Forest Fires in the Carpathian Mountains
Analysis of Policy Responses at the Regional and National Level

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Abstract

Climate change jeopardizes forests in the Carpathian Region, by increasing the risk of forest fires. This qualitative study seeks to develop an integrated assessment of the current regional and national policies regarding prevention and control of forest fires in the Carpathians. The authors have developed a framework of analysis for the policies in force. This analysis conveyed the categorization of the different National and EU legislation according to ten major mechanisms in forest fire protection. The results of this investigation show that there are more preventive than corrective measures to tackle forest fires in both the Carpathian national laws and EU policies. Categories that require the application of technical advancements and scientific knowledge have received the lowest scoring qualification. This might be caused by a delayed translation of scientific knowledge into the legislative process. Additionally, the gaps between national policies and scientific knowledge in climate change and integrated fire management practices have been identified in the concomitant EU and U.S. legislation, respectively.

I. Introduction

The Carpathian region encompasses a semicircular 1,500 kilometer mountain system that cuts across seven Central and Eastern European countries: Czech Republic, Hungary, Poland, Romania, Slovakia, Serbia, and the Ukraine. Covering a total area of about 210,000 square kilometers, the Carpathians constitute Europe's second most extensive mountain range after the Alps and consist of a myriad of natural landscapes of great ecological value.[1]

Many geological formations can be found in the Carpathians, including gorges, alpine glaciers, karst landforms, inactive volcanoes, and pasturelands. The region is also rich in hydrological resources.[2] In addition to an extensive network of rivers (the Danube, the Dniester, the Vistula, and the Oder) that flow to the Baltic and the Black Sea, its numerous lakes and water reservoirs supply clean water for communities, including for agriculture and industry.[3]

The Carpathian Mountain forests cover over 11 million hectares, from which 300,000 maintain natural ecosystems that include the continent's most extensive areas of virgin and old growth forests. These forests offer extensive biodiversity and provide habitats for many endangered species.[4] The native flora of the Carpathians comprises approximately 30% of all European flora with almost 4,000 species and subspecies.[5] Oak, beech, conifer and mixed forests provide shelter and a large number of plant and animal communities supply a great variety of microhabitats for invertebrates and fungi.[6] The Carpathian forests are also home to Europe's main populations of large mammals such as brown bears, wolves, lynxes and bison, as well as rare birds including the endangered Imperial Eagle.[7]

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[1] Saskia Werners, Future Imperfect. Climate Change and Adaptation in the Carpathians (UNEP/GRID 2014) 12.
[2] Maciej Borsa and others, 'VASICA - Visions and Strategies in the Carpathian Area' (UNEP 2009) 128.
[3] Michael Appleton and Hildegard Meyer, 'Development of Common Integrated Management Measures for Key Natural Assets in the Carpathians' (Study WWF Danube-Carpathian Programme June 2014) 77.
[4] ibid 19.
[5] Werners (n-1) 12.
[6] UNEP, 'Carpathians Environment Outlook 2007' (Report 2007) 244.
[7] Appleton (n-3) 20.

The climate patterns in the Carpathians are highly variable, making the identification of a prevailing regional climate extremely complex. This is due to the extended curvature of the mountain chain, with its divisions, providing air masses from the Atlantic Ocean with only a variable impact on the climate, whereas Eastern air masses from Asia, and the Northern boreal and Southern Mediterranean air masses have a severe effect.[8]

Climate data for 16 meteorological variables have been continuously collected over the past fifty years (from 1961 until nowadays) in a common Carpathian database.[9] The opinions of climate scientists of the Carpathian region form a consensus about the prevalence of global warming,[10] which is also indicated by historical data.

A mild increase in temperature and changes in precipitation can prove potentially hazardous to the ecology of the region. Although recorded meteorological data is not always available, several examples can be used to confirm climate change. Though only minor differences are seen regarding the mean air temperature in the last century, in 1961 the maximum air temperature above 850 m (TX) in the Slovakian Carpathians was 18.95 °C. This increased to 23.8 °C by 2010. Temperatures in the Ukrainian Carpathians have also risen. In 1961 maximum temperatures were 21.75 °C, but this had increased to 24.33 °C by 2010.[11] In addition to increases in temperature, a decrease and unpredictability in precipitation has been observed. These effects are particularly evident in the Carpathians: Between 1961 and 1981 the average annual precipitation (PR) ranged between 517.19 mm and 1380.38 mm, whereas from 1982 to 2010 it ranged between 470.97 mm and 1226.18 mm.[12]

Along with the above data on climate change, statistics of the last thirty years on forest fires, compiled by the Food and Agriculture Organization of the United Nations (FAO) and the European Forest Fires Information Systems (EFFIS), serve as evidence of an increasing fire risk in the Mediterranean and anticipate a similar pattern in the mountain areas of Central and Eastern Europe,[13] thus, endangering biodiversity through the loss of habitats, extinction of species, and proliferation of invasive species. Further consequences include failure to maintain economically valuable forest lands, unemployment, migration of vulnerable communities, and loss of human life.

The risk of increased drought, which raises the amount of dried vegetation that serves as natural fuel for combustion is one of the numerous environmental threats to the region, aggravating the frequency and severity of forest fires.[14] Wildfires are a natural part of boreal and temperate

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[8] UNEP (n-6) 241.

[9] 'Carpatclim - Climate of the Carpathian region: Metadata' <www.carpatclim-eu.org/pages/metadata> accessed 1 August 2016.

[10] Monika Lakatos and others, 'Investigation of climate extremes in the Carpathian region on harmonized data' (International Scientific Conference Environmental changes and adaptation strategies, Skalica, 2013) 21; Jonathan Spinoni and others, 'Climate of the Carpathian Region in the Period 1961–2010: Climatologies and Trends of 10 Variables' [2014] 35 Int. J. Climatol. 1322, 1332-1339.

[11] 'Carpatclim' (n-9).

[12] ibid.

[13] European Commision, 'Forest Fires in Europe, Middle East and North Africa 2014' (Technical Report Joint Research Centre 2015) 100-107.; European Commision, 'Impacts of Climate Change on European Forests and Options for Adaptation' (Report 2008) 7-20.

[14] H. Jactel and others, 'Forest Stands Management and Vulnerability to Biotic and Abiotic Hazards' (Technical Report 64 European Forest Institute 2011) 12.

forest ecosystems, because they eliminate undesired species and enhance nutrient availability. However, current climate trends have altered the structure and function of forests. The increase in the occurrence of forest fires causes soil erosion, reduces plant regeneration and accelerates desertification.[15]

Climate change adaptation policies should be designed and implemented to promote practices that support forest ecosystem resilience. The Carpathian Convention, adopted in May 2003 by the seven Carpathian countries aims to foster sustainable development and protection of the region.[16] In addition to providing a forum for dialogue, the convention serves as a platform for cooperation and policy coordination, contributing to the implementation of global multilateral agreements. Additionally, the European Union, of which five of the Carpathian countries are Member States, has issued strategies, directives and regulations to address forest protection which include fire prevention and mitigation measures. This investigation attempts to evaluate the current national and regional policies regarding forest fires in the Carpathians, in order to analyze the gaps between the science of climate change and policies affecting these changes. Given the limitations of evaluating implementation of policies, this study relies strictly on a qualitative analysis of the legislative documentation. The authors have conducted an extensive policy review of the regional and national legislation, and have developed a framework for analysis of the question: *How are the current policies in the Carpathian region tackling the issue of forest fires, and to what extent are they considering the predicted effects of climate change?*

II. Theoretical Framework

To analyze environmental issues related to climate change, such as forest fires in the Carpathians, is highly complex, since there are several stakeholders to consider at different levels.[17] In a holistic approach, many theorists and practitioners based the evaluation of the environmental issues within comprehensive frameworks, taking into account the interactions between society and the environment.

Some models, like the Pressure–State–Response (PSR) developed by the OECD, provide an integrated approach in setting indicators for the evaluation of environmental policies.[18] Built upon the PSR model, the Drivers-Pressures-State-Impacts-Responses framework (DPSIR) widely used by the European Environmental Agency (EEA), proposes a causal sequential model by linking environmental conditions and trends with policy analysis.[19] The DPSIR approach considers the drivers of human and natural events, their pressures and alterations on the environmental state, as well as the consequential impacts and society's response to these changes. These responses include formulating and implementing different types of policy instruments, establishing interna-

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[15] European Commision (n-12) 45.
[16] The Carpathian Convention, 'The Convention' <www.carpathianconvention.org/the-convention-17.html> accessed 5 August 2016.
[17] Per Mickwitz, *Environmental Policy Evaluation: Concepts and Practice* (The Finnish Society of Sciences and Letters 2006) 27.
[18] OECD, 'OECD Environmental Indicators. Development, Measurement and Use' (Reference Paper 2003) 4-9.
[19] Swanson Pintér and others, 'IEA Training Manual. Integrated Analysis of Environmental Trends and Policies' (Training Module 5 UNEP/IISD 2013) 9-10.

tional commitments and institutional strengthening.[20]

As a societal response, policy making aims to influence drivers, pressures, state and impacts of the environment to ultimately contribute to problem solving. Many researchers have recognized the importance of policy evaluation as an impetus for improvement.[21] Evaluations can be applied to the whole policy-making process. However, the timing of such assessment impacts the results.[22]

Pülzl and Rametsteiner[23] have proposed a methodology to analyze environmental and forest related policies. As a response to the increase of international policies committed to the forestry sector, this methodology follows six steps comprised of policies content assessment; relevance, responsibility and form of the implementation to identify potential gaps, as well as synergies and differences between commitments.

Built upon the previously stated frameworks, an evaluation model has been developed to analyze regional and national policies that deal with forest fires in the Carpathians. The comparison has addressed the gap between forest fire climate science and policy making, taking into account best practices from North America and Europe.

III. Previous Evidence

Climate change adaptation in mountainous areas is one of the priorities of the environmental agenda of the United Nations Environmental Program (UNEP). Since October 2003, the UNEP office in Vienna has been acting as the Secretariat of the Carpathian Convention to strengthen regional cooperation in Central and Southeastern Europe. As a result, numerous projects, including the Carpathian Project, Carpatclim, Carpavia, CarpatCC, S4C Science for the Carpathians, and BioREGIO have been conducted to promote sustainable development and deal with environmental issues in the region.[24]

Publications resulting from the aforementioned projects are fundamental to this investigation, as they offer valuable information on the Carpathian region including ecosystems inventories, climate change impact assessments, adaptation strategies, capacity building, monitoring systems and technical tools. A noteworthy example is the Carpatclim project which offers a database on the climate patterns of the Carpathian mountain region.[25]

In addition, forest fire statistics in Europe are compiled by the Joint Research Centre of the European Commission, through the EFFIS database.[26] This tool is used in the early detection and monitoring of fires, identifying fire risk and analyzing causes and contributing factors. Specific prac-

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[20] ibid 37.

[21] Mickwitz (n-16) 25.

[22] Carly Coglianese 'Measuring Regulatory Performance. Evaluating the Impact of Regulation and Regulatory Policies' (Expert Paper No. 1 OECD August 2012) 50-51.

[23] Pülzl and Rametsteiner, 'A Methodical Tool for the Evaluation of the Implementation of International Commitments on National and Sub-National Levels' (The Evaluation of Forest Policies and Programmes conference, Saarijärvi, 2004) 29-41.

[24] UNEP, 'Terminal Evaluation of the Project. Best practice of subregional cooperation partnership for the support of the Carpathian Convention and other Mountain Regions' (Report November 2014) 8-31.

[25] 'Carpatclim' (n-9).

[26] Joint Research Centre of the European Commission, 'EFFIS: European Forest Fire Information System' <http://forest.jrc.ec.europa.eu/effis/> accessed 1 August 2016.

tices to manage forest fires with fire have been evaluated and promoted by the European Institute of Forestry with its Fire Paradox program.[27] Furthermore, voluntary guidelines for forest fire management have been issued by the FAO, outlining the need to integrate policy making with fire management practices.[28] Forest-related institutions and Scholars in Europe, the United States of America and Canada have also highlighted the use of beneficial fires to prevent and mitigate the expansion of forest fires.[29]

The literature and tools available provide an overview on the Carpathians, its forests and the risks of climate change, as well as forest fire incidence and scientific and technological information about appropriate practices in fire management. Nevertheless, there is still a lack of an integrated assessment on the regional and national policies regarding prevention and correction of forest fires in the Carpathian region.

IV. Research Design and Methods

The aim of this paper is to evaluate the current regional and national policies on forest fires in the Carpathian region. What are the current policies dealing with the issue of forest fires and to what extent are they considering the predicted effects of climate change? To answer these questions, the authors have developed a model for the comparison of the implemented legislation and mechanisms. The following steps give more detailed information about the process for the development of the framework for analysis.

Step 1: Selection of relevant policies.

The selection process started with an extensive review of a wide range of legal and policy documents that address forest fires in the EU, the Carpathian region and the USA, by reviewing sources from national authorities, the European Union, NGOs and other stakeholders. The selected policies were categorized as follows:

1) The Carpathian states' specific national forest laws, acts or codes and their further amendments were chosen as basis and complementary laws related strictly to forest fire legislation stipulated for the country.

2) The EU regulations, directives, decisions and the European Commission's general legislation published as Commission Communications (COM).

3) The U.S. national legislation that relates to forestry and fire management, differentiating these laws from the federal-specific legislation.

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[27] European Forest Institute, 'Best Practices of Fire Use – Prescribed Burning and Suppression Fire Programmes in Selected Case-Study Regions in Europe' (Research Report 24 2010) 3-35.

[28] FAO, 'Fire management: voluntary guidelines. Principles and strategic actions.' (Working Paper 17 2006) 25-43.

[29] John Parrotta and others 'Traditional knowledge for sustainable forest management and provision of ecosystem services' [2016] 12 International Journal of Biodiversity Science, Ecosystem Services & Management 1 1-4.; Max Bennett and others, 'Reducing Fire Risk on Your Forest Property' (Technical Report PNW 618 2010) 10-12.; Marc Hanewinkel and others, 'Climate change may cause severe loss in the economic value of European forest land' [2003] 3 Nature Climate Change 203, 203-207.

Step 2: Mechanism categorization and scoring

The main categories were developed in order to examine the mechanisms of prevention and correction of forest fires used in existing regulatory frameworks. Subcategories were also developed to delineate the basic principles of the mechanisms and describe the concepts surrounding them. These categories serve as the basis of evaluation of the mechanism integration level within the legislation. In this context, the level of integration is evaluated through a scoring system that grades the extent in which a mechanism is considered in a policy. The scoring system implemented adheres to the criteria of following *Table 1*.

Points	Integration Level	Criteria
4	*Fully addressed*	Explicit use of the corresponding terminology and alignment of definitions, objectives and/or instruments to the mechanisms of forest fire protection.
3	*Partially addressed*	Terms and measures that refer to the established mechanisms of forest fire protection as contained in the policy.
2	*Somewhat mentioned*	Implicit mention to the mechanism of forest fire protection
1	*Not considered*	No mention of the mechanism

Table 1. Scoring System of the Policies

Step 3: Policy evaluation

The assessment of the EU and Carpathian national policies was performed after a thorough review and scoring process of the selected policies by conducting a matrix analysis. U.S. policies were also included, due to their extensive considerations of climate change related issues and forest fires. To support the value of our judgment, subcategories and key words are used to further define the main categories. The model was built based on the aforementioned techniques to show the legislative performance of every country. The results of the extensive matrix analysis were carried out and visualized through radar charts. This comparison unveiled synergies and differences in the policy making within the Carpathian countries.

Step 4: Assessment of climate change related measures

The analysis established the congruency of the evaluated policies with the scientific knowledge about climate change. This was performed through a comparison of how specific climate change effects are taken into account in the legislation that addresses forest fire. Additionally, adaptation strategies on the mitigation of forest fires were assessed.

V. Integrated Model for the Analysis of Forest Fire Related Policies

The model developed in this paper presents an evaluative approach that incorporates scientific practices in the environmental protection against forest fires, and the policy making process. The revised policies were classified according to legislation type and mechanism. In order to create an objective framework and to minimize the limitations of using self-reporting data, the mechanism categories and subcategories were developed through an extensive examination of the forest fire legislation in the EU, the Carpathian States and the USA, as well as recommendations for the protection against forest fires from international organizations such as the UNEP, the FAO and the World Bank, as well as best practices from academic, scientific and forestry institutions. The categories identified are presented below.

1. Categorization According to Legislation Type

1.1. National Legislation

The sets of laws of the seven Carpathian countries were classified as listed below:

1. The Basic National Forest Law, Act or Code containing a set of rules enacted by the legislative authority of a country regulating the access, management, conservation and use of forest resources.
2. The Complementary National Regulations, Decrees or Decisions or other document, containing specific measures to implement the forest act in regards to forest fires or related issues.
3. The Specific National Fire Protection Law, Act or Code containing a set of rules enacted by the legislative authority of a country regulating fire safety, protection units and procedures for fire prevention, extinction and rescue.

The evaluated national legislation is presented in *Table 2*. underneath.

	Legislation Name	Type
Czech Republic	Forest Act 1995 No. 289/1995 Coll. (Forestry Act) and respective amendments	1
	Fire Protection Act No. 133/1985 Coll. and respective amendments	3
Hungary	XXXVII/2009. Law on Forest, the Protection of Forests and Forest Management	1
	153/2009. (XI. 13.) FVM (Ministry of Agriculture and Regional Development) Decree on the Implementation of the XXXVII/2009. Law	2
	4/2008. (VIII. 1.) ÖM (Ministry of Local Government) Decree on Protection of Forests against Fire Hazards	3
	XXXI/1996. Law on Protection against Fires, Technical Rescue Operations and Fire-fighting Brigade	3
Poland	Forest Act 1991 and respective amendments	1
	Executive Order No. 11 of the Minister of Environment Protection, Natural Resources and Forestry regarding the issuance of the Statute for the State Forestry Administration-State Forests.	2
	Regulation on forest fire prevention	2
	Fire Protection Act of 24 August 1991	3
Romania	National Forest Code No. 46/2008	1
	Law No. 307 of 2006 on Fire Safety	3
	551/1475 of 2006 on Fire Regulation	3
Serbia	Forest Law "Official Gazette of RS", no. 30/2010 and respective amendments 93/2012, 89/2015, 103/2015	1
	Fire Protection Act "Official Gazette of RS", no. 111/2009 and respective amendments "Official Gazette of the RS", No. 20/2015	3
Slovakia	Forest Law No. 326/2005 and respective amendments No. 360/2007, No. 184/2014	1
	314/2001 Coll. on Fire Protection	3
	121/2001 Coll. on Fire Prevention	3
	202/2015 Coll. amending and supplementing Decree of the Ministry of Interior of the Slovak Republic no. 121/2002 Coll. about fire prevention	2
Ukraine	Forest Code of Ukraine No. 3852-XII of 1994 and respective amendment 3404-IV of 2006	1
	Code of Civil Protection of Ukraine 3435 of 2013	3

Table 2. National Legislation

1.2. European Union Legislation

The EU legislation was classified as listed below:

- Regulations are binding legislative acts that must be applied in their entirety across the EU Member States.
- Directives are legislative acts that set out a goal that all EU countries must achieve. It is up to the individual countries to devise their own laws on how to reach these goals.
- Decisions are binding on those to whom they are addressed, either Member State or legal person.
- Other policy documents with no mandatory authority. The Commission takes the initiative of publishing a Communication to set out its own thinking on a topical issue.

The EU regulations, directives, decisions and other documents reviewed in this paper are presented in *Table 3.* underneath.

EU Legislation	Instrument
LIFE 2014-2020. Programme for the environment and climate action (Regulation (EC) No 1293/2013)	Regulation
European Agricultural Fund for Regional Development (EAFRD) (Regulation (EU) No 1305/2013)	Regulation
EU Land Use, Land Use Change and Forestry (LULUCF) accounting rules (Decision No 529/2013/EU)	Decision
Reinforcing the Union's Disaster Response Capacity (COM(2008)130)	Other
EU Strategy on adaptation to climate change (COM/2013/216)	Other
EU Forest Strategy (COM/2013/659)	Other

Table 3. EU Legislation

1.3 U.S. Legislation

In order to be able to compare the U.S. national legislation with the ones of the Carpathian countries, it is relevant to distinguish U.S. national laws from federal-specific ones, due to the fact that local divergences could lead to different interpretations. Guided by this principle, the authors analyzed closely nation-related legislation.

By reviewing U.S. national legislation, one national specific forest act cannot be found, as a consequence of the country's nature, i.e. comprised of fifty states, it is fragmented when it comes to establishing unified and all-embracing legislation.[30] Since the late 1800s, more than 100 laws affecting forestry have been passed by the United States Congress and signed by the US Presidents.[31] In the early years these landmark laws enabled and authorized the administrative institutions for the protection and management of national forests, outlining the basic patterns of forestry. Laws passed in recent years upgrade and regulate the sustainable use of forests and the importance of integrated fire management. All these laws have contributed to the appropriate adaptation of the current scientific recommendations and to the proper use of the latest results.

U.S. decision-makers regulate all aspects of national forestry and fire-fighting management.

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[30] George H. Potter, 'International Fire Safety Legislation: An Overview' <http://www.fireengineering.com/articles/2008/02/international-fire-safety-legislation-an-overview.html/> accessed 10 December 2016.

[31] U.S. Forest Service, 'Laws and Regulations' <http://www.fs.fed.us/about-agency/regulations-policies/laws-regulations> accessed 10 December 2016.

Therefore, the mechanism categories of this paper could contain many of the analyzed laws. The legislation analysis of the U.S. consisted in 40 laws, i.e. approximately 1/3 of the forestry-related legislation.

2. Categorization According to Mechanisms

The mechanism classification was carried out along 10 main points of view with the help of well-defined keywords seen beneath:

1. **Institutional Framework** outlines the organizational system that regulates forests and fire management. Legislation provides a clear description of responsibilities inside the system to avoid overlapping roles and functions. Examples at the national level include ministries holding the main responsibility for formulation of forest policies as well as other governmental offices responsible for implementing these policies. Different levels of administration such as regional directorates and superintendencies are part of the governing bodies mentioned above.
   Key words: *authority*, *ministry*, *minister*, *institution*, *guard*, *(fire) brigade*, *organization*, *office*, *agency*, *body*, *head*.
2. **Financial Instruments** are included in the legislation by fund allocations, fines and other punitive sanctions. Fund allocations can be available in the form of grants and subsidies for programs relating to forest protection and prevention of fires. Resources coming from fines and sanctions are used as compensation for damages, for firefighting and for forest restoration activities.
   Key words: *fund*, *allocation*, *appropriation*, *sanction*, *breach (of law)*, *violation*, *compensation*.
3. **Infrastructure** refers to the civil works for building and upgrading of fire prevention facilities, transportation networks and water supply systems. Construction of roads, fire stations, water reservoirs and fire hydrants are examples of the infrastructure required in the legislation. The availability of such resources affects the speed, safety and efficiency of firefighting.
   Key words: *infrastructure*, *road*, *water*, *hydrant*, *(fire) station*, *transportation*, *supply*.
4. **Firefighting Preparedness** refers to the working conditions and capacity building of fire brigades stipulated in the legislation. These measures include an adequate supply of machinery, tools and uniforms for firefighters, as well as training. In this regard, training on the effective use of equipment, fire suppression techniques and deployment of resources is vital to ensure high performance during a fire event.
   Key words: *firefighting*, *brigade*, *suit*, *unit, clothing*, *equipment*, *truck*, *training*, *tool*, *technique*.
5. **Protection Plan**: The fire management plan established in the legislation, covers, among other measures, the demarcation of protected areas, fire hazard classifications, camp fire regulations and fire bans. The classification of forest areas in hazard classes deals with climate, season, vegetation type and other influencing factors, to control potential fire caused by forest visitors or other users. To achieve this purpose, camp fire and fire bans are issued in areas when conditions are prone to cause a fire event.
   Key words: *plan*, *class*, *(fire) hazard*, *camp (fire)*, *fireplace*, *regulation*, *(fire) ban*.
6. **Monitoring** refers to data management and surveillance activities for prediction, warning and early detection of fire events. These activities comprise the use of automated technologies and information systems to detect fire risks, remote sensing of active fire data and records of his-

torical data. Several tools to monitor fire risk can be established through the usage of ground-based visual systems, ground-based non-visual sensors, manned or unmanned aircraft and satellites.

Key words: *monitor(ing)*, *surveillance*, *detection*, *information*, *(fire) warning*.

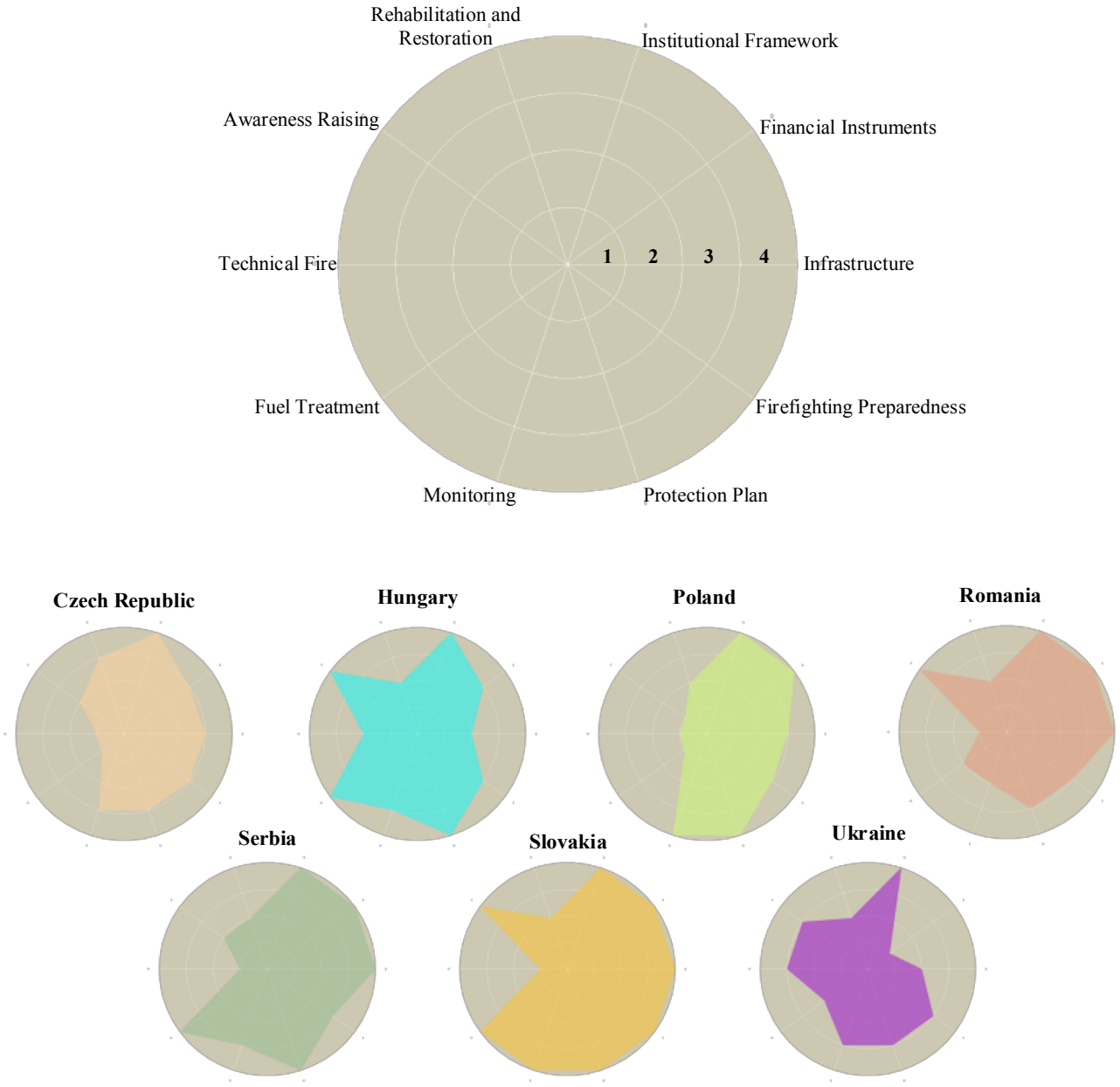
7. **Fuel Treatment** activities cover the controlled arrangement of flammable vegetation. These activities incorporate selective removal of flammable material to interrupt fuel continuity by using fire breaks, fire strips, livestock grazing and other measures. Further fuel silvicultural treatments include the plantation of fire resistant endogenous species to create patchworks of vegetation with different inflammability levels.
   Key words: *silviculture*, *grazing*, *pastoralism*, *(fire) breaks*, *strips*, *fence*, *resistant*.
8. **Technical Fire** measures amount to the controlled use of fire based on an analysis of fire behavior by qualified personnel under specific environmental conditions. These are divided into prescribed and suppressive fires. Prescribed fire or burning is used to remove flammable vegetation for the reduction of hazardous fuels and to maintain healthy ecosystems. Suppressive fire is used to extinguish fires, by consuming unburned vegetation between a control line and the wildfire front; it can also be used to change the direction or force of the fire.
   Key words: *technical*, *suppression/suppressive*, *burning*, *prescribed*, *controlled*, *integrated (fire management)*.
9. **Awareness Raising** refers to the activities engaging local communities in order to protect forests through informative campaigns and capacity building programs. Governments are responsible for issuing flyers and posters, online websites or interactive databases, addressed to the public domain. Media campaigns based on scientific knowledge and research intended to spread a message of fire prevention, proper use of fire, as well as to warn of situations of fire danger, are also part of the measures involved in creating the awareness of local communities. For the same purpose, there are national programs to involve the public in the prevention, detection and reporting of fires. School programs can educate children about forest fires and their impact on ecosystems and natural resources.
   Key words: *information*, *available*, *media*, *campaign*, *program*, *school*, *education*, *week (of forests)*, *research*, *website*, *database*, *newspaper*, *public*.
10. A body of **Rehabilitation and Restoration** activities is available to alleviate environmental impacts due to fire disasters. Some of these measures include: planting trees, reestablishing native tree species, repairing damage to facilities such as campgrounds, building fences, and exhibits, restoring habitats and dealing with invasive plants.
    Key words: *rehabilitation*, *restoration*, *reforestation*, *resilience after (fire)*.

VI. Evaluation Results and Policy Analysis

This chapter presents the results of the conducted policy assessment according to the framework and categories developed by the authors. *Figure 1.* below illustrates the summary of the analysis about the Carpathian national legislation. The matrixes used to classify the E.U. and U.S. policies are presented in *Annex 1* and *Annex 2*, respectively.

Policy Evaluation Matrix

1 – *Not considered at all*; 2 – *Somewhat mentioned*; 3 – *Partially addressed*; 4 – *Fully addressed*



The presented radar charts were made by the authors with the help of *R Project for Statistical Computing* https://www.r-project.org/

Figure 1. Radar Chart of the National Carpathian Legislation

1. Legislation of the Carpathian countries

1.1. Czech Republic

The **institutional framework** for forestry and fire protection in the Czech Republic are stated in the respective Acts. In this regard, forest issues are under the jurisprudence of State Forest Administration Bodies such as the Ministry of Agriculture and District Offices, while the Ministry of Defense is the head of the Fire and Rescue Service. **Financial instruments** permeate the Forest

Act, which provides funding through the State Fund for the environment acquired from fines, sanctions and special fees. In terms of **infrastructure**, the legislation promotes the construction of facilities, roads and water supply systems in order to combat forest fires. The construction of road networks shall not be interfered and must be cleared for firefighting purposes. Relating to **fire-fighting preparedness**, the Fire Protection Act details the different fire protection units with their obligations, rights and duties. The Act regulates the required training, equipment and stations and it is applicable for urban settlements and forests. In regard to **protection plans**, the Forest Act establishes a management strategy and guidelines to protect the forests, and establishes prohibitions against starting fires. Nonetheless, rules for an integrated fire management plan, including regional and seasonal fire risk assessment, are not present in the Act. Additionally, this Act establishes a general provision of forest **monitoring** stations. The Fire Protection Act on the other hand establishes measures for early fire detection in forests during high fire risk periods. **Fuel treatment** activities, such as describing different tools to prevent fires to spread, and the use of **technical fires** are not covered in the analyzed legislations. The Forest Act also promotes **awareness raising** activities, including scientific research on forest protection. Yet, further awareness raising activities are needed. Finally, in terms of **rehabilitation and restoration** activities, the Forest Act burdens forest owners with the responsibility of reforesting the land and conducting restoration activities after the occurrence of a fire, as well as to take measures to increase their resistance. This is facilitated by the provision of funds for such measures.

1.2. Hungary

With regard to **institutional framework**, subdivision of duties and responsibilities are well-established among different Hungarian bodies. A Minister responsible for forests are present – currently under the leadership of the Ministry of Agriculture – whose work is being assisted by other Ministers depending on pre-defined specific topics. A national authority, called *NÉBIH* (National Food Chain Safety Office), was established to cover better forest management targets. In the field of fire-fighting, it cooperates with the National Directorate General for Disaster Management and its regional offices which are under the authority of the Ministry of Interior. For fire-fighting Hungarian Defence Forces are also mentioned. In connection with **financial instruments**, procedural costs, financial support of fire-fighting brigades, fines for forest protection are mentioned, however, specified funds or fines relating to fires are not clearly established. The importance of **infrastructural** investments for forest protection against fires are a must, though specific numbers and goals are not set up. As a part of **firefighting preparedness**, the analyzed fire-specific law lists effective fire-extinguishment containing the importance of fire detection system, appropriate equipment, the built up of communication system and the systematic use of a National Forest Fire Database. The division of duties in case of fires are well-defined. **Protection plans** consists of clearly separated classification of forest areas in fire hazard classes, fire protection plans including all the necessary requirements, fireplace regulations and national/regional fire bans. Fire **monitoring** is mostly present through ground-based personal examination and use of historical data (in the National Forest Damage Inventory). Though, explicit detection types and methods are not described. Regarding **fuel treatment**, fire protection strips, breaks, fences and shrub zones are added as techniques to interrupt fire advancement. Grazing is forbidden in the forests. The use of **technical fires** (integrated fire management) is totally absent in the basic forest code, it appears only in the 4/2008 Decree on Protection of Forests against Fire Hazards. A wide

range of **awareness raising** methods appear in Hungary, including the accessibility of the National Forest Database, the Inventory of Forest Managers, educational opportunities (mostly in vocational schools), research projects and the availability to attend conferences, trainings regarding forest protection. Ministerial communication about the *Week of Forests* is also present. **Rehabilitation and restoration** management focuses practically on reforestation after fires and its funding.

1.3. Poland

The legislations in Poland present a clear established **institutional framework** for forestry and fire protection. The Forest Act establishes the State Forest Enterprise as the body responsible for forestry under the jurisdiction of the Ministry of Environmental Protection. Additionally, an autonomous section to specifically protect forest against fire hazard is stipulated in the Executive Order No. 11 of the Minister of Environment Protection, Natural Resources and Forestry. The Fire Protection Act establishes the Ministry of Interior as the main authority regulating Protection Units for firefighting. **Financial instruments** are embedded in the Polish Forest Act, establishing funding through State Budget for protection of the forest, which receives income from donations from the state budget, allowances, fines and sanctions. Measures related to **infrastructure** are included in the Regulation on Forest Fire Prevention, which implements the Forest Act. This regulation addresses the location of emergency roads for forests, their signalization, and bases with firefighting equipment. **Firefighting preparedness** measures are covered in the Fire Protection Act. The Act is applicable to the urban environment with some provisions on forests. It details the different fire protection units, their working procedures, tasks and duties and also regulates the special training that shall be provided to all members of the service and voluntary brigades. In regards to the **protection plan**, the Forest Act sets mandatory forest management plans which include a description and assessment of the state of the forest, objectives and tasks. Available camp areas and prohibitions against starting fires in the forest are also stated in the Act. Furthermore, the Regulation on Forest Fire Prevention provides a detailed classification methodology for the establishment of forest fire risk categories. The Fire Protection Act also designates **monitoring** measures for early detection in forests, including the development of a National Decision Support Information System with data gathering. The Regulation on Forest Fire Prevention also deals with additional measures related to patrol observation for early detection of fires in areas of high risk. **Awareness raising** activities, **fuel treatment** activities and the use of **technical fire** are not set in the analyzed legislation. The Forest Act establishes the responsibility of **restoration and rehabilitation** activities on the forest owner, who may obtain grants from the central budget allocated to cover the costs associated mainly with afforesting land.

1.4. Romania

Administrative levels of the Romanian forestry sector is clearly defined. As a part of **institutional framework**, task-sharing is present among the Ministries of Finance, of Interior and of Environment and Forests. National authority has been established, called *Regia Nationala a Padurilor Romsilva* (National Forest Administration Romsilva), in order to be able to meet the expectations of sustainable forest management (SFM). Forestry personnel and civil protection are of great importance of the system. In view of **financial instruments**, the basic forest code is rather stringent: sanctions and fines are well-described for forest crimes (e.g. lighting fires in for-

ests), and reducing the national forest area might be punished by imprisonment or fine. These fines could also serve as allocations for rehabilitation methods after fire. The evaluated legislation underpins that the attempt for committing crimes is also punishable; in addition to this, someone can be obliged to pay fines if fails to be involved in fire-fighting during forest fires. Further financial plans appear regarding fire prevention and firefighting. With regard to **infrastructure**, the legislations highlight that forestry roads and their construction is in line with best practices agreed by the central authority responsible for forestry. Forest roads cannot affect in any way water quality and the biosphere in the forests. The 307/2006 Law on Fire Safety defines the necessity of roads for firefighting, their maintenance and the stakeholders involved in creating them. In other aspects, such as the creation of fire stations, fire hydrants and water reservoirs, these laws are taciturn. **Firefighting preparedness** consists of the distribution of responsibilities in case of fires and the provision of firefighting equipment. The necessary items for this purpose are not listed. Additionally, Special Fire Safety Training for fire brigades are observed. In the mechanism of **Protection Plan** the laws consider Forest Management Plans which are mandatory for those managers/owners who own forest areas over 10 ha. Fire Protection Plans are also provided not only for forest areas, but also for built-up urban ones. Fire bans are present in the laws, while camp fire regulations are not detailed enough. The basic **monitoring** principles are available through these laws, such as its relevance, the communication methods (reporting obligations about a fire event), and the duties associated with its maintenance. Any other specified technique is not present to be able to analyze. General descriptions can be seen with regard to **fuel treatment**: fire protection strips, firebreaks and windbreaks are commonly used, grazing is prohibited is the forest areas. Information about **technical fire** is not available. A broad range of **awareness raising** possibilities can be found in the Romanian laws: the operation of the National Register of Forest Managers and Owners, the Inventory of National Forests (I.F.N.), the provision of scientific research opportunities that could be implemented in the practice, forestry awareness trainings in secondary schools (the Central Public Authority for Education use its curriculum to teach fundamental concepts about forests). A National Centre for Training in Forestry (*Centrul Naţional pentru Perfecţionare în Silvicultură*) exists to transfer acquired knowledge for the parties concerned. Similarly to Hungary, the *Week of Planting Trees* is organized every year between 15th March and 15th April. Great emphasis is put on media promotion. Finally, **rehabilitation and restoration** techniques contain reforestation as possible solution.

1.5. Serbia

The Forest Law of Serbia details the authorities constituting the **institutional framework** for forestry issues in the country, with the main body being the Ministry of Agriculture, Forestry and Water. The Fire Protection Act establishes the Ministry of Interior as the head of the Fire and Rescue Service. The Forest Law and the Fire Protection Act refer and complement each other. Additionally, both documents set the legislative framework for the Autonomous Provinces and their respective organs. The Forest Law establishes the **financial instruments** that serve as a basis for the Budget Fund of Forest from the budget of the Republic, compensations, fines, donations and other incomes. Construction and maintenance of technical **infrastructure** to combat forest fires, such as roads and water sources are explicitly stated in the Forest Law. **Firefighting preparedness** measures are covered in the Fire Protection Act, which details the organization of the fire departments, their rights, responsibilities and obligations. The Act also regulates special train-

ing, equipment and uniforms that shall be provided to all members of the service and voluntary brigades, as well as specific technical measures for firefighting and cooperation responsibility between units. The Act sets the rules for firefighting generally for urban areas and considers some provisions for forests. In regard to **protection plans**, the Forest Law establishes several types of mandatory management programs that set the rules for forestry protection. Among these, a specific plan of forest protection against fire is included. Available camp areas, prohibitions against starting fires in the forest and responsibilities during a fire event are also stated in the Law. Furthermore, the Fire Protection Act sets the classification of fire risk of the land. Forest **monitoring** activities and data gathering on forests are established in the Forest Law through the National Forest Information System. Moreover, forest owners are obliged to keep record of fire disasters occurred in forests. Silvicultural **fuel treatment** activities, such as fire breaks, fire lines and fire stripes to protect forest from fires are also regulated by the Forest Law. Pasturage is permitted in accordance with forest management plans. The use of **technical fire** is not reflected on the reviewed legislation. The Forest Law lists information dissemination activities to the general public. Further measures of **raising awareness** on forestry related issues are not considered. In terms of **rehabilitation and restoration** activities, this Law burdens forest owners with the responsibility of reforesting the land after the occurrence of a fire.

1.6. Slovakia

In terms of **institutional framework**, the Ministry of Agriculture and Rural Development of the Slovak Republic is the main body to cover forestry-related issues. A forestry agency was established by the Ministry on 1st of January 2006, called the National Forest Centre of Slovakia (NFC). In fire prevention, responsibilities are divided among the Ministry of Interior, the District Directorate of Fire and Rescue Service, the Slovak Hydrometeorological Institute and the fire brigades. The analyzed legislations consider the Ministry of Defence and the voluntary fire brigades to be relevant stakeholders, too. In connection with **financial instruments**, the amount of fines generally depends on the seriousness of the violation against forests. Exact fines (in euros) can be found in the law 314/2001 on Fire Protection. There are available funds for fire-fighting and fire alarm system. **Infrastructural** measures appear explicitly regarding the importance of road construction and the availability of water supplies in order to prevent forest fires. Forest managers/owners are required to maintain forest roads in a reasonable condition, and in case of emergency, they are obliged to ensure cleansed roads for rescue team. The duty of each municipality is to sustain free boarding areas and roads for firefighting. It is of crucial importance to maintain emergency exists and embarkation areas near forests. These solutions are perfectly complemented by the installations of places from where the possibility of reporting fires is assured. The types, numbers and storage of firefighting equipment are present in the laws. The evaluated legislation provides an insight into the **firefighting preparedness**: evacuation plans, the usage of water courses to extinguish fires, storage conditions of firefighting assets (e.g. fire extinguisher, emergency lightning, shovels, hoes, axes, rakes, pickaxes and pumpers, etc.) are manifested. Special training on fire prevention and the registry of the technical equipment also contribute to a better fire management. Apart from these, the Law 121/2001 on Fire Prevention contains a Fire Alarm Plan, a detailed list about the firefighting techniques – pipes, hydrants, extinguishers, ventilators, sprinklers, spray, foam, powder and aerosol – and additional opportunities of mobile communication. Regarding **protection plans**, appropriate camp fire areas and their regulations are installed,

forest management plans and fire safety plans (also in increased fire risk period) exist. National bans are either unknown for protecting forests. In the field of **monitoring**, abundant information can be found: surveillance of forest fires is put into effect through historical recordings, early fire warning system, aircraft and ground-based fire monitoring, fire and voice alarm. A State Fire Supervision Project deals with fire control and underlying causes of fires.

The **fuel treatment** category comprises fire breaks, closures and tracks, watercourses and the planting of fire resistant species. Grazing is forbidden in the forests. A great emphasis was put on the fire-resistance of buildings. **Technical fire** was not considered, however legislations mentioned the expression of integrated fire management (IFM). Forest Management Records, National Inventory and Forest Monitoring (NIFM), Registries of Forest Guards and Managers all contribute to the **awareness raising** of the public. Practical training in forestry (in vocational and high schools) is discussed, as well as education regarding fire prevention for all kinds of schools. Information about the conference, training and other opportunities are generally published on the website of the Ministry of Interior. **Restoration and rehabilitation** methods include Premature Restoration Plans and Early Recovery Plans after fire. Sustainable forest management (SFM) is mentioned.

1.7. Ukraine

The **Institutional framework** in the Ukraine clearly distinguishes the rights and duties of each governing body. Ukrainian forestry is under the authority of the Ministry of Agrarian Policy and Food of Ukraine. State Agency of Forest Resources of Ukraine (*State Forestry Agency*) is the central executive body whose implementing activity is coordinated by the Cabinet of Ministers of Ukraine through the Ministry. Forestry of the Autonomous Republic of Crimea, specialized service of Civil Protection, non-military rescue operations, local authorities are also considered in the evaluated laws. Administrative fees and compensations are described in the field of **financial instruments**, however, special fund allocations or fines related to fires are not highlighted. **Infrastructure** mechanism considers the importance of constructing roads to prevent harmful effects on forests – fire is not specified among these effects – and water supply. Relating to the area of **firefighting preparedness**, exact definitions are provided regarding fires, some of these are fire prevention, rescue operation and emergency response. Evacuation plans, special clothing of the fire-fighters and their basic equipment are present. Emphasis was put on training courses for fire-fighters and on victims involved in emergency operations who are entitled to receive free psychological assistance. Increased fire hazard periods are mentioned in the laws at the side of civil protection plans in the category of **Protection Plan**. The Forest Fire Protection Plan is highlighted. Regular **monitoring** of forests are conducted through the collection of data and ground-based analysis. Surveillance of forests with the help of helicopters and airplanes are also available. The way how the early and automated detection of emergency situations operate is not specified. **Fuel treatment** contains only the technique of firebreaks. In connection with **technical fire**, suppression fire is mentioned in the Code of Civil Protection of Ukraine 3435 of 2013. **Awareness raising** refers to the State Forest Inventory, the national programs and scientific research opportunities which results could be implemented in the forestry practice. Training on fire safety and the information/warning of civilians through media are underlined. At last, among **restoration and rehabilitation** activities reforestation is mentioned after forest fires.

2. The E.U. Policy Analysis

The European Union established a legal framework to protect EU forests from fires in the early nineties. In 1992 the EU regulation came into force for specific measures devoted to forest fire prevention. This instrument, valid until 2002, focused on monitoring fire activities and supported national restoration efforts. From 2002 to 2006, it was replaced by the 'Forest Focus', which also continued monitoring practices to protect forests against fires. As a reference, the Common Agricultural Policy (CAP), built on the regulation of 1992, consolidated the financing role of fire prevention in rural development. The European Agricultural Guidance and Guarantee Fund (EAGGF) also co-financed forest fire prevention activities and the restoration of forest areas.

The European Union has a number of **financial mechanisms** to be allocated to protect forests against fires. The EU Strategy on adaptation to climate change proposes a disbursement of 20% of the EU budget for climate change-related issues for the 2014-2020 period. This includes financial support for the LIFE Program, of which 75% of their approximate €3,500 million budget goes towards fire prevention activities as part of their environment sub-program. The EU Strategy also aids European Structural and Investment Funds. The latter includes the European Agricultural Fund for Regional Development (EAFRD), which replaces the CAP and has greatly benefited from the aforementioned: Its total budget amounts around €95 billion, with an estimated 30% going to the protection of the environment and climate change mitigation. This accounts for measures for prevention and restoration of damaged forest from fires. The Communication from the Commission to the European Parliament and The Council on Reinforcing the Union's Disaster Response Capacity was issued in 2008. This document promotes the mobilisation of financial support through the European Regional Development Fund (ERDF), and the EU Solidarity Fund (EUSF).

Besides of setting financial mechanisms, there are several propositions set by the EU Strategy in order tackle forest fires. Another component set by the EU Strategy on adaptations to climate change is the strengthening of **infrastructure** to cope with extreme events and other climate impacts. Subsequently, the EAFRD provides financial support for the construction of protective infrastructure against fires.

The EU Communication on reinforcing the Union's Disaster Response Capacity also encompasses **firefighting preparedness** measures. The Communication proposes the creation of a Disaster Response Training Network to further enhance both the preparedness of civil protection services and the capacity of firefighting teams. This policy also foresees the possible financing of EU-level equipment to complement national resources, including fire-fighting aircraft.

Additionally, **protection plans** and actions are addressed in several EU policies. The EAFRD regulation establishes that Member States must undertake preventive actions as part of a forest protection plan with special focus in areas classified of medium or high fire risk. Furthermore, the EU Communication on reinforcing the Union's Disaster Response Capacity establishes mandatory reporting on forest management, afforestation, deforestation and reforestation for Member States. The EU Land Use, Land Use Change and Forestry (LULUCF) decision, the EU Climate Change Strategy and the EU Forest Strategy further discuss the importance of protective actions against fire.

The EU has listed **monitoring** among the priorities to detect potential hazards in forestry. Since its inception in 1998, the EFFIS platform provides assessment of situations pre and post

fires and supports fire prevention through risk mapping. The Commission Communication on reinforcing the Union's Disaster Response Capacity stresses the importance of EFFIS in the monitoring and early detection of fires, and proposes further investment in projects on information and communication technologies to improve early warning and response systems. As one of its focal objectives, the Forest Strategy also emphasizes the increase of knowledge and the amelioration of forest information systems, including current EFFIS improvements. The LIFE program and EAFRD regulations also consider financial support for these activities.

In regard to **fuel treatment** for fire prevention, the EAFRD provides financial aid to silviculture and the use of grazing animals on a local scale. Embedded in this category, the regulation funds the installation of firebreaks and maintenance costs. In accordance with the LULUCF decision on preventing pollution caused by forest fires, these measures must also be included in reports of emission removals pledged by the Member States.

The EU Climate Change Strategy remarks the importance of **raising awareness** through capacity building, stakeholder involvement and information and communication dissemination. One of the flagships of the LIFE Program is the financing of these activities addressed to protect forest. The EAFRD also offers financial support for rural communities regarding environmental awareness activities.

Within the framework of European legislation, **technical fires** are not included due to their controversial nature. However, technical fires have been examined in depth by the European Forest Institute, proving that their practice is successful for the contention and prevention of forest fires.

The EAFRD also provides financial support in terms of **restoration and rehabilitation** measures. The Commission Communication on reinforcing the Union's Disaster Response Capacity further proposes support from the EU Solidarity Fund for the recovery from disastrous fires.

Finally, given that national **institutional framework** measures are not applicable at the EU level, all policies analyzed aim to reinforce the international cooperation between Member States, in order to provide a common action plan ensuring an integrated EU approach to disaster prevention and mitigation.

3. The U.S. Policy Analysis

In connection with the U.S. **institutional framework**, the Forest Reserve Act of 1891 (known as "*Creative Act*" or "*General Land Revision Act*") gave the President authority to establish forest reserves from public domain lands. The forest reserves formed the foundation of the National Forest System. Forestry and Fire Management sectors are now under the authority of the U.S. Department of Agriculture. The Transfer Act of 1905 assigns the management of "*forest reserves*" – now known as national forests - from the General Land Office (within the Department of Interior) to the Bureau of Forestry (within the Department of Agriculture). The Bureau of Forestry was renamed Forest Service and now it is operating as the unavoidable agency of the USDA.

The Federal Land Assistance, Management and Enhancement Act of 2009 ("*FLAME Act*") shows the **financial** ability of the country. This act creates the Wildfire Suppression Reserve Fund

for catastrophic emergency fire suppression activities. The Appropriations Act for Fiscal Year 2010 (PL 111-88) appropriated approximately $2.1 billion to the USDA Forest Service and $795 million to the Department of Interior (DOI) for fire management.[32] Moreover, the FLAME Fund provided an additional $413 million to the USFS and $61 million to DOI in order to cover costs related to fire suppression.[33]

The U.S. **infrastructural** strength is reflected through the Secure Rural Schools and Community Self-Determination Act of 2000. The act provides financial assistance to rural counties (which are parts of the National Forest System) in the interest of creating forest-related schools, programs and roads, and maintaining current infrastructure. Among other purposes, these are all contribute to the reduction of the threat posed by fires. In the fiscal year 2015, approximately $252 million were spent on these measures.[34]

Regarding **firefighting preparedness**, the Federal Fire Prevention and Control Act of 1974 takes into account the American scope immediately at the beginning of the given legislation (Sec. 2. (3)): "*Fire kills 12.000 and scars and injuries 300.000 Americans each year, including 50.000 individuals who require extended hospitalization. Almost $3 billion worth of property is destroyed annually by fire, and the total economic cost of destructive fire in the United States is estimated conservatively to be $11.000.000.000 per year.*" The cited act describes the training of firefighters, the appropriate clothing, the firefighting equipment and the fire monitoring system. The Fire and Aviation Management Program is an integral part of the U.S. Forest Service that leads cutting-edge computer-simulated fire management, aviation technology, rescue operations and fire research.[35]

Protection plans include Environmental Assessments (EAs) and Environmental Impact Statements (EISs) required by all federal agencies and defined clearly in the National Environmental Policy Act of 1969 (known as "*NEPA*"). More fire-specific plans include the National Fire Plan, which basic premises focus on investing now in an optional firefighting force, reducing hazardous fuels, and protecting the overall community. In this way, these provide for immediate protection and future cost savings. The plan is described in the Federal Wildland Fire Management Policy of 1995, 2001 and 2009. The federal agencies emphasize the implementation of the written ideas into practice.[36]

Monitoring techniques are best tracked in the aforementioned Federal Fire Prevention and Control Act of 1974. These techniques have already been implemented in practice: besides the ground-based inspection, the usage of common helicopters and airplanes, the National Aviation Safety Management System was created to better cope with fires,[37] and the Unmanned Aircraft

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[32] U.S. Department of Agriculture, 'Secretary of Agriculture and Interior Praise Creation of "FLAME" Wildfire Suppression Reserve Fund' <http://www.usda.gov/wps/portal/usda/usdahome?contentid=2009/11/0555.xml> accessed 26th October 2016.
[33] ibid.
[34] U.S. Forest Service, 'All Service Receipt. Final Payment Summary Report' (Report 2016) 1-2.
[35] U.S. Forest Service– Fire & Aviation Management, 'Managing Wildland Fires' <http://www.fs.fed.us/fire/management/index.html> accessed 10th December 2016.
[36] National Interagency Fire Centre, 'Guidance for Implementation of Federal Wildland Fire Management Policy' (Guidance 2009) 7-8
[37] U.S. Forest Service, 'National Aviation Safety Management System Guide' (Guidance 2016) 1-3

Systems (UAS) is currently under testing.[38] The Modular Airborne Fire Fighting Systems (MAFFS) can provide immediate assistance during severe wildfires: these military C-130 aircrafts are able to discharge their entire load of up to 3.000 gallons of retardant in less than 5 seconds, covering an area ¼ of a mile long by 100 feet wide. Once the load is discharged, it can be refilled in less than 12 minutes.[39] Additionally, the Active Fire Mapping Program operates with the help of MODIS and VIIRS Satellite Imaginaries.[40]

Fuel treatment is available in the Healthy Forests Restoration Act of 2003 (known as "*HFRA*"). Hazardous fuel reduction and forest restoration projects operate in line with the National Fire Plan and the Healthy Forests Initiative. It is also notable the possibility of pastoralism in the States of Oregon and Washington where the vegetation can be renewed by the usual and abundant rainfall. This exception is provided in the Forest Service Organic Administration Act of 1897 (known better as "*Organic Act*").

In the recent decades special emphasis has been put on the use of **technical fires** highlighting the positive effects of fires. The mentioned "*HFRA*" Act underpins the strategic use of prescribed and suppression fires to further modify fire behavior. A case study shows the implementation of the technique: the *Carpenter 1 Fire* started by lightning in 2013 and was suppressed by technical fire.[41] Lightning-ignited fires are another threat to consider from the viewpoint of suppression fires when detection and response times could significantly vary. Besides climatic effects, factors including vegetation characteristics and fire management policies could also influence the fire regime.[42] There is a need of a fine balancing act to protect values from fires, which could be fulfilled in the Emergency Wildland Fire Response Act of 2008.

Awareness raising mechanism includes a wide range of activities: the establishment of state forestry agencies to broaden the cooperative efforts (*Clarke - McNary Act of 1924*), the forestry research program for colleges and universities (*McIntyre-Stennis Act of 1962*). Nowadays, agricultural subsidies (*Farm Bill of 2002*) are more common, however, groups who plant trees, and provide conservation education is also possible to join.[43]

Finally, **rehabilitation** methods have to be elaborated in accordance with the Endangered Species Act of 1973. Financial and technical assistance are given to reforestation solutions, as well as involvement of other agencies and organizations are required. In the fiscal year 2004, $25.000.000 is distributed for such scope, defined in the "*HFRA*" Act of 2003. Practical applications of the

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[38] U.S. Forest Service– Fire & Aviation Management, 'Unmanned Aircraft Systems' <http://www.fs.fed.us/fire/aviation/uas.html> accessed 10th December 2016.

[39] U.S. Forest Service – Fire & Aviation Management, 'MAFFS' <http://www.fs.fed.us/fire/aviation/airplanes/maffs.HTML> accessed 10th December 2016.

[40] Remote Sensing Application Centre, 'Active Fire Mapping Program' <https://fsapps.nwcg.gov/afm/index.php> accessed 10th December 2016.

[41] U.S. Forest Service - Fire & Aviation Management, 'Through Effective Response' <http://www.fs.fed.us/fire/management/response.html> accessed 10th December 2016.
U.S. Forest Service - Carpenter 1 Fire Programmatic/Cost Fire Review Humboldt-Toiyabe National Forest, 'National Oversight Review'
<http://www.fs.fed.us/fire/publications/fire_review_reports/2013/carpenter_1_fire.docx> accessed 10th December 2016.

[42] ibid.

[43] U.S. Forest Service, 'Partnerships' <http://www.fs.fed.us/working-with-us/partnerships> accessed 10th December 2016.

legislation include the improvements of habitat, the hazardous fuel reduction near communities, the achievement of fire-resilient communities, the rehabilitation of roads and fire lines, the survey and treatment of non-native and invasive species, and the enhancement of wildlife habitat.[44]

4. Climate Change Specific Strategies

Climate change effects on the increase of forest fires are seldom addressed in the main Carpathian National Forestry or Fire Legislation. In the Czech Republic the reviewed Acts take into consideration that greenhouse gas emissions are damaging to the forest and that measures of restoration are needed. In the Hungarian legislation appears merely the desire for decreasing the negative effects of climate change, any connection between climate change and forest fires is not revealed. The Polish Regulation on Protection of Forest from Fires estimates the risk of forest fires through the monitoring of climatic parameter. However, adaptation strategies to control fires and increase the resilience of forests are not embedded in the respective Acts. In the Romanian national forest code, the mitigation of the impact of climate change on forests is explicitly mentioned, the adaptation of forests to climate change is detected.

In Serbia, the Forest Law and related amendments concern the effects of climate change in the increased frequency of forest fires. In 2012, Serbian forests experienced severe droughts, which resulted in the drying of many species and the ignition of over 3000 ha of forest. The current legislation aims to improve adaptation mechanisms in order to mitigate the adverse consequences of climate change and the rehabilitation of affected areas. In the Slovakian forest code, parameters relating to climate change were not discovered. Though, the 121/2001 Fire Prevention Law contains information about emergency fire events, when meteorological conditions are monitored in the interest of giving immediate response to fires. Slovak Hydrometeorological Institute could provide further support for doing so. In the analysed Ukrainian laws, palpable information about climate change was not available.

European Union legislation recognizes the increased fire risk due to climate change. Besides acknowledging the importance of forests due to their CO_2 removal capacity, the EU addresses the risk that emissions from forest fires further contribute to climate change. Additionally, the increased occurrence of disastrous forest fires in the Southern regions of Europe has stressed the need for stronger adaptation strategies that tackle this issue. The EU efforts to address climate change and their adaption measures for forest fire prevention are significant. In this regard, their support on scientific activities to increase knowledge on climate change effects on forest fires is pivotal. This is a recurrent subject in the whole analysed EU legislation, focusing on monitoring, research and raising awareness actions. This aims to develop adaptation practices to increase forest resilience to extreme climate events.

In recent years, the climate change policy of the United States is strongly divided due to conflicting economic and environmental interests, with the country signing the Kyoto Protocol and not ratifying it or withdrawing from it. In spite of this, there has been many initiatives for accepting an Act related to climate change e.g. the Global Warming Pollution Reduction Act of 2007, a bill designed to amend the Clean Air Act, but remained introduced in Senate. The Climate Protec-

[44] USDA-FS, 'People Restoring America's Forests: A Report on the Collaborative Forest Landscape Restoration Program' (Report 2011) 1-5

tion Act and the Sustainable Energy Act both proposed in 2013 also failed. These were experiments for funding R&D on geologic sequestration of CO_2, setting new emission standards for vehicles, and replacing coal-based power generation. The evaluated U.S. legislations monitor climate change by gathering information on the emissions of greenhouse gases. The impact of climate change on the increase of fire frequency is usually suggested by research in global climatic warming.[45]

Scientific research related to the Federal Wildland Fire Management Policy[46] highlighted that CO_2 released from prescribed fires is progressively removed by the subsequent regrowth of vegetation. Lower intensity prescribed fires – which are needed in the ecosystem - emit far less CO_2 than high-intensity fires. Therefore, there is an intention to increase prescribed fires to reduce high-intensity. The use of fire for ecosystem management and fuel reduction is perceived through consistent policies, such as the Healthy Forests Restoration Act of 2003 or the Federal Wildland Fire Management Policy of 2009.

VII. Conclusions and Recommendations

The overall national legislation of the Carpathian countries sets in a detailed manner the institutional framework and responsible authorities for forestry issues and fire protection. Similarly, financial instruments of funding for forest protection, including fines and other sources, are clearly established for most of the countries in the region, apart from the Ukraine.

In connection with infrastructure, national decision-makers have recognized and emphasized the relevance of forest roads and other structural improvements. Firefighting preparedness in terms of brigades, equipment and training is well established in the general Fire Acts of all Carpathian countries. Protection measures established in the forest management plan include fire protection strategies. These plans contain all the necessary measures to perform before, during and after disastrous events.

Information Systems for monitoring to cope with fires are compulsory in Poland and Serbia. Ground-based detection and the collection of data on forest fires are common monitoring methods for all Carpathian countries.

The implementation of fuel treatment measures is mostly based on cost-efficient solutions. The use of technical fires is not included in any national Forest Code. However, some provisions for controlled and suppressive fires activities are set in Hungarian and Ukrainian fire-specific laws.

Most of the Carpathian countries make use of awareness raising activities – they operate several databases, newspapers and websites – to disseminate forest protection solutions and a sustainable use of forest reserves. However, these opportunities - being a noteworthy contribution to a better handling of forest fires - mostly remain out of public purview. According to the authors, this category would be further fostered by the national forest programs, forestry strategies and afforestation programs already running in various countries with the support of the European Union. Rehabilitation and restoration methods contain the concept of reforestation plans and their

[45] Johnathan T Overpeck and others 'Climate-induced changes in forest disturbance and vegetation' [1990] Nature 343, 51-53.

[46] U.S. Department Of Interior 'Federal Wildland Fire Management Program & Policy Review' (Report 1995) 7-9

financing, but further elaboration appears to be needed. For instance, main aspects are delineated, but consistent strategies to further prolong the existence of forests remain scarce.

To conclude the conducted analysis, the authors have encountered more preventive than corrective measures in regards to forest fires in the Carpathian countries' legislation. In relation to categories 1 to 5, the Acts of the countries have received higher qualifications due to the traditional nature of the measures. On the contrary, categories from 6 to 10 that require more technical and up-to-date knowledge have received a lower qualification. This might be caused by a delayed translation of scientific knowledge into the legislative process. At the same time, while the impact of climate change on the frequency of forest fires is acknowledged, the Carpathian National Laws are yet to integrate adaptation strategies to control fires and mitigate their consequences.

The European Union legislation establishes the allocation of financial resources for the protection of forests. Adaptation strategies to increase forest resilience to fire are strongly supported, as the EU has long been committed to international efforts to tackle climate change. Prevention mechanisms are also emphasized over correction mechanisms. In this regard, most of the categories except for technical fires are enforced in the existing regulatory framework of the EU. It is noteworthy that the monitoring and awareness raising mechanisms are repeatedly highlighted as pivotal to meet the regulatory objectives in developing climate change adaptation practices.

These results indicate that even though most of the countries comply with the EU legislation and benefit from its programs, there is room for improvement in the vertical integration from the EU policy framework to national and local administrations. Furthermore, the existing links between civil protection and environmental policies should be reinforced based on a more cohesive institutional coordination to expand the outreach of preventive measures. Finally, as U.S. policies provided an in-depth insight into the practical realisation of novel fire technologies in legislative decisions, it would be advantageous to get possession of concepts about integrated fire management, fire-resilient communities and monitoring strategies also in the Carpathian national legislations.

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EU Legislation				
1. Institutional Framework	*2. Financial Instruments*	*3. Infrastructure*	*4. Firefighting Preparedness*	*5. Protection Plan*
	. LIFE 2014-2020. Programme for the environment and climate action (Regulation (EC) No 1293/2013) *. European Agricultural Fund for Regional Development (EAFRD) (Regulation (EU) No 1305/2013)* *. Reinforcing the Union's Disaster Response Capacity (COM(2008) 130)* *. EU Strategy on adaptation to climate change (COM/2013/216)*	*. European Agricultural Fund for Regional Development (EAFRD) (Regulation (EU) No 1305/2013)* *. EU Strategy on adaptation to climate change (COM/2013/216)*	*. Reinforcing the Union's Disaster Response Capacity (COM(2008) 130)*	*. European Agricultural Fund for Regional Development (EAFRD) (Regulation (EU) No 1305/2013)* *. EU Land Use, Land Use Change and Forestry (LULUCF) accounting rules (Decision No 529/2013/EU)* *. Reinforcing the Union's Disaster Response Capacity (COM(2008) 130)* *. EU Strategy on adaptation to climate change (COM/2013/216)* *. EU Forest Strategy (COM/2013/659)*
6. Monitoring	*7. Fuel Treatment*	*8. Technical Fire*	*9. Awareness Raising*	*10. Rehabilitation and Restoration*
. LIFE 2014-2020. Programme for the environment and climate action (Regulation (EC) No 1293/2013) *. European Agricultural Fund for Regional Development (EAFRD) (Regulation (EU) No 1305/2013)* *. Reinforcing the Union's Disaster Response Capacity (COM(2008) 130)* *. EU Forest Strategy (COM/2013/659)*	*. European Agricultural Fund for Regional Development (EAFRD) (Regulation (EU) No 1305/2013)* *. EU Land Use, Land Use Change and Forestry (LULUCF) accounting rules (Decision No 529/2013/EU)*		*. LIFE 2014-2020. Programme for the environment and climate action (Regulation (EC) No 1293/2013)* *. European Agricultural Fund for Regional Development (EAFRD) (Regulation (EU) No 1305/2013)* *. EU Strategy on adaptation to climate change (COM/2013/216)*	*. European Agricultural Fund for Regional Development (EAFRD) (Regulation (EU) No 1305/2013)* *. Reinforcing the Union's Disaster Response Capacity (COM(2008) 130)*

Annex 1. Matrix Analysis of the EU Legislation

USA Legislation				
1. Institutional Framework	***2. Financial Instruments***	***3. Infrastructure***	***4. Firefighting Preparedness***	***5. Protection Plan***
. Transfer Act of 1905 *. National Forest Management Act of 1976, Referred as "NFMA"* *. Forest Service Organic Administration Act of 1897, Referred as "Organic Act"* *. Foreign Operation Appropriations Act of 1978* *. Clarke - McNary Act of 1924* *. Weeks Act of 1911* *. Forest Reserve Act of 1891 Referred as "Creative Act" or "General Land Revision Act" or "FRA"* *. Federal Land Policy and Management Act of 1976* *. Federal Advisory Committee Act of 1972 Referred as "FACA"* *. Cooperative Forestry Assistance Act of 1978*	*. Forest Service Organic Administration Act of 1897, Referred as "Organic Act"* *. Emergency Wildland Fire Response Act of 2008* *. Federal Land Assistance, Management and Enhancement Act of 2009 Referred as "FLAME Act"*	*. Forest Service Organic Administration Act of 1897, Referred as "Organic Act"* *. Federal Water Pollution Control Act Amendments of 1972, Referred as "Clean Water Act" or "CWA"* *. Secure Rural Schools and Community Self-Determination Act of 2000* *. Twenty-five Percent Fund Act of 1908*	*. Federal Water Pollution Control Act Amendments of 1972, Referred as "Clean Water Act" or "CWA"* *. Fire Administration Reauthorization Act of 2008* *. Food, Conservation, and Energy Act of 2008, Referred as "Farm Bill" or "2008 U.S. Farm Bill" or "Agricultural Security Improvement Act of 2008"* *. Federal Fire Prevention and Control Act of 1974*	*. Forest and Rangeland Renewable Resources Planning Act of 1974, Referred as "RPA"* *. Land and Water Conservation Fund Act of 1965* *. Clarke - McNary Act of 1924* *. Weeks Act of 1911* *. Federal Wildland Fire Management Policy (2009, 2001, 1995)* *. Federal Land Assistance, Management and Enhancement Act of 2009 Referred as "FLAME Act"* *. National Environmental Policy Act of 1969, Referred as "NEPA"*
6. Monitoring	***7. Fuel Treatment***	***8. Technical Fire***	***9. Awareness Raising***	***10. Rehabilitation and Restoration***
. Federal Fire Prevention and Control Act of 1974	*. The Healthy Forests Restoration Act of 2003 Referred as "HFRA"*	*. Clean Air Act of 1963, Referred as "CAA"* *. The Healthy Forests Restoration Act of 2003 Referred as "HFRA"*	*. Multiple-Use Sustained Yield Act of 1960 Referred as "MUSYA"* *. Forest and Rangeland Renewable Resources Research Act of 1978* *. Forest Ecosystems and Atmospheric Pollution Research Act of 1988* *. Renewable Resources Extension Act of 1978* *. McIntyre-Stennis Act of 1962* *. Bankhead–Jones Farm Tenant Act of 1937 Referred as "BJFTA"* *. McSweeney-McNary Act of 1928* *. Smith-Lever Act of 1914 Referred as "Agriculture Extension Act"* *. Farm Security and Rural Investment Act of 2002 Referred as "2002 Farm Bill"* *. Federal Advisory Committee Act of 1972 Referred as "FACA"*	*. Federal Wildland Fire Management Policy (2009, 2001, 1995)* *. The Healthy Forests Restoration Act of 2003, Referred as "HFRA"* *. Comprehensive Environmental Response Compensation and Liability Act of 1980 Referred as "SuperFund" or "CERCLA"* *. Emergency Wildland Fire Response Act of 2008* *. Food, Conservation, and Energy Act of 2008, Referred as "Farm Bill" or "2008 U.S. Farm Bill" or "Agricultural Security Improvement Act of 2008"*

Annex 2. Matrix Analysis of the USA Legislation