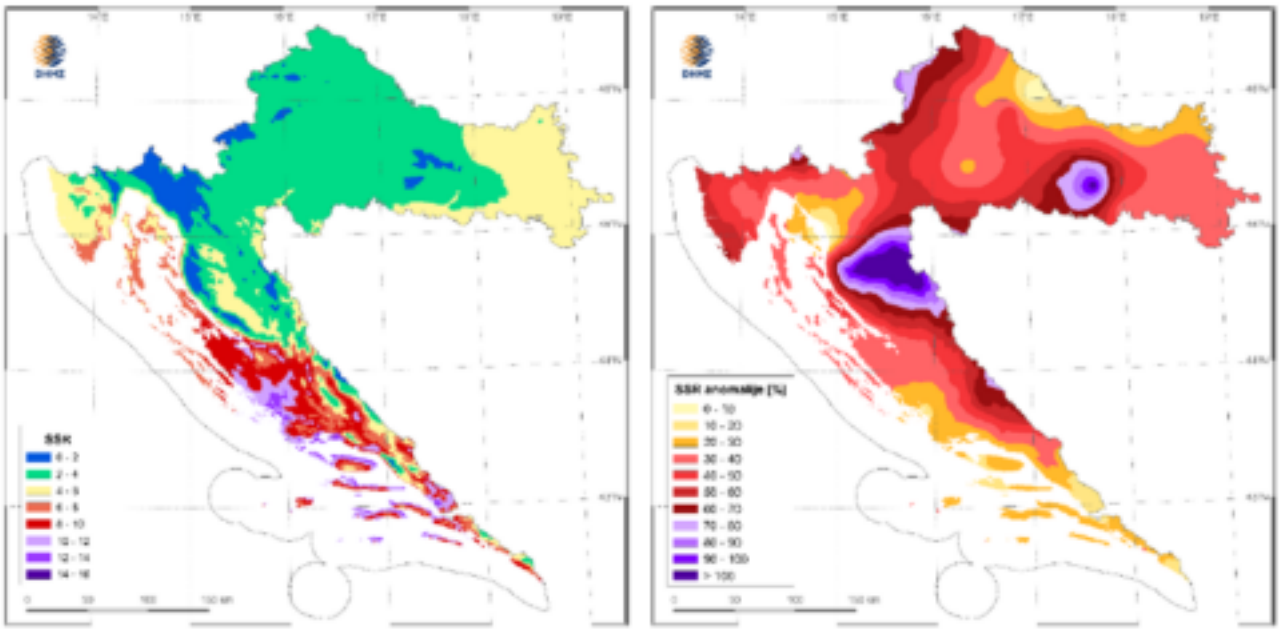
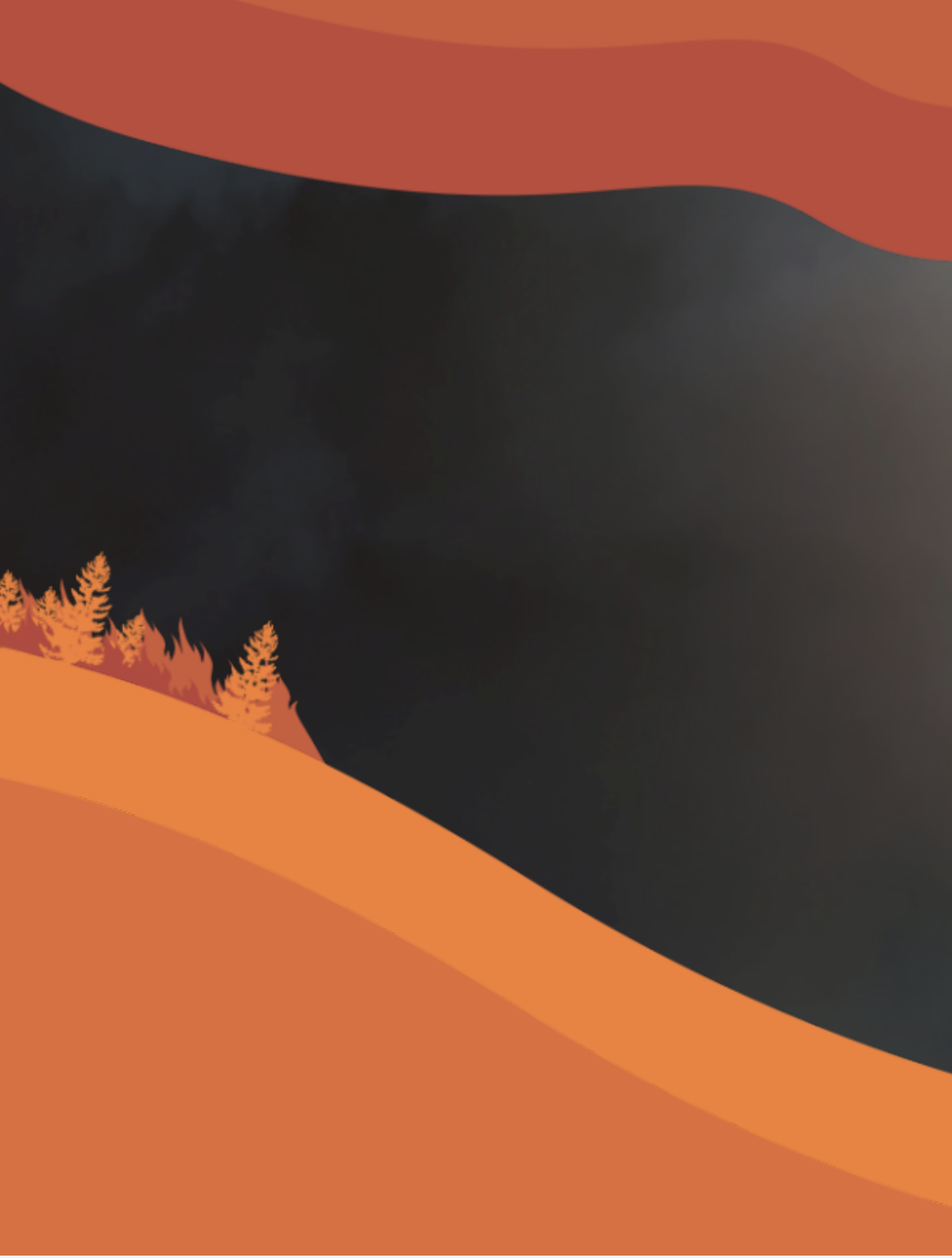


Figure 13. Spatial distribution of mid-season SSR during the fire season in the more recent climatological period 1991–2020 (left); the ratio of the mean values of the SSR during the fire season in 1991–2020 to the mean values of the SSR during the fire season in 1961–1990.

Source: DMVZ 2023.





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