driver+

Driving Innovation in Crisis Management for European Resilience

WILDFIRE MANAGEMENT IN EUROPE

FINAL REPORT AND RECOMMENDATION PAPER CMINE TASK GROUP WILDFIRE

The final output of the one-year mandate of the CMINE Wildfire Task Group work is a recommendation to align EU legislation and national, regional and local levels of governance regarding land management to facilitate the mitigation of the risks of wildfires.

Nina Dobrinkova, Bulgarian Academy of Sciences (IICT-BAS)

February 2020

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Crisis Management Innovation Network Europe1 (CMINE), one of the outputs of Driving Innovation in Crisis Management for European Resilience2 (DRIVER+), is a Community of Practice that fosters innovation and enhances a shared understanding in the fields of Crisis Management and Disaster Risk Reduction in Europe. CMINE is creating an umbrella network of stakeholders active in Crisis Management by linking existing projects, networks and initiatives. Different task groups have been set up to develop approaches aimed at resolving current issues in different Crisis Management domains.

Wildfires occur traditionally in countries situated in the southern parts of Europe. However, in the last few years, northern countries are experiencing wildland fires (e.g. vegetation fires). The reasons for this new situation have been discussed during a series of CMINE Wildfire Task Group meetings in 2019.

In this final report, we summarise our main findings, which refer to two substantial topics: landscape management and climate change. There are more and more parcels of land which have become abandoned, and regardless of the many reasons for its occurrence, the outcome is always the same. Vegetation is not managed due to an absence of people and no animals are in place to graze on the grass and shrubs. This vegetation grows every spring and every autumn provides potential fire propagation fuel waiting to be ignited.

Climate change is another global issue which is creating dangerous weather conditions with extremely high temperatures during the summer season and mild winters, which is leading to wildfire occurrences in some parts of Europe all year round. In our report, we will describe three case studies from Portugal, Greece and South Wales, all reaching the same conclusions: the absence of a land management strategy and extreme weather are the best conditions for life-threatening wildfires.

The only way of dealing with this evolving problem is the adoption of common legislation applicable to the EU Member States and its associated countries with implementation on all levels: national, regional and local. Neighbouring countries have to be included in the initiative in one way or another for larger territory to be protected. The population must be proactive and do its best to maintain the land within their neighbours. State reactions in most cases of rapid wildfire spread demonstrate that coordination between all first responders in the field is lacking. Therefore, working together must cover national and all other levels up to the community representatives' special regulations. Coordination and cooperation initiatives, which in cases of major disasters will be helpful, should also be in place.

The scientific community can also help implementing new ICT and satellite tools for simulations that calculate potential scenarios for wildfire spread. This can support the civil protection decision-making process. The gaps between the research community and operational response can be overcome only if all stakeholders learn to work together and the responsibilities are clear.

[1] https://www.cmine.eu/.

[2] Launched in May 2014, DRIVER+ is a project funded under the 7th Framework Programme of the European Commission, whose main aim is to cope with current and future challenges due to increasingly severe consequences of natural disasters and terrorist threats, by the development and uptake of innovative solutions that are addressing the operational needs of practitioners dealing with Crisis Management.

ACKNOWLEDGEMENTS

The Final Report builds on the insights, experience and expertise of a large group of experts.

Editors-in-chief

- **Nina Dobrinkova** (Bulgaria): CMINE Theme Chair Wildfire, Associated Professor at the Institute of Information and Communication Technologies – Bulgarian Academy of Sciences (IICT-BAS)
- **Chuck Bushey** (United States): CMINE Vice Theme Chair Wildfires (International Association of Wildland Fire, National Wildland Fire Management Cohesive Strategy, Fire Ecologist and Fire Behaviour Analyst with Montana Prescribed Fire Services, Inc.)

Key authors

- **Alexander Held** (Germany): Vice Theme Chair Wildfires Senior Expert (Forest Fire and Silviculture), European Forest Risk Facility (@ EFI)
- **Marc Castellnou** (Spain): Pau Costa Foundation, Strategic fire analyst with the Regional Fire Services, Catalonia, Spain and the head of the GRAF units
- **Cathelijne Stoof** (The Netherlands): Wageningen University, Tenured Assistant Professor (Soil, Water, Landscapes, Fires)
- **George Boustras** (Cyprus): Director, Centre for Risk and Decision Science (CERIDES) and Dean, Ioannis Gregoriou School of Business Administration
- **Georgios Eftychidis** (Greece): R&D Manager, Center for Security Studies-KEMEA (Environmental Planning, Forester, Policy Maker, Disaster Management)
- **Ciaran Nugent** (Ireland): Forest Engineer, Irish Forest Service
- **Craig Hope** (United Kingdom): Lead Wildfire Officer, South Wales Fire and Rescue Service
- **Carlos Trindade** (Portugal): Forest Engineer, Wildfire Management, Civil Protection Officer
- **Adrián Cardil Forradellas** (Spain): Forest Engineer, Private Company for forest fires modelling solutions representative

Reviewers

Peter Moore (Italy): Forest Officer in Forest Fire Management & Disaster Risk Reduction
Rob Testelmans (Belgium): Policy, Safety and Security Advisor in the municipality of Geel
Dejan Radović (Serbia): Research Associate in University of Belgrade

Graphic design and production
ARTTIC, DRIVER+ project

Suggested citation
CMINE Task Group Wildfire Management Final Report. The DRIVER+ project and CMINE, 2020.

Contact point and further use
Please contact Nina Dobrinkova, ninabox2002@gmail.com, Bulgarian Academy of Sciences (IICT-BAS) if you wish to distribute, translate or edit this material. We encourage and support full, open and free use of this working paper and kindly request that our work is referenced using the suggested citation.

Institute of ICT, Bulgarian Academy of Sciences
"Acad. G. Bontchev" Str., Bl. 2
Sofia 1113, Bulgaria
http://iict.bas.bg/

Task Group Composition and Rationale

The CMINE Wildfire Task Group call for members had been planned to be open to EU Member States, but also to non-EU ones. The final composition of ten countries was intentional so as to cover not only southern European countries but also northern ones. The reviewers were selected from non-represented countries in the main task group. In a predominantly male-dominated field, our group included two female representatives from Bulgaria and Netherlands. The ten members of the task group represent specialists from academia, policy makes, practitioners, first responders and private companies. The knowledge in the group varies from field expertise to operational response and scientific theoretical background. The composition of the reviewer's panel also included people with different knowledge and backgrounds, with the idea to have a balanced review in our group discussions covering all major knowledge that the group members have.

The Wildfire Task Group structure consisted of a Task Group Chair, two Vice Task Group Chairs, Task Group members and Task Group Reviewers. The Task Group Chair was the person who communicated with all Task Group Members and Reviewers. Two Vice Task Group Chairs have been selected from the Task Group in order to easily facilitate the Task Group management. The official communication and official documents, which the group members and reviewers have discussed and produced, have been reviewed by the Task Group Chair and the Vice Chairs.

The face to face meetings were organised predominantly by the Task Group Chair, with the help and support of the Vice Chairs and the local hosts. Any organisational matters for the task group members, which needed additional attention, were dealt by the Task Group Chair. During its one year mandate, the task group members, comprised of ten people with different backgrounds covering the expertise of policy makers, practitioners, and private companies from forest fire propagation services, forest engineers, firefighters to academia. The CMINE Wildfire Task Group Members were representatives from the states of Spain, Greece, Cyprus, Ireland, Germany, UK, Portugal, US, and the Netherlands. The CMINE Wildfire Task Group Reviewers acted as advisors during task group discussions via emails or WhatsApp. An opinion outside the main group with corrective functions was deemed necessary. However, one of the reviewers came to the second face-to-face meeting of the task group.

There have been two groups performing the general organisation duties of the CMINE Wildfire Task Group. The first one was the management group which included the Task Group Chair and the vice chairs. The second one was the general group members. Because of the field work and heavy schedules, both groups created a WhatsApp CMINE Wildfire Group, where all required tasks and activities were centralised and discussed in real time. Online tools like skype and Zoom have been used for bilateral communication or smaller group discussions.

Disclaimer

The opinion stated in this report reflects the opinion of the authors and not the opinion of the European Commission. All authors are committed to publish accurate and up to date information and take the greatest care to do so. However, the authors, their organisations and DRIVER+ consortium members cannot accept liability for any inaccuracies or omissions, nor do they accept liability for any direct, indirect, special, consequential or other losses or damages of any kind arising out of the use of this information.

INTRODUCTION

CONTEXT OF THE TASK GROUP

The occurrence of wildfires has become a common sight in the Mediterranean region. These new fire outbreaks have led not only to the loss of millions of hectares of forests and billions of euros but also to the tragic loss of hundreds of human lives. Furthermore, the intensity and number of fires in the "traditional" fire countries have continued to increase. A new development is the occurrence of wildfires in states that were up to now only exposed to such events to a minor extent. Examples include Sweden, Ireland and Germany, for whom wildfires are not a common natural hazard on their territories. Fire is frequently a part of a natural cycle within the forests, but the fires we have seen in recent years are no longer natural as human activities influence them. Additionally, restoration of productive, bio-diverse and resilient forests is becoming more and more difficult.

However, the focus in addressing wildfires is mainly on fire suppression and that will not be enough to safeguard our forest ecosystems and societies. We need to move towards more integrated fire management approaches at a European level. Many experts agree on that and promote a more pro-active fire management, where fuel loads are actively managed and fire strategies planned across landscapes. The benefits of such pro-active wildfire management are numerous: more controlled fires, improved human health and decrease of economic losses.

A variety of solutions have also been proposed and proved useful in wildfire management, e.g. prescribed burning or well-timed forest management. Practical implementation of these approaches is, however, facing hardships. The reason in most cases is limited funds and lack of common understanding on the land management. Under such conditions, some very challenging improvements are still on hold instead to be done.

In the CMINE Wildfire Task Group, we believe in working together with practitioners, scientists, local authorities and policy makers to identify barriers and gaps in the implementation of a more pro-active wildfire management. Lighting up a spark between all three groups for a discussion was our goal during our one-year mandate. The promotion of working together was necessary to enable a constructive dialogue and understanding on how to move towards a more pro-active fire management. This was the main scope of the CMINE Wildfire Task Group activities during 2019.

GOAL OF THE TASK GROUP

The Crisis Management Innovation Network Europe (CMINE), which is one of the outputs of DRIVER+, is a Community of Practice that fosters innovation and enhances a shared understanding in the fields of Crisis Management and Disaster Risk Reduction in Europe. CMINE is creating an umbrella network of stakeholders active in Crisis Management by linking existing projects, networks and initiatives.

CMINE comprises of an online community platform, face-to-face meetings and workshops, all of which aims to tackle current and future challenges and facilitate the uptake of research and innovation by practitioner organisations. Different task groups have been set up to develop approaches aimed at resolving current issues in different Crisis Management domains, such as the Task Group Floods, Task Group Wildfires and Task Group Volunteer Management. CMINE is designed to evolve continuously through collaboration, to

become a pan-European platform, which is centred on exchanges between various Crisis Management professionals.

The main goal of the CMINE Wildfire Task Group was the creation of a common expert view for policy, science and practice, based on expert opinion and expertise. Suggestions for simple actions which can give significant impact in fire-prone areas have been listed in the conclusion part of the report. The group tried to organise all expert knowledge available among its members in a structured easy to understand report for non- "fire" people. Background information on the Task Group members and SWOT of the Task Group are in Annex 1 and 2, respectively.

Further, this task group's primary aim was to be a catalyst for change in the fire management paradigm, shifting the focus more on prevention than on mitigation of the unwanted effects of fires. The group was promoting the SENDAI Framework recommendations as well as the recommendations of the EU Commission report, "Forest Fires, Sparking fire smart policies in EU"[3]. The new focus on prevention and land management as main tools to combat mega-fires was in the centre of the group discussions, suggestions and final outcomes.

EUROPEAN FIRES 'STATE OF THE ART'

Wildfires have been a critical topic in Europe during the past decades and especially in recent years. Not only due to their increased occurrence across the continent but also due to their high magnitude. Large, uncontrollable fires are becoming the norm; from Portugal in 2017 to Sweden and Greece in 2018, many countries such as these suffer yearly from wildfire events that cost millions of euros in natural, social and infrastructural damages.

Between 2000 and 2017, the impact of forest fires in the European Union has been assessed in terms of environmental, human and economic losses. According to the European Forest Fire Information System (EFFIS), approximately 480 000 ha have burned per year, accounting to a total of 8.5 million ha of forest land. 611 firefighters and civilians have tragically lost their lives over these 17 years, while the economic impact amounted to more than EUR 54 billion or an estimated EUR 3 billion per year. Following the current pace of economic growth and environmental degradation, the European Commission PESETA II project[4] indicated that the economic impact of forest fires for Greece, Spain, France, Italy and Portugal might increase to over EUR 5 billion per year by 2070-2100.

In fact, by April 2019, the burned areas in ha over Europe had already reached the total for the full year of 2018 (EFFIS). By 26 August 2019, nearly 290,000 ha have been burned in Europe (EFFIS). These figures are still under-representing the total burned area, as EFFIS does not map fires smaller than 30 ha. A total of 1746 fires were registered by the EFFIS system of a magnitude of 30 ha or more.

As we observe an increasing number of fires during last year's fire seasons; fire prevention is more often referred to as a top priority in local and international agendas. Due to these emerging insights, discussions

[3] Available at the link: https://resilience-blog.com/2019/02/28/sparking-firesmart-policies-in-the-eu-lets-train-together/.

[4] https://ec.europa.eu/jrc/en/peseta/reports

on effective preventive measures (forest management schemes), improved preparedness and corresponding action plans are imperative.

GENERAL INFORMATION ON WILDFIRES

Fire regimes have changed in Europe over the last decades. The magnitude of fires has been increasing, and the occurrence of so-called 'mega-fires' is more common, especially in the Mediterranean region. However, wildfires are also spreading from south to north across the continent to countries where the culture of fire is less known, e.g. Germany, Poland and Sweden. Several reasons contribute to these changes and patterns in the European fire regime:

- **Climate change** is creating unpredictable weather events that might alter the fire regime of a given ecosystem. Hotter and drier weather causes the vegetation to be more susceptible to fire and ignitions due to high flammability levels. Fire disturbances might also serve as vegetation renovation processes in non-fire prone areas, thereby leading the path to new species. Recent statistics released by JRC and EFFIS prove the extreme weather changes (see Figure 1 and Figure 2).

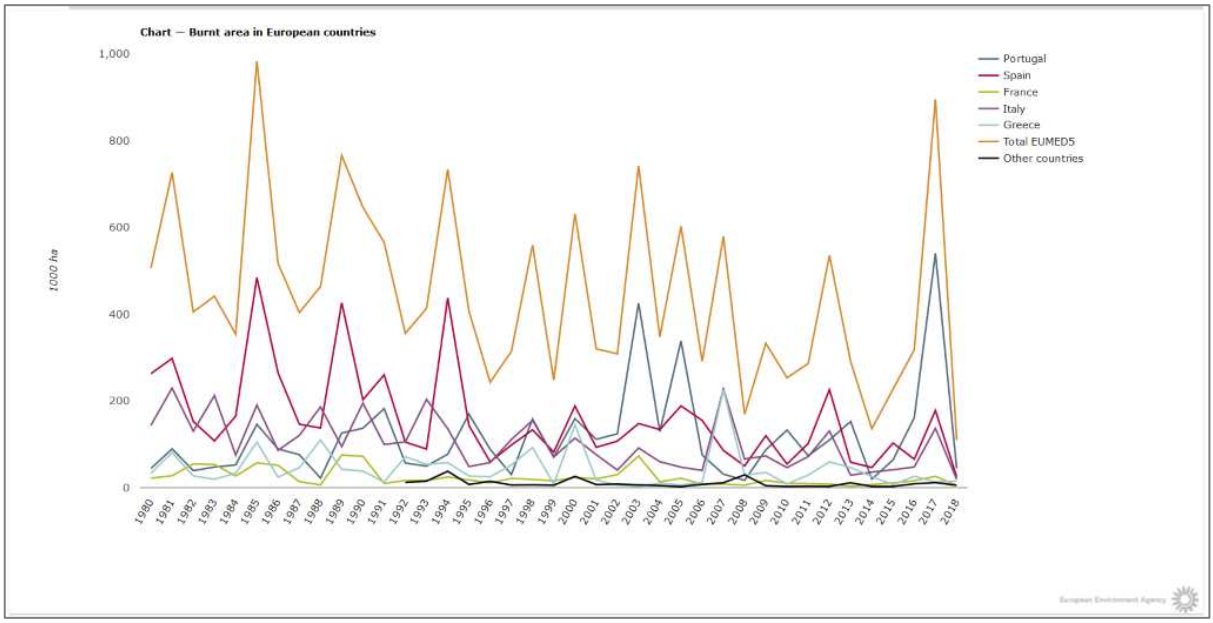

Figure 1.: Burnt area in European countries (Data source: EFFIS European Fire Database - Total burnt areas provided by Joint Research Centre (JRC)

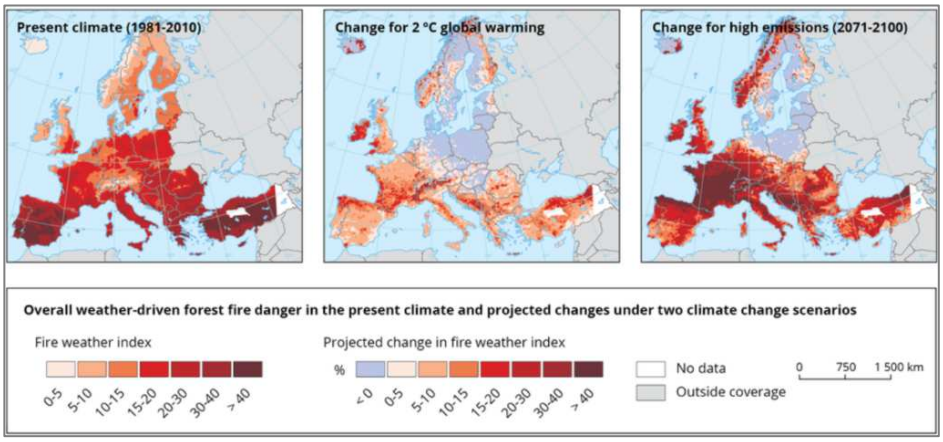

Figure 2.: Forest fire danger in the present climate and projected changes under two climate change scenarios (Data source: Projections of Fire Weather Index (PESETA III) provided by Joint Research Centre (JRC)).

- **Fire-history** of the landscape explains how prepared the society is and how much fuel there is to burn if these systems were stable. However, we cannot assume to manage landscape like in the last century.
- **Rural abandonment** causes forest expansion due to lack of land use and management.
- **Poorly adapted forest management** towards wildfires can lead to an increase in fuel loads and fuel continuity. This situation may impact the number and size of fires as it will be challenging to prevent human-caused ignitions. This can only be reached by better education and awareness of societies. Together these factors explain to some degree the changes in the European fire regimes and are entry points to tackle the wildfire management problems.

All of these patterns are well known outside Europe and the US representative in the CMINE Wildfire Task Group – Mr. Charles Bushey (ex-president of the International Association of Wildland Fire (IAWF)) appointed this during the discussions. He has provided in summarised document pieces of the US Cohesive strategy, which according to the group members can be used in Europe as example of lessons learned (see Annex 1).

WILDFIRE CHARACTERISATION

Any fire will need fuel, oxygen and an ignition source. Wildfires occur when there is suitable weather for fire (dry and hot), an ignition source and enough of flammable fuel available. Once the wildfire is burning, its intensity is affected by wind, slope, aspect and the amount of available fuel. When these three factors are aligned, the fire has its maximum intensity. However, the factors are not aligned uniformly across the burning area. For example, if the head of the fire is aligned with wind, the flanks and heel of the fire will not be aligned. This variation creates a fire signature, from where the fire behaviour can be seen. The signatures can also be used to predict future fire behaviour. Finally, a trigger point is a place on the terrain where a change in the alignment of forces will change the fire behaviour, creating either opportunity or danger. Trigger points are a time and/or place where the tactic or placement of resources needs to be changed to assure firefighter safety.[5]

[5] More about fire safety in the source - https://www.fs.usda.gov/managing-land/fire/safety.

On a landscape scale, nothing can be done in fire management to influence fire weather or to remove the available oxygen or the shape of the terrain. And while it is possible to reduce the human-caused ignitions via awareness-raising and education, it is unlikely that they can be eliminated. Furthermore, there will always be natural ignitions e.g. lightning. The only factor that can efficiently be modified is the type and amount of fuel in the landscapes. The magnitude of fires is directly related to the amount of available fuel.

CONSIDERATIONS OF WILDFIRE MANAGEMENT

In the case of wildfires, prevention is usually much more cost-effective than suppression. The focus should thus shift away from focusing mainly on suppression to more integrated fire management, which gives more attention to preventive measures e.g. through fire-adapted forest management that applies effective approaches to prepare for future wildfires.

There are several approaches to wildfire prevention. A ground rule for successful prevention is clearly defined roles and responsibilities of local communities (cited from the report: "Forest Fires – Sparking Firesmart policies in the EU"). On a rather technical level there are numerous options, a few of which are listed as follows:

- constructing fire and fuel breaks by either removing the entire vegetation or significantly reducing the fuel load,
- performing fuel treatments along the roadsides to reduce fire spread but also to reduce ignitions from the roadside,
- performing prescribed burning to reduce fuel amounts on landscape level,
- use of grazing in the landscape are efficient ways to prevent high-intensity fires (Xanthopoulos et al., 2006).

Fuel types also affect fire behaviour as not all fuel will burn in the same way. By creating a mosaic of different fuel types and loads, fire behaviour and spread can be influenced. This will result in heterogeneous fire effects and more fire-resilient landscapes (Fernandes, 2013). In the long term, efficient fire prevention needs further research and on-site experiences, a profitable forest product supply chain, and coherent policies on a landscape level.

OUTPUT OF THE GROUP

The CMINE Wildfire Task Group, after its one-year mandate, has structured its outputs and conclusions as follows:

- Pro-active wildfire management requires practices, tools and programmes readily available and effectively functioning at the different phases of crisis management: prevention, preparedness, response and recovery.
- This involves coordinated and harmonized planning at the landscape level, including education programmes on a Pan-European level, assessment of fire risk and the development of an action plan for wildfire management.
- An integrated fire management approach first and foremost has to be clear and have shared Vision and Strategy of all affected and mandated stakeholders in order to achieve, resilient landscapes where communities can be adapted to this natural hazard and that can lead to adequate response.

This vision provides overall direction and defines specific objectives:

- Avoid catastrophic fires,
- Reduce unwanted fires and their negative effects,
- Use positive fire effects,
- Increase fire-fighter safety and fire-fighting efficiency.

Then, to implement this vision and objectives, there is a need for respective fire management plans with a strategy covering:

- Early warning and rapid detection,
- Good access,
- Well trained and equipped fire services,
- Community awareness,
- Leadership and coordination among involved actors,
- Reduction of fuel load and fuel availability,
- Forest conversion towards resilient structures, i.e. “continuous cover forestry”.

There are several project lines focusing on fire research at the European level. The European Commission (EC) identified five major research themes in its 2018 report on ‘Forest Fires: Sparking fire-smart policies in the EU’ (see Figure 3). The majority of research-driven projects give attention to fuel management (prevention) and technological tools (suppression). However, the research projects most of the time have very good ideas, but hardly ever go to the real practice. Applications of fuel management measures are still seen as one central point in wildfire management agendas. Nevertheless, funding continues to go mainly on fire suppression.

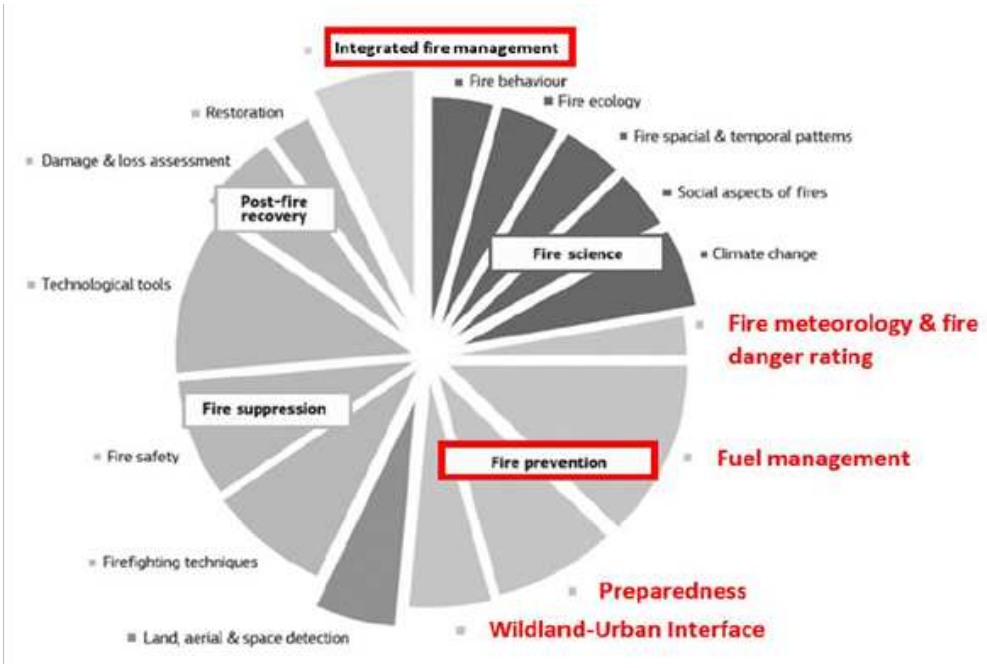

Figure 3.: Relative occurrence of forest fire research themes covered by EU-funded projects. Fire prevention and integrated fire management programmes still need to gain momentum at the wildfire management agendas. Modified from European Commission report 2018 ("Forest Fires, Sparking firesmart policies in EU").6

The final output of the one-year mandate of the CMINE Wildfire Task Group work is a recommendation for a common EU legislation that will glue together all missing pieces between the national, regional and local levels of governance regarding land management.

Fire is not necessarily a bad thing as it is part of the natural lifecycle of the non-urban areas. However, climate change, abundant rural zones and poor land management will only increase the future bill to pay. Prevention measures should be priority for investments, and this is how suppression costs will decrease. Land management changes are not easy and do not happen fast, but this is the only way we can tackle the new weather conditions. The CMINE Wildfire Task Group has this feature as a main outcome in all of its discussions and suggestions that are presented in this final report.

OVERVIEW OF THE WILDFIRES AND THEIR RECURRENCE PATTERN IN EUROPE

Wildfires are a serious and increasing threat throughout Europe. They occur as mega fires in South Europe and as unprecedented fires in North Europe. The reason for this phenomenon is the decline of rural economies and agroforestry mosaics in Europe that creates more continuous and dense forest landscapes.

Wildfires can burn when three major parameters are in place at the same time: weather conditions, geography and vegetation that is flammable. There is very little that can be done about geography and weather conditions; however, vegetation has many options in terms of land management and land use which

[6] Available at the link: https://resilience-blog.com/2019/02/28/sparking-firesmart-policies-in-the-eu-lets-train-together/.

unfortunately are not popular, because are not easy to implement. Thus, land management is avoided as an option and millions of euros are instead invested in expensive equipment and machinery. However, fires do not disappear, in fact fires in southern Europe have become “mega” fires and fires in northern Europe last longer and are classified as “unprecedented” fires.

The European Union in the last 20 years has invested over EUR 103 million in 56 wildfire related projects. The type of projects varied from largescale integrated projects to smaller projects and individual Marie Sklodowska Curie Grants. Other research projects which emphasise the demonstration of effective forest fire management, were funded under the LIFE program, or under the Civil Protection Mechanism. EU funding also targeted coordination actions between research institutions and cooperative actions among neighbouring countries Figure 4 (see Forest Fires – Sparking Firesmart policies in the EU report).

Figure 4. The EU projects on the wildfire topic from results to recommendation cycle (see Forest Fires – Sparking Firesmart policies in the EU report)7.

In general, most projects concentrate on research in Europe, particularly around the Mediterranean Basin, including non-EU countries from this area, but research was also carried out in other parts of the world. Projects were divided into 6 thematic areas corresponding to the sequence of forest fire risk management activities. The areas most addressed by EU research on forest fire were fire prevention, fire suppression and fire science. Less attention has been dedicated to research topics related to post-fire recovery and fire detection (see Forest Fires – Sparking Firesmart policies in the EU report).

In the period 1st January to 9th December 2019, there was more than a tripling in the number of wildfires occurring in Europe as compared to the average number of wildfires during the period 2008 to 2018, as recorded by the European Union EFFIS system and illustrated in Figure 5.

[7] Available at the link: https://resilience-blog.com/2019/02/28/sparking-firesmart-policies-in-the-eu-lets-train-together/.

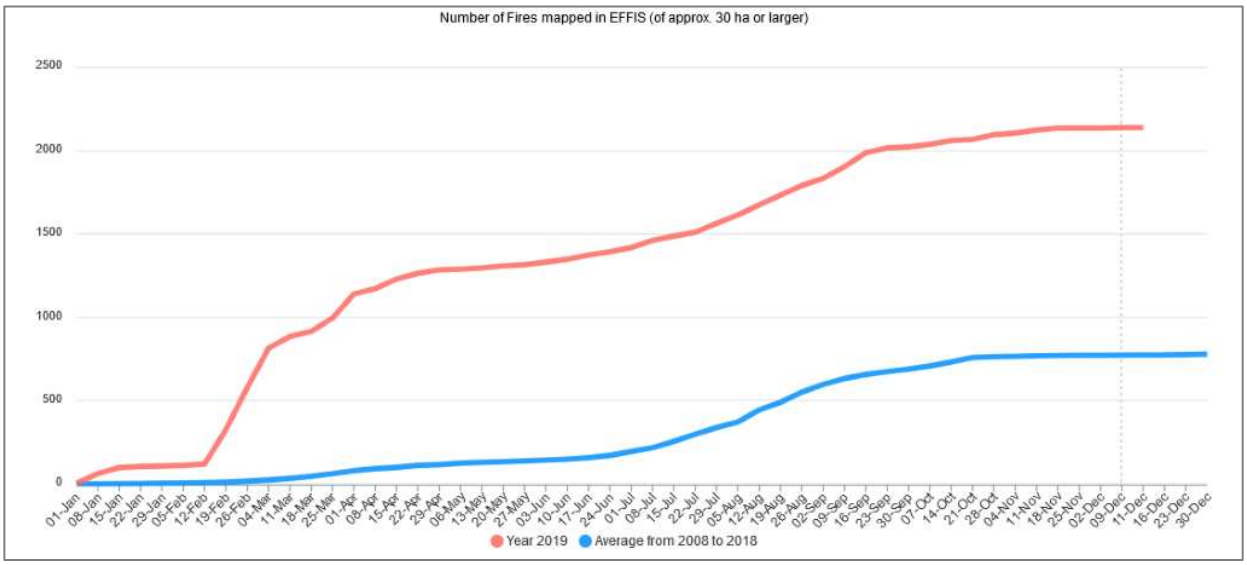

Figure 5. Number of fires in the period Jan. 1st – Dec. 9th, 2019 (red) and average number of fires between 2008-2018 (blue)[8].

The summer of 2018 illustrates that climate change is driving the fire regimes faster than expected. Climate change is more visible as it generates drought stress in abandoned rural areas, where dense vegetation is available for burning during wildfires. This phenomenon is not only affecting the South, but all of Europe too, as presented in the EU Annual Report on Forest Fires for 2018.[9] According to the report, wildfires damaged nearly 178 000 ha of forests and land in 2018.

During the fire season of 2017 wildland fire destroyed 1.2 million ha of forests and land in Europe, based on the EU Annual Report on Forest Fires for 2017.[10] The 2017 report was about megafires as single events and the 2018 report was about globalisation of such events.

The first Pan-European fire season took place during the summer months of 2018. The novelty is that it is not as if fires are only recently started happening in Northern Europe. In fact, in 2007, 2011 and 2014 notable fire seasons occurred in these countries. What sets it apart is the fact that during the summer of 2018, Peloponnesus and the Algarve burned on the same day as the forests of Sweden, Latvia, the agroforestry mosaic from Denmark and a range of other ecosystems in central Europe. This all happened on 23 July 2018 (Castellnou, 2018).

During the second physical meeting of the CMINE Wildfire Task Group, it was decided that every EU Member State representative in the group will search and provide details about his or her country statistics regarding climate and wildfire occurrence.

[8] EFFIS service for EU countries about seasonal fire trends - https://effis.jrc.ec.europa.eu /static/effis.statistics.portal/seasonal-trend/EU.

[9] Annual Forest Fires report of EU for 2017 – https://ec.europa.eu/commission/news/ annual-report-forest-fires-europe-2018-sep-20_en.

[10] Annual Forest Fires report of EU for 2017 – https://ec.europa.eu/commission/news/ annual-report-forest-fires-europe-2018-sep-20_en.

CASE STUDIES

The CMINE Wildfire Task Group tried to do a structured summary using publicly available information about every group Member State, about wildfire's occurrence to the respective territory. The discussions about the nine EU Member States presented in the CMINE Wildfire Task Group logically led to a more profound analysis about recent wildfires that have been life-threatening. The countries on which the group decided to focus were Portugal, Greece and UK. The tragic cases in Portugal in 2017 and in Greece in 2018, as well as a case study from South Wales aimed to present "south" and "north" view of wildfires in Europe. Based on these three case studies we came up with some conclusions that can be used as recommendations for decision-makers. In the third face to face meeting, the group used half a day to visit in person the area in South Wales where the case study described has happened.

PEDRÓGÃO GRANDE (PORTUGAL, JUNE 2017)

This case study has been presented by Mr. Carlos Trindade to his key note speech at the EWWF Wildfire Conference 2019. The case study description in the report is based on his presentation.

Portuguese territory has 70% of its surface area occupied by sylvan spaces, which includes forests (35%), shrubs lands and pastures (31%), unproductive land (2%), inland waters and wetlands (2%).

The sylvan spaces that currently exist in the Portuguese territory result from the long evolutionary process that is linked to human presence. Portugal today has a forest sector with peculiar characteristics, it has one of the smallest public forest areas of the world, only 3% of the total area is made up of public forest systems with highly productive potential and the possibility of adapting to many forest species.

The Portuguese forest is quite diverse in its composition of native species (especially Quercus sp., with 36% of the total, and maritime pine, with 30%), there are also exotic species such as eucalyptus (with 26% of the total wooded surface) present.

The forest area has increased significantly between the nineteenth and late twentieth centuries, due to public policies and private actions of forestry plantations. In the public area, more than 1 million ha were forested. However, with the increase in the number of wildfires and burnt areas since 1995, the forestry area has failed to increase and has even decreased slightly (-4.6 %) in 2010.

The forest and the associated resources contribute annually to the Portugal economy with EUR 982 million, not including the related value of the recreation, landscape and ecosystems services (e.gs. water, carbon retention etc.). Traditional forestry industries (forestry, hunting, fishing and industries) create around 80,000 jobs mostly in regions with demographic and economic difficulties.

Despite the high number of owners and the small size of the forest property, the goods produced this way support an important and integrated industrial chain, based on natural resources, supporting itself as a strong export sector. According to an estimate for 2001, the actual annual economic output was EUR 1.3 million, i.e. EUR 344 per ha per year. Therefore, forest and forestry in Portugal are of great importance for the economy. Portugal, in the European context and even internationally, is a country specialised in the

forestry sector, its revenue is an important contribution to GDP. This is larger than the European average figures (Figure 6).

Figure 6. Forest coverage in Portugal (Source: Maria Caetano, Cristina Igreja, Filipe Marcelino e Hugo Costa, "Ocupação/uso do solo em Portugal Continental 1995/2010" presentation -2017 May).

Human activities were fundamental element in the Portuguese landscape formation. On the most difficult landscapes, domestic animals ingested the vegetation for production of meat, milk and wool. The local population used fire to clear, heat or cook food. Forest areas (forest and scrubland) were instruments of the agricultural success and livestock activities. They were objects of management for the goods and services they produced and, because of their value, were fostered, cared for and protected.

In the 1960s the traditional rural society foundations in Portugal began to weaken. Littoral industry, big city services and the reconstruction of Europe attracted many Portuguese people to immigrate or leave their villages and move to the larger cities. During this period depopulation of rural Portugal areas had begun. During that time, the earlier managed plant communities which had a degree of adaptation to fire became artificially substituted by the industrial forest industry with tree species not accustomed to fire. The Portuguese farmers and shepherds, which had historically used fire as a tool to clean up and do firefighting, were now missing. The strong agricultural community in the country, which had been doing

the farming, cutting the scrublands, and their animals (goats and sheep) grazing the vegetation no longer existed. “Natural fuel breaks” were no longer in place and the vegetation was growing unrestrained.

In April 1974, Portugal experienced a “democratic revolution,” resulting in stronger forest control by the state. Special legislation was introduced for forested areas, preventing landowners, shepherds and farmers from using the land. The end of the previous regime resulted in the start of an exponential increase of forest fires. In 1980, wildfire management was removed from the jurisdiction of the Portuguese foresters and this service was delegated to the Portuguese firefighters.

During the period from 1960s to 1990s, massive depopulation of the rural areas in Portugal was taking place. Fire as a tool to manage land and vegetation disappeared from the population’s knowledge. Fire use was kept away and its worth as an important tool for landscape modelling was forgotten. As a result, there was a great accumulation of forest canopy that modified the vegetation and thus became more prone to more intense fires, of larger size and with greater difficulties of extinction, especially during unusually dry years, as is associated with global warming. The end result was the large Pedrógão Grande Fire which was actively burning during 17-21 June 2017 (Figure 7).

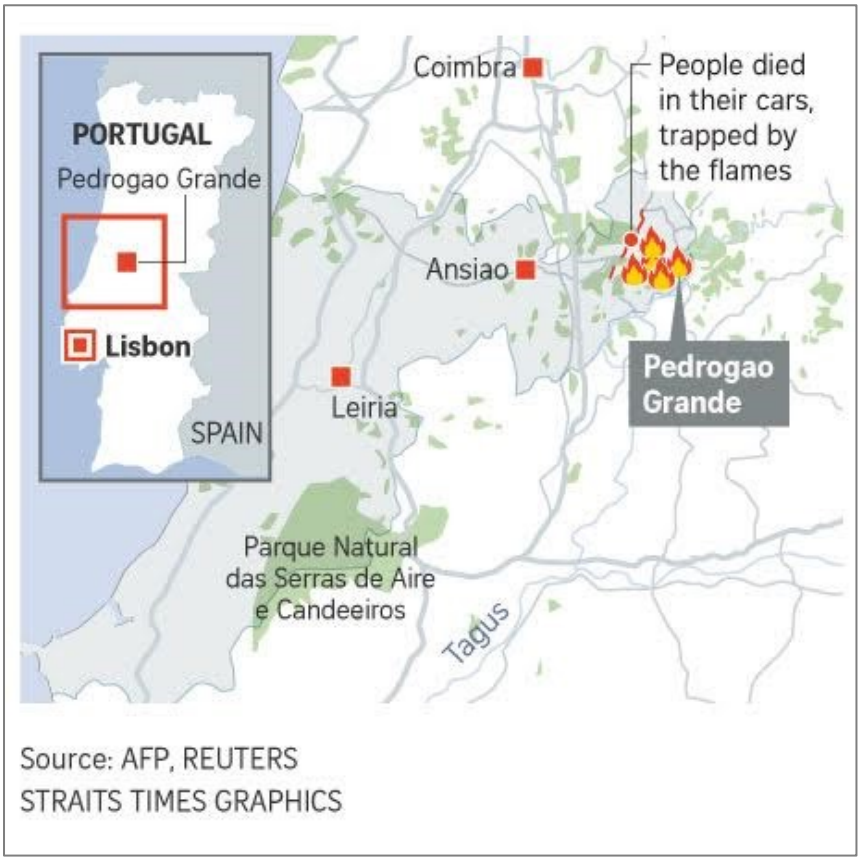

Figure 7. Pedrógão Grande Fire location in Portugal[11].

[11] Reuters news Pedrógão Grande Map - https://www.straitstimes.com/world/europe/ portugal-forest-fire-it-does-not-seem-real-it-is-out-of-this-world.

An intense heat wave preceded the fires, with many areas of Portugal registering temperatures exceeding 40 °C (104 °F). During the night of 17–18 June, a total of 156 fires erupted across the country, particularly in mountainous areas 200 km (120 miles) north-northeast of Lisbon. The fires began in the Pedrógão Grande municipality before spreading dramatically causing a firestorm where 66 people died and more than 200 people were injured (Rego et al, 2017). The fire was caused mainly by lack of prevention that generated accumulation of fuel which in turn generated conditions for megafire development.

BRECON BEACONS NATIONAL PARK (SOUTH WALES, APRIL 2017)

This case study has been presented by Mr. Craig Hope during the Field Trip organized for the CMINE Wildfire Task Group in the South Wales Fire and Rescue (Aberdare) visit. The case study description in the report is based on his presentation.

Historically, agriculture in Wales has been a major part of the economy. Wales is a largely rural country that forms part of the United Kingdom. Wales is mountainous and typically has a mild, wet climate. This results in only a small proportion of the land area being suitable for arable cropping, but grass for the grazing of livestock is present in abundance. As a proportion of the national economy, the importance of agriculture has become much reduced in recent years, and a higher proportion of the population now lives in the towns and cities in the south of the country. Tourism has become an increasingly important form of income in the countryside and on the coast. Arable cropping is limited to the flatter parts and elsewhere dairying and livestock farming predominate. Arable crops and horticulture are limited to south-eastern Wales, the Welsh Marches, and the north-eastern part of the country, the coastal fringes and larger river valleys. Dairying takes place on improved pasture in lowland areas and beef cattle and sheep are grazed on the uplands and more marginal land. Much of the land at higher elevations is extensive sheep-walk country and is grazed by hardy Welsh Mountain sheep. Large areas are grass and scrub lands, nearly 15% of Wales is covered by trees, the majority of this being pine plantations that were originally planned to be used as pit props for the mining industry. As with other parts of the United Kingdom, farming has been under great economic pressure, leading to declines in the number of people permanently employed on the landscape and increasing the role of part-time farming. Early farmhouses have been changed into bed and breakfast guest houses, or converted into self-catering accommodation, and farmers have diversified into the tourism-related industry and other activities.

South Wales is a loosely defined region of Wales bordered by England and the Bristol Channel to the east and south. It has a population of around 2.2 million, almost three-quarters of the whole of Wales, including 400,000 in Cardiff, 250,000 in Swansea and 150,000 in Newport. This area is the most fire prone for grass and brush fires based on South Wales Fire and Rescue Service (SWFRS) annual report 2018-19.

Warm wet summers lead to an abundance of annual wildfire fuels such as bracken and Molinia grasses. Less grazing animals and changes in land use have led to an accumulation of greater dead and dormant vegetation (fuel loading). The number of sheep in Wales in 2017 was more than 10 million, whereas in the period 2018–19, there were 8.56 million sheep, which is 5.2% decrease year on year. This decrease of sheep and other farmed animals has allowed an increase in the grass and brush load making these areas vulnerable in case of ignition. Wildfires can occur as soon as the herbaceous vegetation becomes dormant, usually November to May with most fires occurring in March, April and May, and coinciding with the Easter holidays.

Between 8 and 9 April 2017 an area of 800 hectares was burnt by a deliberate fire in the Brecon Beacons National Park, South Wales. It was once heavily grazed and a drinking water catchment for the South Wales valleys is now becoming very vulnerable to large fires. This fire spread for about 24 hours in the park zone causing huge damage. Normally this type of fast progressing fires burning this number of hectares is unusual. However official statistics from Global Wildfire Information System (GWIS) per country show that since 2001 the United Kingdom has been experiencing wildfires of approximately 25 ha or larger, see Figure 8. South Wales has been collecting its own wildland fire statistics since 2010. The data base is maintained by the South Wales Fire and Rescue Service (SWFRS). The summary of fire investigation results indicates that most of the grass wildfires in the South Wales are deliberate. In rare cases there are also some accidental fires, but most of these were also probably caused by humans. One of the reasons for such fires is that large areas of scrubland and forest are very close to residential properties.

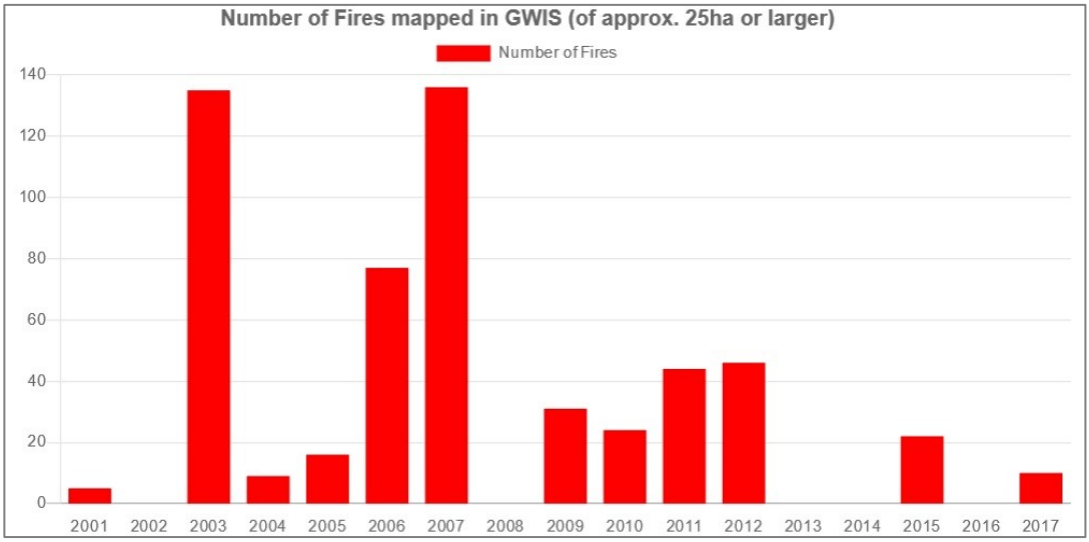

Figure 8. GWIS statistics about UK wildfires - 25ha or larger since 2001 ((GWIS) per country statistics).

Between 2000 and 2008 there were over 55,000 recorded grass fires and nearly 550 forest fires in South Wales; this equates to eight times more per unit area than in the United Kingdom as a whole, see Figure 9.

Figure 9. Grass fires statistics 2010-2018 in South Wales source by annual report 2018-19 SWFRS (see (SWFRS) annual report 2018-19).

In order to reduce the wildfire risk in 2007, SWFRS started the "Wildfire Project". The aim of this project was to reduce the number of deliberate wildfires in South Wales. The two parts to the project covered operational tactics and equipment including community safety. Fire breaks of 800 meters have been created in Wildland-Urban Interface (WUI) areas, see Figure 10.

Figure 10. WUI in South Wales is common thus fire breaks are part of the prevention measures of the local fire brigade – source SWFRS (see (SWFRS) annual report 2018-19).

SWFRS estimates an annual cost in their service area of around £7m due solely to wildfires (see (SWFRS) annual report 2018-19). Traditionally sheep and farming animals were grazing this type of grasslands, and their reduction on the landscape is the most probable reason for such fires to easily spread. Solutions in legislative economic stimulus of the farmers to increase landscape grazing may most probably solve the problem.

GREECE (ATTICA, GREECE JULY 2018)

This case study has been presented by Mr. George Eftychidis during the Workshop Wildland-Urban Interface - FIRE MANAGEMENT as part of the Mediterranean Security Event 2019 (MSE2019). The case study description in the report is based on his presentation.

Attica region is located in Central Greece and encompasses the city of Athens, the capital of Greece. The Greater Athens Area (GAA) hosts approximately 40% of Greece's total population (4 million out of 10.3 million). It has a Mediterranean climate with a long, hot and dry period extending from late spring till early autumn and a short, cold and wet period during winter. The rapid land use changes that took place in the GAA the past decades, due to the expansion of the urban grid, have changed the landscape of Attica significantly. Areas that were previously covered by low vegetation or water courses are currently occupied by roads (e.g. AttikiOdos) or settlements (e.g. Mandra). Land-use change combined with the abandonment of rural areas, long-term fire exclusion practices, climate warming

and the predominance of fire-adapted though highly flammable species (e.g. pines) have increased fire hazard.

The 2018 fire season in Greece started at the beginning of May without great problems. The weather was quite mild, with precipitation above average and no heat waves or strong winds. The situation changed suddenly on 23 July when the second deadliest ever-recorded wildfire event in the 21st century occurred, after the 2009 Black Saturday bushfires in Australia when 173 people were killed. One hundred and four (104) people were killed and one hundred and fifty (150) more were injured that day. Furthermore approximately 1650 homes were damaged or destroyed in a wildland-urban interface fire spanning 1,431 ha in size.

Operationally, this was the result of the engagement of the Fire Service in two simultaneous extreme fires in the western and eastern part of Attica (Figure 11).

Figure 11. The location of the two simultaneous fire events in the Western and Northeast. (Copernicus EMS © 2018 EU, EMSR300 – Delineation Maps).

At noon of that day, a fire erupted in a forested area on Mount Geraneia in western Attica, near the village of Kineta, approximately 50 kilometers west of Athens. The fire grew rapidly since it was fanned by strong winds and swept through Kineta causing damage to houses. Soon it spotted over the six-lane Athens-Corinthus national road and moved towards the plant of a large oil refinery. The situation was critical since the fire simultaneously threatened people and property in the wildland-urban interface (WUI) of Kinetta: the travellers in the national road where the traffic was blocked and the oil refinery plant. Thus, the Fire Service dispatched a very large part of their ground and aerial firefighting resources in Attica to the affected area.

While the activity of the western Attica fire was culminating, catching the full attention of the fire service, a second wildfire erupted on Mount Penteli at 16:41 in the north-eastern part of Attica. The origin was inside the perimeter of an August 2009 wildfire in the settlement of Daou Pentelis, roughly

5.2 km west of the coast. According to weather measurements at the National Observatory of Athens on Mt. Penteli, upwind of the fire, the prevailing wind was WNW with speeds ranging from 32 to 56 km/hr for the first two hours after the fire start, with gusts of 50 to 89 km/h. Temperature didn't exceed 31°C and relative humidity varied between 34% and 43% Relative Humidity (RH) making the probability of spotting relatively low. Until that day, the season had been much wetter than usual and the vegetation was not water stressed.

The cause of the wildfire remains still unknown. Because of the extreme weather conditions, fire spread swiftly to the east, affecting as it travelled along, the settlements of Kallitechnoulopis, NeosVoutzas, Rafina and reached Mati, where it finally stopped right at the coastline. Organized evacuation operations took place at a church charity institution (Lyreion) and all children in summer camps of the wider area. Over 700 residents have been evacuated or rescued, mainly from the seaside settlements located north of the port town of Rafina, namely Kokkino Limanaki and Mati.

23 July was the first day of the 2018 season for which a "very high" fire danger rating (class 4 in the 1-5 range) had been designated in the region of Attica, and also to a large part of south-eastern continental Greece, according to the Fire Danger Prediction map issued daily by the Greek General Secretariat for Civil Protection (Figure 12). This rating was due to a forecast of strong to extreme westerly winds.

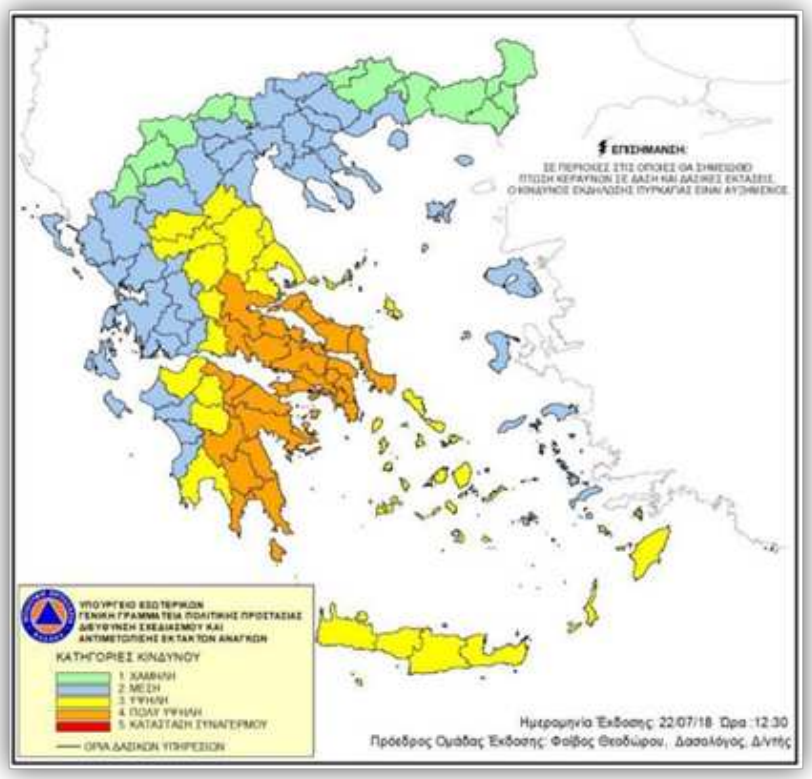

Figure 12. Attica very high fire danger at the time of the fire start day

The starting point of the East Attica Fire (Matti Fire) was within the perimeter of Daou Pentelis, 5.2 km west of the coast. The first house that burned was 150 m from the ignition point. The combination of fast fire spread in a populated area, lack of a common overview of operations and poor coordination between the involved actors, combined with incorrect assessment and initial underestimation of the situation, led to a delayed and inadequate response –as many resources had been moved to the Kineta fire, which allowed the eastern Attica fire to grow rapidly.

The wildfire, classified as a crown fire, aided by very strong winds of an approximate velocity of 90 km/h, crossed the main highway of the area (Marathonos Av.) within a very short time (estimated approximately 30 to 40 min depending on the location). It moved towards the settlement of Mati where it reached the sea with a fire front of approximately 1 km, allowing for a minimal response time by the inhabitants and numerous visitors of the area. The difficult weather conditions, the area morphology and the town configuration resulted in the entrapment of a great number of people. Scorching areas along a 5 km path, it reached the coast in approximately two hours. Initially it spread in areas burned in 2005 and 2009 (regeneration), moving fast though burning with medium intensity (Figure 13).

Figure 13. Path of the Mati fire across the burned areas of 2005 & 2009 and the WUI settlements

Next it reached the northern boundaries of the settlement of Neos Voutzas. Its rate of spread, especially in the last stretch towards the coast, reached 4-5 km/h for short periods of time. In its path, it burned mostly small stands of mature pines (Pinushalepensis) or ornamental plants and trees in the yards of houses.

The aftermath of the Mati fire was tragic. The amount of people killed reached 102, while more than 150 were seriously injured. The flames scorched approximately 1400 ha (Figure 14) and damaged more than 1200 buildings and 300 vehicles.

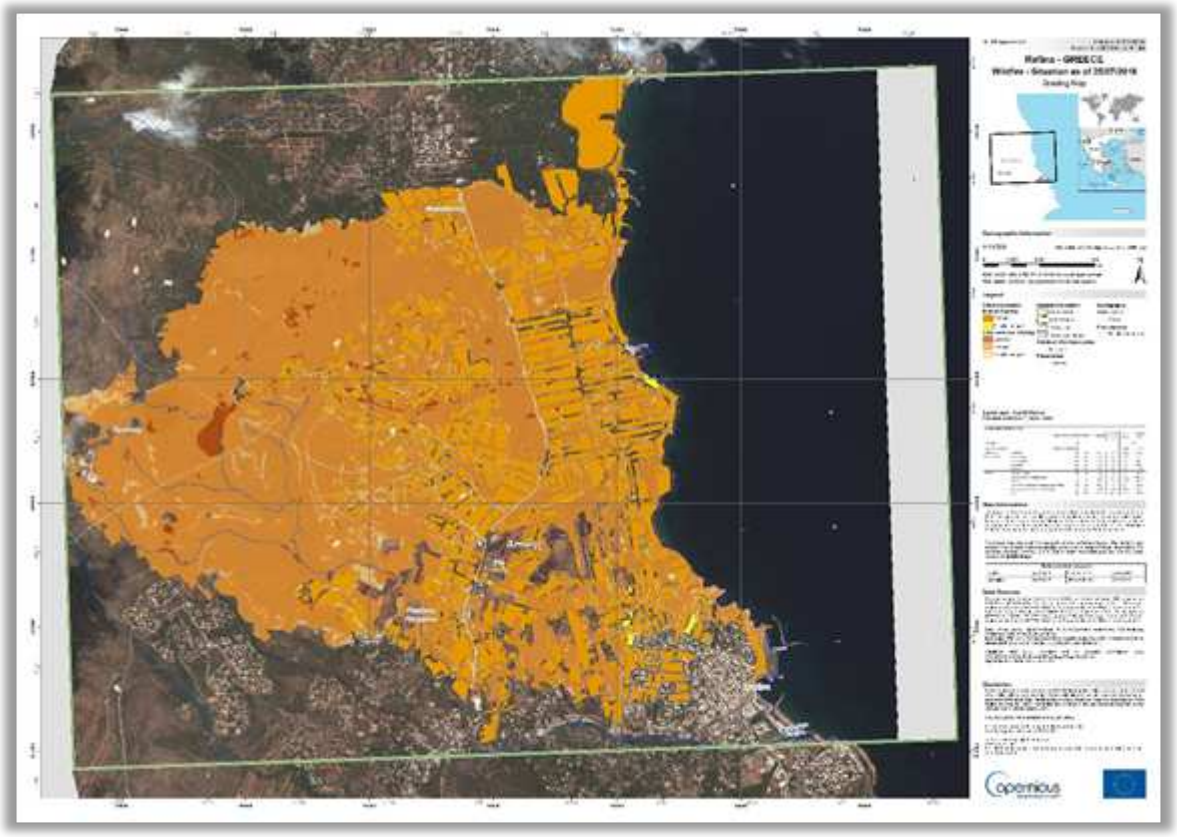

Figure14. Burned area of the East Attica fire 23th July 2018 (Source: Copernicus EMS)

There are several underlying causes that turned the Mati WUI fire into a tragedy. These include low-perception of wildfire risk by residents and visitors (tourists), a mixture of illegal and legal buildings in the same area, poor construction materials, lack of land planning, inadequate implementation of land development rules, lack of coordination and information sharing between agencies and authorities, inefficient firefighting system, confusion of responsibilities, limited use of scientific knowledge and decision support tools, fragmented (non-integrated) wildfire management structure inappropriate evacuation plans, unprepared to deal with fire local authorities and communities etc.

OUTCOMES AFTER THE GREEK CASE STUDY IN SUMMARY

A main outcome of the Greek case study was the fatalities; the official number was 101 people, which led the group to reach the following five major conclusions:

1. Land Management in the affected zones was poorly implemented and fire prevention measures were inadequate,
2. Climate conditions are unprecedented and not expected from the locals,
3. Local population is not properly prepared to protect their neighbourhood, thereby it is not possible to expect local authorities and public services to protect them and their property,
4. No local was familiar with the idea that such an event may happen to their area,
5. Firefighters are in big trouble when sent into places like the WUI since these areas are associated with an extensive mixture of tall vegetation, fire-ignorant and unprepared people and buildings spread out and covered by flammable vegetation.

CONCLUSIONS

In the three case studies, Portugal, Greece and the United Kingdom, the main reason for fire occurrence and spread is the continuous and unmanaged fuel bed consisting of dead and dormant vegetation, which has been accumulated due to forced protection of the area. In the scientific fire management community this is known as the "Wildfire Paradox." The process in which the lack of forest and grassland management result in an increased demand of fire suppression efforts and drives further to changes in fire regimes that burn at increasingly greater fire behaviour. The "Paradox" refers to the fact that the vigorous suppression of any wildfire ignition contributes to creating increasingly homogeneous and continuous fuel loads, which will contribute to extreme fire behaviour when the weather conditions are favourable.

The "Wildfire Paradox" can be linked to the "Wildfire Generation" concept. Presented by Marck Castellnou in his EFI interview where he stated: "Different fire generations are identified to explain the evolution from moderate to large-sized wildfires, burning with high intensity (i.e. megafires). In the first place, wildfire became a threat due to the fuel continuity (1st generation). Over time, fuel continuity increased leading to faster fires (2nd generation) and more intense fires (3rd generation). The third-generation wildfires challenge fire suppression agencies as they spread fast and with a higher intensity over dense and continuous vegetation across the landscape. These fires are typically a problem of Southern European countries, but currently they are migrating also to Northern Europe (Castellnoul, 2018).

Summers in temperate countries that are traditionally wet, have all of a sudden been transformed into long, hot and dry periods. Large fuel loads have become available in a landscape without a previously defined fire regime. In these landscapes, fires do not burn as in 1st generation, but rather as 2nd and 3rd generation; fast and with high intensity. Northern countries, with large areas of wildland vegetation and forests are currently experiencing fire regimes of increasing intensity. However, fire services across the EU have not had the opportunity to explore the problem and learn or develop a rationale for changing tactics and strategy. They are going from fire regimes of small and rare fires directly into megafires. The only option seems to be to fight flames directly, but by doing that there is a high risk of losing the big picture. In such a scenario, a defensive strategy will help fight flames; however, flames are only the visible part of the deeper roots of the wildfire problem. It is not a problem of fighting flames; it is a landscape problem.

Southern Europe is already in the 3rd generation of wildfires, with two added weaknesses, the wildland-urban interface and multiple fire events occurring at the same time. These two phenomena demand an exhaustive amount of resources and often cause the collapse of the firefighting mechanism. The more resources are invested in fire suppression, the larger the "Wildfire Paradox" Becomes. Fires in the wildland-urban interface are the 4th generation and simultaneity of fire events is the 5th generation (e.g. 3rd and 4th generation fires). The immediate response is the international cooperation and support to the wildfire suppression operations. But this is not the solution, it is only temporary containment. Once the 5th generation of wildfires take place, the success of fire suppression depends mainly upon the likelihood and duration of extreme weather events. And that is an uncertainty at its best. So, economy and landscape depend on uncertain weather events.

If we are keen to fight the real problem, this should be fought from the very beginning; acting on the fuel load availability and having a better understanding of fire ecology (response of vegetation and wildlife to fire) and the role of fire as a natural disturbance. Landscape management and planning should integrate wildfire risk. Fires are neither strange nor exceptional. They are part of the natural lifecycle and cannot disappear. Fire seasons that up to recent times only happened in the south are now a reality across Europe. Firstly, to reduce the fire intensity and spread rates, it is necessary to reduce the load of dead fuel. Secondly, to reduce fuel continuity it is necessary to restore a mosaic structure recreating a heterogeneous landscape that includes agriculture. In that sense, bio-economy shall become a priority, as it contributes to reduce emergencies and the risks associated with climate change."

The lessons learned fighting wildfires in the past can be of great help. All are pointing at the recovery of the mosaic landscape in order to keep fire generations at a minimum. Taking a defensive strategy will only contribute to enlarge the problem, and forests will no longer be an ally but an enemy, then megafires will happen more often. The evidence of failing to see this big picture is the focus on the demanding daily emergency.

Portugal spend EUR 25 million in wildfire prevention and EUR 75 million in wildfire combat until 2016 (on average per year). The aerial support each year has increased. The aeroplanes and helicopters, and the number and burned areas in Portugal has also increased. However heavy equipment does not solve the wildfire occurrence problem. Thus, municipalities started to experiment and implement new tactics. The municipality of Mafra in Portugal is a good example of implementing prescribed fire burning into a mosaic pattern, see Figure 15.

Figure 15. Mosaic prescribed fire burned areas in Mafra municipality

Such initiatives on a land management scale can and will bring good results if people work together with the responsible authorities.

The current trend under the context of climate change is the spread of increasing fire occurrence and behaviour currently happening in Southern Europe to more northern regions of Europe. Those forests that

are not adapted to the new climate are experiencing renovation through disturbances. It is urgent that we face the current situation in a manner that helps forests, and societies to adapt and change, rather than take up the difficult strategy of preserving the current forests. We should aim to create the landscape of the future, resilient against large emergencies, protected from climate change and from megafires. Forest management and the associated bio-economy are tools to act.

The fire suppression services should be well trained and provided with the appropriate resources. However, their efficiency relies upon the preparation of the landscape to fight the flames on it. Without prepared landscapes there is no possible suppression of the 6th generation fires, or 'fire storms' that were seen in Portugal, Chile, Greece and USA in 2017 -2018, and again in Australia in 2019-2020. More will occur in the years to come.

The population must be proactive and do its best to maintain the land within their neighbourhoods. State reactions in most cases of rapid wildfire spread show that coordination is missing between all first responders in the field. So, working together must cover national and all other levels up to the community representatives' special regulations and coordination cooperation initiatives, which in cases of major disasters will be helpful and should be in place. The scientific community can be a pillar on simulations about potential scenarios for wildfire spread. This can help and support the civil protection decision-making process. The gaps between the research community and operational response can be overcome only if all stakeholders learn to work together and the responsibilities are clear.

WAY FORWARD

WHAT CAN BE THE USE OF THE OUTPUTS OF THIS TASK GROUP? HOW CAN THEY BE PUT IN PRACTICE?

The output of the task group work is mainly aimed to present that land management measures timely done can affect the wildfire occurrence and spread pattern. The municipality of Mafra in Portugal is a good example where mosaic type of vegetation distribution is implemented in practice. There is statistical evidence that these measures nowadays give results and wildfire events are not so big and devastating in their propagation pattern. These land management activities on communal level affect positively the region of Mafra municipality. Thus, our task group is supporting the idea that such good examples need to be collected and policy makers need to be informed with field trips and easy to understand explanations about what can be done better in order for the population to be protected.

HOW CAN THE OUTPUTS BE FURTHER ADVANCED? WHAT WOULD BE A FURTHER STEP?

The findings and discussions of the wildfire task group working in 2019 are not rocket science, but knowledge that comes from practice and has one main aim – to improve the current conditions and create better ones. Based on literature-based analyses cross-border events have to be in place for improvements in the current wildfire prevention and preparedness measures. In summary they are:

RECOMMENDATION 1: STIMULATE CROSS-BORDER COOPERATION

The first one, namely "*isolated national thinking and lack of political will*", is related to lack of will and motivation to collaborate with neighbouring countries, in order to enhance transboundary policies, tools, and practices. This lack of will may be observed not only during events situated near or at borders but also when events within a country are solely managed by it without utilising available supportive tools coming either from other countries or multinational or international institutions (e.g. EU support mechanisms). While such situations are not clearly under the scope of the issue at hand, they indicate a problematic attitude towards cooperation with one's neighbours. Bearing in mind that the scope of events may change or be expanded over time, due to reasons such as climate change or unsustainable development, the stakes lie with challenging the perception of countries that "*emergencies can be adequately dealt without the need for international assistance*" (Albris et al, 2017). Moreover, there is a misperception that bilateral agreements are more than enough of a support to draw upon and, thus, wider mechanisms, such as those of the EU, are unnecessary. For instance, France which is surrounded by countries that are adequately equipped to provide support during a disaster is considered unlikely that any event would require extra European means. Therefore, when the French authorities decide to call for international assistance, this will generally involve a request for specific equipment from neighbouring countries (Ettinger et al, 2017). People living in the border areas are already helping each other in cases of disasters, not only fires. However, in some cases missing political decisions make teamwork impossible.

RECOMMENDATION 2: ESTABLISH LEGAL EUROPEAN FRAMEWORK DEALING WITH WILDFIRES

The second challenge, namely "*absence of policies and tools for transboundary crisis management*", which highlights the need for setting up adequately effective and useful international structures for transboundary crisis management. Although, as already stated, there are a number of bilateral and multilateral signed agreements between several countries for dealing with specific hazards, there is often a

lack of legal instruments and concrete policies that can be used by national, regional and local governments to effectively use transboundary aspects for crisis response (Albris et al, 2017). There is directive INSPIRE that give frame and ideas about flood events and how they can be evaluated. Wildfires are having no such measure and every country has different approaches to deal with them.

RECOMMENDATION 3: NOMINATION OF CLEARLY IDENTIFIABLE CONTACT POINTS ACROSS EU

The third challenge, namely "*lack of standardized forms of communication*", is related to the recurring issue of lack of standardised forms of communication between official agencies across countries. This issue also includes the concept of knowledge sharing beyond communication during an emergency or crisis. Characteristically, (Albris et al, 2017) quoting a Swiss official who said that "*miscommunication problems may arise between two different political cultures*" with one potentially wanting "*to take their time in considering their options*". A different and more basic facet of this problem is the lack of clearly identifiable contact points across nations. In cases of disaster every EU country has representative in the respective Ministry of Interior officially dealing with such topic, however it is not easy to find and talk with this people about improvements suggested from expert's level.

RECOMMENDATION 4: ESTABLISHMENT OF CROSS-BORDER CLIMATE CHANGE ADAPTATION PLANS IN EU

For the fourth challenge, namely "*lack of attention to climate change adaption as a cross-border issue*", refers to variations in the way countries interpret climate change and put policies into actions, thus adding an additional layer of complexity. Such issues are further exacerbated for countries surrounding by multiple neighbours. National climate change adaptation plans often do not tackle transboundary aspects of climate change impacts. Climate has no borders and sooner we have a range of measures to approach specific issues better for the population it will be.

RECOMMENDATION 5: ESTABLISHMENT OF CROSS-BORDER ENVIRONMENTAL RESOURCES AND DISASTER RISK REDUCTION EU PLANS

Finally, the last challenge identified by (Albris et al, 2017, Becking, 2017) namely "conflicting priorities in environmental resources and disaster risk reduction", which relates to the vigour with which various countries draft regulations and policies for environmental protection and conservation. Such differentiations may result in different levels of attention to be paid over crises in border areas making disaster management a complex issue, where environmental and economic pressure is in place. Borders are lines which does not exist in the nature. Having timely measures about fires, floods or any other hazards in the cross-border areas will affect the inner parts of every country in positive way.

All steps and measures are studied; it is only the decision-makers, who will have to decide how all of the available knowledge will be implemented in practice.

WHAT OTHER CHALLENGES NEED TO BE ADDRESSED?

Land management is the main outcome of all discussions that the CMINE task group had. However, land management changes can only be done if implemented on national, regional and local levels. Such initiatives require common legislative framework that does not exist at the moment in Europe.

The European FIRE Directive discussion need to be initiated among a broader audience and one major message has to be in place – **if we do not start working together now, in future it may be too late**.

POTENTIAL SYNERGIES WITH OTHER INITIATIVES/OTHER TASK GROUPS

During the CMINE Wildfire Task Group lifetime, there were another 3 groups working in parallel in Europe covering the wildfire topic from their particular point of expertise. Synergies that can be done between CMINE Wildfire Task Group and the other 3 initiatives are:

SURE project - https://sure.efi.int/,

FireIN project with their - Lessons on Fire - https://lessonsonfire.eu/,

FireLinks COST action - https://firelinks.eu/.

CMINE representatives took part in the 3 other project's workshops and open discussions. These 3 projects have similar ideas as the ones discussed within the CMINE task group. Every CMINE task group member has had collaboration with some of these projects' representatives before. Non-official common activities have been performed already between the CMINE group and the 3 projects listed.

REFERENCES

Albris, K., Lauta, K. C., &Raju, E.. Overcoming obstacles for disaster prevention: Challenges and best practices from the EU and beyond (Deliverable 2.2). Enhancing Synergies for disaster Prevention in the EurOpean Union (ESPREssO). (2017) Retrieved from: https://research.ku.dk/search/?pure=en%2Fpublications%2Fovercoming-obstacles-for-disaster-prevention-challenges-and-best-practices-from-the-eu-and-beyond-deliverable-22(1b56bf0e-2887-47df-bb29-15a8450f23f3).html.

Annual Forest Fires report of EU for 2018 – https://ec.europa.eu/jrc/en/publication/forest-fires-europe-middle-east-and-north-africa-2018.

Annual Forest Fires report of EU for 2017 – https://ec.europa.eu/commission/news/ annual-report-forest-fires-europe-2018-sep-20_en.

Becking, T.. Analysis of disaster management structures and cross-border collaboration in the Benelux and its bordering countries (master's thesis). (2017) Retrieved from: https://www.emric.info/nl/professionals/Publicaties/ Studies/thesis-tobias-becking-public.pdf.

Castellnou, M.: Why and how forest fires are becoming a European problem? 2018 (https://www.efi.int/news/why-and-how-forest-fires-are-becoming-european-problem-2018-08-09).

EFFIS service for EU countries about seasonal fire trends - https://effis.jrc.ec.europa.eu /static/effis.statistics.portal/seasonal-trend/EU.

Ettinger, S., Gérard, F., Le Cozannet, G., Fontaine, M., Grandjean, G. & Baills, A.. Synthesis report of legal, policy and science approaches within the frame of disaster risk reduction (DRR) and climate change adaptation (CCA)-ESPREssO Project, National Report-France. BRGM and AFPCN-France. (2017)

Fernandes PM. Fire-smart management of forest landscapes in the Mediterranean basin under global change. *Landscape Urban Plan*110: 175– 82. 2013

Forest Fires – Sparking Firesmart policies in the EU https://ec.europa.eu/info/sites/info/files/181116_booklet-forest-fire-hd.pdf.

Global Wildfire Information System (GWIS) per country https://gwis.jrc.ec.europa.eu /static/gwis_stats/.

REGO, F.C; OLIVEIRA, T. FERNANDES, et al., Economia da Floresta e Ordenamento do Território - Conselho Económico e Social; Lisboa, 2017.

Reuters news Pedrógão Grande Map - https://www.straitstimes.com/world/europe/ portugal-forest-fire-it-does-not-seem-real-it-is-out-of-this-world.

South Wales Fire and Rescue Service (SWFRS) annual report 2018- https://www.fire.nsw.gov.au/gallery/files/pdf/annual_reports/annual_report_2018_19.pdf.

The July 2018 Attica (Central Greece) wildfires: Scientific report v1.1. E. Lekkas – P. Karydis. Accessed at: https://www.scribd.com/document/385101078/Newsletter-Attica-Fires-2018-v11-pdf#download&from_embed

Xanthopoulos, G., Caballero, D., Galante, M., Alexandrian, D., Rigolot, E., Marzano, R. Forest fuels management in Europe. In: Andrews PL, Butler BW (eds), Fuels Management-How to Measure Success, USDA Forest Service, Portland, pp. 29-46. 2006.

Xanthopoulos, Gavriil & Athanasiou, Miltiadis. (2019). Attica Region, Greece July: A tale of two fires and a seaside tragedy. 28.2. 18 - 21. 2018

LIST OF ABBREVIATIONS

CM	Crisis Management
CMINE	The Crisis Management Innovation Network Europe
CS	Cohesive Wildland Fire Management Strategy
CoPCM	Community of Practice in Crisis Management
DRIVER+	Driving Innovation in Crisis Management
EC	European Commission
EFFIS	European Forest Fire Information System
EU	European Union
ICCS	Institute of Computer and Communication Systems
IICT-BAS	Institute of Information and Communication Technologies of the Bulgarian Academy of Sciences
IIT	Institute of Information Technologies
IPP	Institute for Parallel Processing
TG	Task Group
WRF-Fire	Weather Research Forecast - Fire

ANNEX 1: FROM US COHESIVE WILDLAND FIRE MANAGEMENT STRATEGY TOWARDS EUROPEAN WILDLAND FIRE MANAGEMENT PHILOSOPHY

Compiled by: Chuck Bushey using free US based sources

The US wildland fire management agencies were directed to begin developing a Cohesive Wildland Fire Management Strategy (CS) in 2009. Wildland (vegetation) fires were killing people, destroying increasingly greater numbers of homes and community infrastructure, and burning critical natural habitat across the country and it was evident that a program of increased collaboration between organizations involved in planning for, and managing wildland fire was necessary. Disturbing increasing annual trends in fire size and especially cost was evident. A different approach, or philosophy, to managing wildland fuel and fire was needed; a collaborative partnership among all organizations and land management agencies to address the challenge. It was evident that no one land management agency, or group of agencies, could address the problem by themselves. Help was needed from all levels bottom to the top including: NGOs, wildlife management organizations, private sector fire suppression forces, indigenous peoples, city/rural and volunteer fire departments, and private land owners or managers. CS was developed to fill this need; it is a philosophy; a way of doing business across jurisdictions and ownerships. An "All Lands, All Hands" tactic; since fire recognizes no political boundaries neither should CS. It is a collaborative attitude. It is not a mandatory approach, people and organizations must want to participate.

In a national evaluation the three greatest challenges became the three basic national goals or tenets of CS and are to be supported by the best available science.

1. Restore and maintain landscapes: Landscapes across all jurisdictions are resilient to fire-related disturbances in accordance with management objectives
2. Fire-adapted communities: Human populations and infrastructure can withstand a wildfire without loss of life and property, and
3. Wildfire Response: All jurisdictions participate in making and implementing safe, effective, efficient risk-based wildfire management decisions

The CS philosophy is a "Way of Doing" business involving collaboration between all levels, all agencies, departments, NGOs, etc., it is the key to escaping fire management silos and is a framework to better capture and promote "working better together." CS involves "All Hands – All Lands" and evaluates wildfire risk across all regions and identifies regional and local priorities to meet the three tenets. Increased connections, communications, and collaborations at all the different levels creates the strength.

All of Europe is experiencing similar trends in fire numbers and size, as well as upward spiralling costs; especially as climate change moves warm, dry weather further north from the southern Mediterranean lands where wildland fire occurrence has historically been more common place. In recent years the three tenets of CS have been written into wildland fire and fuel (vegetation) management doctrines across Europe

and is becoming woven into the strategic thinking of cross-border cooperation, standardization and fire training. However, the philosophy has only been adopted piecemeal.

A portion of the vision of the Cohesive Strategy is as a people, we learn-to-live with wildland fire, and its associate smoke impacts across our landscapes and adjacent to our communities. This is taking place in portions of Europe while other regions have yet to address the challenges. Making our residential communities and infrastructure resilient to fire is about accepting levels of risk as the difficulties for fire management grow more formidable and complex. The observed increases in European fire occurrence and behavior no longer gives the land and fire management agencies and states the luxury and insulation of individually meeting their public protection missions. In our complex wildland fire system, in order to see a reduction in wildfire risk, we must be willing to take some short term risk for the long term gain. This includes allocation of resources for long-term land management that will reduce fuel loads (vegetation) and resultant fire behavior by mechanical, biological or other non-fire methods, and by prescribed fire allowing for greater control over the outcome and reduce the risk of unintended consequences.

This CS philosophy must also include the work environment in which we dispatch our wildland fire personnel. Reducing risk to firefighters and the public is the priority in every fire management activity. Firefighters should have the best and most effective equipment, training, PPE, and health and safety support from their respective organizations. This includes the aspect of standardization across state boundaries so when firefighters are dispatched to a different country there is trust between European states and fire organizations that they can safely and efficiently work together. Wildland fire will always occur in Europe, current trends show the occurrence increasing; CS is a philosophy of working together across boundaries to help ensure public safety.

Sources:

Federal Land Assistance, Management, and Enhancement Act of 2009 (Flame Act of 2009). https://forestsandrangelands.gov/documents/strategy/flame_act_2009.pdf.

The National Strategy: The Final Phase in the Development of the National Cohesive Wildland Fire Management Strategy. April 2014. https://www.forestsandrangelands.gov/documents/strategy/strategy/CSPhaseIIINationalStrategyApr2014.pdf.

National Action Plan – An Implementation Framework for the National Cohesive Wildland Fire Management Strategy, April 2014. https://www.forestsandrangelands.gov/strategy/documents/strategy/NationalActionPlan_20140423.pdf.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement n° 607798