net risk work

FOREST RISKS IN A CLIMATE CHANGE CONTEXT

TRENDS AND RISK MANAGEMENT CHALLENGES OF WILDFIRES, STORMS, AVALANCHES, FLOODS AND THEIR INTERACTIONS IN EU LANDSCAPES

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This publication is the final technical report summarizing main results of NET RISK WORK (Networking for the European Forest Risk Facility Initiative) project, co-funded by European Union Humanitarian Aid and Civil Protection (ECHO/SUB/2016/740171/PREV10).

Project description: NET RISK WORK project promotes knowledge and lessons learned exchange and networking around risk management of four major European natural hazards and their interactions; wildfires, storms, avalanches and floods. Throughout the project, best practices capitalization, tools for assessing risk evolution under climate change scenarios and knowledge exchange with experts across Europe has been carried out. The project gives continuity to the European Forest Risk Facility Initiative started in 2014 encouraging networking under informal and permanent multi-actor platforms seeking a better transfer of knowledge into practices and policy making. On the website there is free access to all project results.

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INTRODUCTION

Changing climatic conditions, together with changes in land uses, might modify intensity, frequency and distribution of natural hazards and the incorporation of new risk areas in unusual territories.

In this context, all European countries seem to be subject to an increased risk of natural disasters. The expected trend will affect areas that historically have not experienced significant impact from a specific natural hazard (e.g. wildfires in northern Europe) and also with new hazards interactions (new risks coming up and influencing existing ones as wildfires affecting mountain forests increasing avalanche risk). This changing context presents new risk management needs regarding known situations until now, at different levels (national, regional, local), which also generates new needs of collaboration between countries.

In recent years there have been several examples of new risk scenarios with extraordinary incidents due to their extension and intensity. During the NET RISK WORK project (2017-2018), for instance, extreme wildfire events had occurred across the world, such as large fires in Chile and Canada in 2017, fatal fires in Portugal and NW Spain (Galicia) in 2017 and in Greece in 2018, or unusual types of forest fires in Scandinavia in 2018.

To face these new risk situations, actions encouraging the sharing of knowledge and good practices between natural hazards and local/regional expertise should improve the Disaster Risk Reduction strategies, preparing the national Civil Protection systems to cope with the impact of climate change. Numerous initiatives such as the European Commission Disaster Risk Management Knowledge Centre (DRMKC) seek to promote the transference of scientific knowledge into practice, as well as an increased cooperation of risk assessment and disturbance management.

NET RISK WORK project has facilitated knowledge and lessons learned exchanges and networking around four main forest risks in Europe: wildfires, storms, avalanches, floods and their interactions as well. An integrative approach through common cross-sectoral topics of risk management strategies and observing all components of risk formula and risk cycle stages has been considered. This publication summarizes the main results achieved during the project, which is addressed to operational actors involved in forest risks management and Civil Protection.

Contents are organised in two Sections. The first one considers the main understandings and tools for risk assessment which the project is based on: risk definition; description of cross-sectoral components for an integrative approach and links with Sendai Framework for Disaster Risk Reduction 2015-2030 and the RescEU initiative; fundamentals of risk awareness; best practices collected; a specific tool developed to analyse risks evolution in a climate change context and their interactions; the networking building experience through *Risk nodes* and the *RiskPlatform* tool and, finally; a Chapter on the risk management requirements from the Civil Protection perspective.

The second Section includes the most relevant aspects per each forest risk with regards to climate change tendencies and the risk management achievements and challenges, considering also potential forest risks interactions across Europe.

The final remarks are accompanied with references and three annexes about the best practices and relevant R+D projects on the issue collected, as well as the risk assessment tools developed.

The document aims to provide ideas and guidance for all risk managers, when coping with future challenges of increasing forest landscapes resilience and Civil Protection.

SECTION I.

DEALING WITH RISK MANAGEMENT COMPLEXITY

Chapter 1. Defining risk

Depending on the discipline, various definitions of **risk** exist. The most comprehensive and applied across disciplines is ISO 31000 – Risk Management developed by an international committee with the input of several thousands of experts. Published by the International Organization for Standardization (ISO), it defines risk as: "**the effect of uncertainty on objectives**". This approach includes positive and negative impacts on objectives.

It goes beyond the former, and the still frequently applied understanding of risk as a "combination of the probability of an event and its negative consequences" or the "chance or probability of loss", which focus mainly on negative outcomes.

Consequently, **risk is largely related to predefined management objectives**.

For this reason, NET RISK WORK project applies a "**goal-oriented risk management approach**" (Figure 1), which determines the **level of risk** mainly as a combination of the hazard, vulnerability, and exposure. Since the hazard (i.e. storm, wildfire, flood and avalanche) is usually not influenceable, activities and measures for risk reduction aim to reduce the vulnerability and exposure (see diagram below). Consequently, the management objective determines the appropriate type of measures for risk reduction. Without a clear management objective, it is hard to identify meaningful activities.

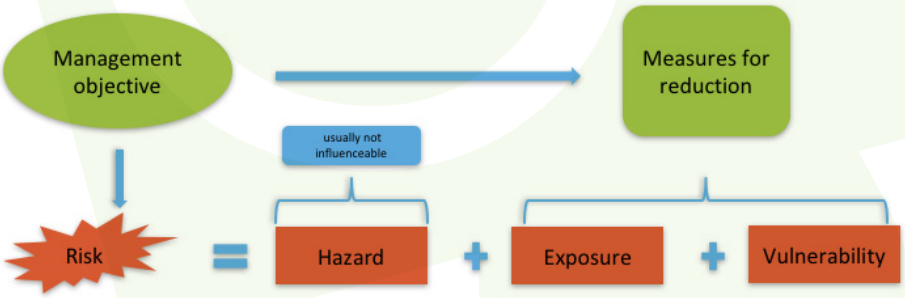

Figure 1. Goal oriented risk management approach.

Hazard: In the present document, hazard is understood as natural hazard. Focus is particularly on forest-related hazards: storm, wildfire, flood and avalanche. A natural hazard is a process or phenomenon that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage. Natural hazard events can be characterized by their magnitude or intensity, speed of onset, duration, and area of extent (UNISDR, 2009).

Exposure: People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses. Measures of exposure can include the number of people or types of assets (e.g. forest resources and services) in an area. These can be combined with the specific vulnerability of the exposed elements to any particular hazard to estimate the quantitative risks associated with that hazard in the area of interest (UNISDR, 2009).

Vulnerability: The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. There are many aspects of vulnerability, arising from various physical, social, economic, and environmental factors. This definition identifies vulnerability as a characteristic of the element of interest (community, system or asset) which is independent of its exposure. However, in common use, the word is often used more broadly to include the element's exposure (UNISDR, 2009).

Risk management is a systematic approach and practice of managing uncertainty to minimize potential harm and loss, as defined by the management objective. The underlying principle is that risk cannot be avoided but needs to be actively addressed and incorporated into management. Understanding factors that influence vulnerability and exposure is a central element of risk assessment.

Risk management cycle: Risk management takes place during different phases and at different levels. The phases are described in the so-called disaster risk management cycle: **prevention - preparedness - response – recovery** (Figure 2, see Chapter 2). Traditionally, there has been the tendency towards measures covering the response and recovery phases, while prevention and preparedness stages have been less considered. This imbalance has been recognized by various initiatives and is addressed at various levels of government.

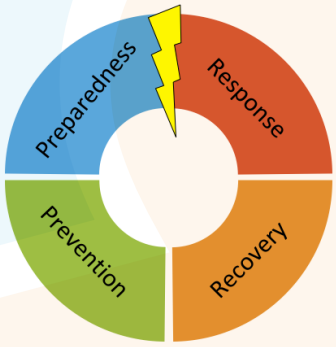

Figure 2. Risk management cycle.

For instance, the Directorate-General for European Civil Protection and Humanitarian Aid Operations (DG ECHO) of the European Commission follows a **disaster prevention framework** and provides services and support for disaster risk reduction. Among its objectives is "sharing of experience and expertise, which will help to further reduce the impacts of hazards in the most efficient and acceptable ways and allow the joining of forces for the challenges ahead" (DG ECHO, 2010a). Developing a European perspective may create significant opportunities of successfully combining resources for the common objective of preventing and mitigating shared risks. Within this context, **guidelines for risk management capability assessment** have been developed (DG ECHO, 2010b). These assist with self-assessment of capabilities for risk assessment, risk management planning, and implementation of risk prevention and preparedness measures.

Chapter 2. Understanding risk components

Predefined by a combination of hazard, exposure and vulnerability, risk mitigation and avoidance actions are diverse in topics (e.g. from biophysical to social vulnerability (Cutter, 1996)), time scale (short, medium and/or long-term effects) or distributed across the corresponding stages of the risk management cycle (i.e. prevention-preparedness-response-recovery).

The multiple facets of risk management can be analysed and organised by a two-dimensional matrix. On one axis the predefined **cross-sectoral components** are indicated, which are common among mitigation measures that determine Disaster Risk Reduction (DRR) strategies. In the second axis, the **stages of the risk management cycle** are depicted. The dimension of **time** is normally inherent to the results of each mitigation activity.

Although no unique framework for **cross-sectoral components of risk management** exists, these can be sorted according to the most common DRR requirements. The NET RISK WORK project has established the following:

- **Risk and vulnerability assessment and mitigation**: comprises the assessment of risk level (e.g. through modelling, mapping or qualitative surveys); identification of underlying causes of the driving hazard, exposure and vulnerability; as well as the corresponding mitigation measures.
- **Cost-effectiveness assessment:** covers the positive effects of risk mitigation measures compared to avoided costs due to the risk reduction.
- **Risk planning, governance and policy framework**: mainstreams the previous two components into preventive risk planning graphics and protocols, while remaining within the corresponding regulations and a public-private multi-actor governance framework for regional/national DRR strategies.
- **Community involvement and risk communication**: refers to actions promoting risk awareness and participation of exposed population in mitigating risk under the general framework of risk culture.
- **Civil protection, emergency and post-disaster management**: considers all actions related to the protection of people, goods and environmental services, and the organisation of the emergency services during the event. Recovery and post-disaster management initiatives are also included as a reaction to a disaster (e.g. from assessment of lessons learned to recovery plans or changes in risk management policies and resources).

The **risk management cycle** is commonly divided into four different phases to manage disasters. The first two applies before the disaster and the other two follow the disaster:

- **Prevention**: includes actions that reduce or eliminate the likelihood or effects of a disaster.
- **Preparedness**: aims at building the needed capacities to efficiently manage emergencies and achieve orderly transitions from the response to a sustained recovery phase.
- **Response**: seeks to contain, control or minimise the impacts of an incident.
- **Recovery**: steps to minimise disruption and recovery time, including the aim of avoiding or reducing future disaster risk.

A holistic understanding of Disaster Risk Management (DRM) addresses all cross-sectoral components and all four phases of the risk management cycle. Consequently, management objectives are defined, and key challenges identified that relate to a hazard, the exposure and the vulnerability, as well as their interactions (e.g. a consolidated risk culture improves emergency management as protocols of confinement or evacuation plans become recognised and they can be trained). Lessons learned based on cross-sectoral components can be potentially transferred to other natural hazards (e.g. previous successful experiences that involve

citizens in flood risk mitigation or integrate flood risk in urban planning can offer an essential foundation in case of wildfires increasingly impacting on the wildland-urban interface). These recommendations can fall under the fields of risk communication or legal framework development, for instance, or they can correspond to different phases of the risk management cycle. Respectively, next to the cross-link assessment, special attention has to be focussed on the effects of various communication vessels for the corresponding phases within the risk management cycle. For instance, scenarios with less exposed and vulnerable elements, less efforts during the response and recovery phases should be required.

Picture 1 and 2. Connecting prevention-preparedness and response capacity.
In the case of wildfire (left), vulnerable roads surrounded by dense fuel cover add difficulties to the emergency management. The lack of forest cover (right) increases avalanche risk and make necessary structural prevention measures. (Author: E. Plana)

This integrative approach is closely aligned with the **Sendai Framework for Disaster Risk Reduction 2015-2030**[1] (Sendai Framework, UNISDR 2015) goal of "Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience" and the corresponding four Priorities for Action (Figure 3):

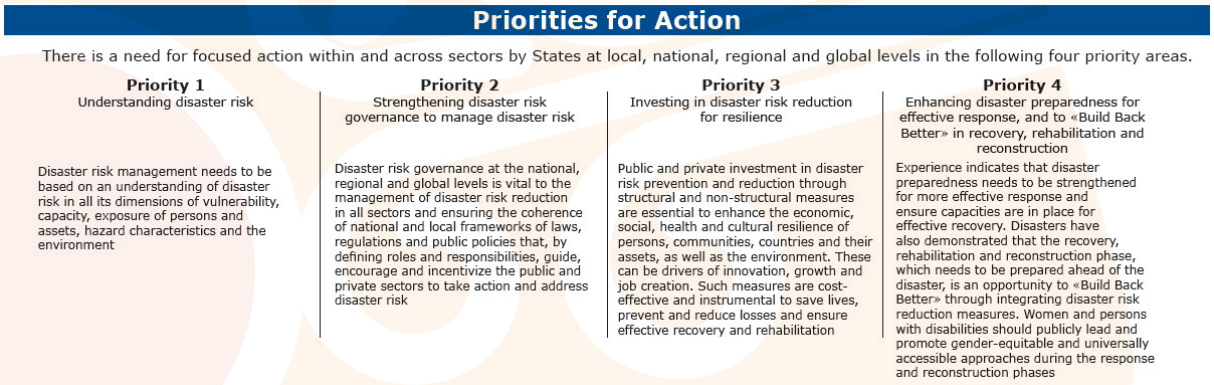

Figure 3. Priorities for Action of Sendai Framework for Disaster Risk Reduction 2015-2030.

1 https://www.unisdr.org/we/coordinate/sendai-framework

On the other hand, the most recent **rescEU** initiative[2] from the European Commission focusses on the prevention-preparedness-response multi-hazard approach that is urgently needed in the European Union and its Member States. It mentions the objective of "Strengthen the focus on prevention action as part of the DRM cycle, as well as reinforce coherence with other key EU policies acting, inter alia, in the field of climate change adaptation, disaster prevention and disaster response."

2 Strengthening EU Disaster Management: RescEU Solidarity with Responsibility. COM (2017) 773 final. https://eur-lex.europa.eu/legal-content/es/TXT/?uri=CELEX:52017DC0773

Chapter 3. Awareness – raising in the theory and practice

The need to raise awareness was one of the most recognized requirements for success in all workshops during the project phase. This is reflected by the IPCC (2011), stating that a lack of risk awareness is an important risk amplifier itself. Yet, in practice there are many barriers to overcome in order to raise awareness for certain risk drivers, especially for climate change related ones. One of these can be described as visibility bias. Gradually changing conditions associated with climate change are largely invisible to the observer. Therefore, natural hazards are often the only windows of opportunity for action, but – as states of emergency - fail to promote systematic approaches to risk mitigation and adaptation. In addition, crisis management is still mostly focused on reactive measures, which are much more visible and therefore communicable to the public than mitigation measures implemented through risk management.

The problem is based on the perception of risk. While easy to define technically as "the combination of the probability of an event and its negative consequences" (UNISDR, 2009), the actual individual and social perception of risk usually differs strongly from this calculating approach. There are many semantic images of risk, such as risk as a pending danger, a personal thrill or even a gamble (Renn, 2008). The same ambiguity applies to risk perception. Aspects like personal or institutional control of a danger, the voluntariness of taking the risk, individual concern, the question if a danger is man-made or its familiarity, all influence the way risks are handled, prevented of fully accepted by individuals or society. Combined with the way risks are communicated, a social amplification or attenuation of a risk (Renn, 2011) can be recognized. Mass media plays an important role in this field. Media influences what is perceived as important, urgent or who is to be considered as an expert. The IPCC (2011) recognizes the importance of mass media by acknowledging their ability to frame the discussion on the risks of climate change.

Awareness-raising in theory

Raising risk awareness is meant to bridge the gap between factual risk level and individual risk perception and is reflected in the concept of social risk perception: "Awareness occurs at the interface between sensory processing and planning" (Koch, 2004). Mostly, a deficit in knowledge is quoted as reason, but research on cognitive dissonance shows that knowledge and action are not necessarily connected.

Information alone cannot raise awareness. The tripartite model of attitude, sometimes referred to as the ABC-model, divides attitude into three separate and not mandatorily correlating components (Stoknes, 2014, Figure 4).

1. Cognition: referring to the knowledge and actual understanding of a phenomenon.
2. Affect: referring to the emotional response to a certain phenomenon.
3. Behaviour: referring to the actual action and the perceived self-efficacy or behavioural control.

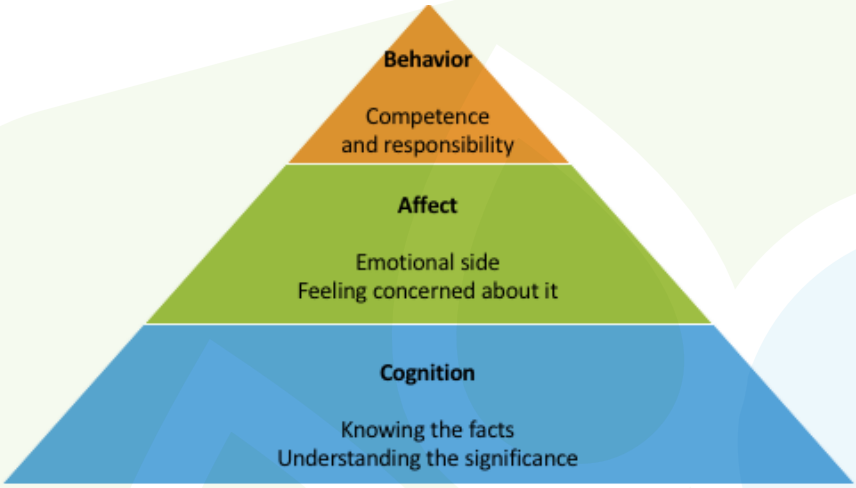

Figure 4. Tripartite model of attitude as requirements for risk awareness.

In order to effectively raise awareness, all of these components need to be addressed sufficiently:

Cognition: Knowledge provision has to fit the necessities of the receiver regarding information density, the choice of the right medium and, especially in the context of climate change, has to be clear about its complexity and the limits of knowledge concerning the future.

Affect: In a professional context, the emotional side of a message is often not addressed directly in risk communication. The concern to involuntary transport manipulating messages can be assumed as reason. Yet, the significance of this component should be addressed. Including personal references and stories helps to associate with the message. Working with groups in which participants can share their experience and addressing their feeling of responsibility can create an environment that promotes this component of attitude.

Behavior: Action can be induced by showing options for behavioral change. Creating incentives and a positive culture of action is the objective for communication measures. First steps are often difficult to take. Therefore, calling attention to no-regret or low-regret strategies with positive effects regardless of the occurrence of a hazard or climate change are helpful beginnings. In addition, emphasizing the recipients' capabilities by showing examples for action, respectively best practices are promising approaches.

Awareness-raising in practice

Altogether, awareness-training requires a deliberate framing of the message (Shanahan, 2007). Pre-existing patterns of understanding need to be matched with the argumentation in order to re-frame the message, or, in other words, trigger a new way of thinking. Concerned people who are worried about the future tend to overemphasize the catastrophic potential of a risk. This concern needs to be addressed and confronted with opportunities for action, such as the aforementioned no-regret strategies. Politicians and the private sectors, on the other hand, can be addressed by emphasizing financial opportunities.

Raising risk awareness in practice needs to embrace all aforementioned components of attitude. Especially when working with practitioners, their professional ethics and identity need to be addressed. Help and education can be perceived as an assault on one's own competence, especially in stressful situations during crises (e.g. after hazards). In these situations, decisions become simple and fast, following routines becomes the default option and a tendency to make legitimate decisions rather than accurate (maybe novel) decisions to save face in front of colleagues or superiors.

This is where the value of bottom-up approaches like networking activities (see Chapter 6) come into play. Professional networks such as communities of practice can enhance risk awareness and improve crisis management by serving as a constant reminder of the value of prevention and, even more important, create a group feeling in which information from expert to expert can easily flow. Typical errors due to stress during crises can be prevented since the access to experts has already been established during normal times.

Awareness-raising in practice therefore is not to be seen as a stand-alone measure but more like a step by step process towards an enhanced risk culture across a whole sector. The project NET RISK WORK contributes to this change with promoting regional nodes under the umbrella of a European Forest Risk Facility (see Chapter 6) which stands for this step by step process in forest management.

Chapter 4. Collecting good forest risks management practices and tools

OBJECTIVE

The management of natural risks and emergency situations is often complex and depends on the experience of the stakeholders and practitioners that are either directly confronted by the risk or required to manage it. Different types of natural hazards happen (e.g. forest fire, flood, avalanche or storm) across Europe allow managers and other key actors to get the chance to learn and validate if management has been done properly. However, in extreme scenarios (very large floods or wildfires for instance), may not happen during one life time in one region, or repeated rarely, making it difficult for managers or land owners to rely solely on their own personal experience. In addition, with the new scenarios of climate change, regions that are not used to certain type of risks will now have to face them with little or no experience (e.g. large forest fires in Central and Northern Europe).

On that sense, NET RISK WORK project develop a specific action to identify the Best Practices (BP) and Operational Tools (OT) for risk assessment and management that are currently or have been examples of success. The action seeks also to confront the approaches from the different risks to understand whether they could be interesting for, or applied to, other types of risks. The novel repository created is aimed to be a dynamic database of good practices and tools for practitioners and managers, and also provides resources for other projects that aim to improve risk management and assessment.

The information provided in this Chapter aims at helping readers and actors interested in collecting good practices and tools to learn about successes and difficulties encountered throughout the collection process that has been developed under the NET RISK WORK project. The next sections explain in detail (1) the methodology developed and the lessons learned during the process of collection the results obtained and (2) other projects that have been identified which aim to collect good practices and tools.

COMPILATION METHODOLOGY

The compilation of BP and OT from different natural risks and actors required defining a clear process of collection in order to be efficient, accurate and useful. Described next are the steps followed to design and collect BP and OT from different natural risks together with the lessons learned during the process.

Steps followed and lessons learned during the process

The objectives defined to design the methodology to collect BP and OT have been reached at the end of the development process that has involved the participation of several actors (partners of NET RISK WORK and external experts) in order to include the lessons learned during that process and achieve a certain level of maturity (see summary in Table 1):

1. **Gather BP and OT from and for the practitioner community**. This would exclude collecting BP and OT that are already collected in scientific papers (e.g. fields studies, validation of research methods).
2. **Develop an efficient template to collect BP and OT**. For this, the development of a standardised template was decided, experiences from previous projects have been considered (i.e. EUFOFINET and FRISK-GO). The template was required to be (1) user friendly, (2) understandable by practitioners, (3) manageable, (4) processable and (5) useful. The template developed includes three sections to describe the BP or OT:

a. Classification.
b. Description and analysis.
c. Additional information.

An example of the template can be downloaded from the NET RISK WORK website.

3. **Provide a general overview of the BP and OT** that exist on different risks (wildfires, storms, floods and avalanches). The format of the template and the information collected should be adequate to be shared online through existing platforms (e.g. *RiskPlatform*, see Chapter 6).
4. **Be able to classify the BP and OT in a simple way,** in order to ease the search for these when needed. The initial classification proposed has followed the priorities of the Sendai Framework.
5. **Carry out tests to validate the methodology**. The NET RISK WORK partners carried out tests and final validation by conducting an initial BP and OT collection.

Table 1. Summary of the methodological approach used.

Objectives	Methodology used to achieve the objective	Motivation and constrains	Alternatives considered
1. Efficient ways to collect existing BP and OT from the practitioner community	Develop a standardised template	-A template that is easy to use for practitioners -Can be available on the website after the project ends -Allow comparison of BP and OT	Collection of BP and OT during face to face meetings
2. Provide a general overview of the BP and OT available in Europe and worldwide		- A form compiles only essential information to avoid being too long and ambiguous -Inter-operability with online platforms	
3. Classification of the BP and OT to be easily searchable in a repository	Split by natural risk, topic, DRM phase, author, domain, etc.	-If too many BP and OT, it will be difficult to find them -Use existing resources to describe classification (e.g. Sendai Framework) -The information to classify needs to be pulled from the information collected in the form	
4. Validation of the methodology	NET RISK WORK partners collect the initial BP and OT	NET RISK WORK partners are experts and have good knowledge of the ongoing practice in their field of expertise	Ask external practitioners for validation[3]

3 The methodology was presented during the 1st risk knowledge exchange workshop of the project (see Section II).

RESULTS

While doing the validation, the NET RISK WORD partners collected interesting BP and OT that are used by them or their networks. A total of 41 cards were collected, the complete version of each card can be downloaded online in the project website.

The main cross-sectoral components of DRR strategies represented in the tools and best practices gathered by the partners are Risk vulnerability and assessment mitigation, Civil protection, emergency and post disaster management, and Community involvement and risk communication. Most of them are applied at local and regional scales (Table 2-6).

Table 2. Best practices and operational tools on Risk and vulnerability assessment and mitigation.

Name	Summary
Avalanche risk vulnerability mapping (Switzerland)	Identification and classification of avalanche risk vulnerability of urban areas and infrastructures according to the avalanche risk intensity (high, medium, mild) related to urban planning. For each zone, a specific regulation applies according to the infrastructure type and its degree of vulnerability.
Forest management by natural risks (France)	Forest management guidelines for black pine (*Pinus uncinata*) forest taking into account the natural hazards (falling rocks, avalanches, landslides, erosion and floods).
ClimateimpactOnline portal	Climate information website that visualizes the changing climate conditions and their impact on land use sectors for different scenarios up to 2100.
Tree species suitability maps	Decision support tool to help forest managers during tree selection for climate adaption.
Fuel clearing legal obligations	Details of the clearing legal obligations near forests and their implementation and control measures.
Operative exchanges to implement fire analyst methodologies	Exchange of lessons learnt, knowledge and methodologies by expert technicians spending at least one month in another fire brigade.
Tactical fire course	The aims at disseminating the advantages of using fire as cost-effective and more efficient tool than other technics; training fire fighters in using fire as fuel reduction tool; implementing prescribed burning programs.
Wildfire activity prediction	Daily evaluation of the probability of fire occurrence and spread rate in a given area due to forecasted weather conditions.

Table 3. Best practices and operational tools on Cost-effectiveness assessment.

Name	Summary
KoNeKKTiW project	Community of Practice for sharing information about education on climate change related to forest risks. It develops activities from presentations and lectures to risk management consulting and online manuals.
Adaptation workbook	It is a structured process considering the potential effects of climate change and design land management and conservation actions that can help prepare for changing conditions. The process is flexible to accommodate a wide variety of geographic locations, ownership types, ecosystems and land uses, management goals, and project sizes.
Goal oriented risk management with the Influence-Change-Exposure method	The method aims to help forest owners or enterprises to assess their risk factors based on their management goals. The method is based on the idea that different management goals require different measures since the vulnerability and exposure of a forest enterprise is dependent on those goals.
Wildfire Investigation in Northern Ireland	Case report of FRISK network sending experienced investigators from 2 countries and to Northern Ireland. to investigate suspected arson fires.
Damage assessments to Enhance cost-benefit Analyses	Methodology for cost-benefit assessment in case of floods and earthquakes.
Storm Handbook – Coping with Storm Damaged Timber	Web based collection of best practices regarding guidelines for coping with storm damaged timber.

Table 4. Best practices and operational tools on Risk planning, governance and policy framework.

Name	Summary
Space-based Information Support for Prevention and Recovery of Forest Fires Emergency in the Mediterranean Area	Space-based end-to-end information services, based on satellite remote sensing data, to support prevention/preparedness and recovery phases of the Forest Fires emergency cycle in the European Mediterranean Region.
Wildfire risk prevention plans	The formulation of a wildfire risk prevention plan allows for a better inclusion of the forest fire risk in the development project of a municipality with the objectives to identify the risk prone areas and raise public awareness; limit the number of fire outbreaks; reduce the vulnerability of people and goods already at risk; prevent new establishments of people, buildings or activities in fire prone areas.
Forest fire weather index forecast and real time fire weather danger monitoring (South France)	Operational oriented meteorological support for forest fires.
Use and classification of the land according to flood risk (Catalonia, NE Spain)	Flood risk zoning and vulnerability cartography. This reference cartography is the frame for establishing urban regulations. Zoning is divided at different risk levels according to the "return period". The possible use and classification of the land according to the different risk zone defined is stated.
Use and classification of the land according to avalanche risk (Andorra)	Official cartography (avalanche risk zoning), to provide delimitation of different levels of hazard, to create a specific regulation for each level (conditions for urban development, establishing technical issues, etc.), and to identify the key actors involved.
WALD-WIKI – Platform for Your Knowledge, Forest and Region	Wiki for private forestry associations that enables them to organize operations and establish a system to compile, generate, share, disseminate and continuously update expertise and empirical knowledge on climate change, crisis management, and transformation in forest ecosystems.
Assessment of biomass availability (municipality of Catalonia, NE Spain)	This assessment is based on accessibility, the growth of the forest mass and the reduction of the fire risk, in order to make a rational and sustainable use that does not endanger the resource and perpetuates it over time.
FRISK Assistance in Slovenia	Case report of supporting Slovenian decision makers in managing the response activities after the ice sleet / snow break. Experiences from two major storm events were shared, and the management of crisis response as well as lessons learned.
Course of webinars for fire risk situation assessment	Periodic webinars as a tool for sharing lessons learnt, and situation of fire risk assessment during fire season among different regions and countries.

Table 5. Best practices and operational tools on Community involvement and risk communication.

Name	Summary
Cultures of Disaster Resilience among children and young people	Create dialogues with youngsters and children through workshops in weekly sessions during school time.
Flood/fire groups – national flood forum (United Kingdom)	The National Flood Forum aims to give support to individuals and communities at risk of flood, to enable people to take control of their own flooding concerns (increasing the social resilience to the flood risk), by helping communities to prepare for flood risk (community involvement and risk awareness), representing people at risk so that decision making accounts of local knowledge, common concerns and grassroots expertise, and working to put flooding issues at the centre of policy making arena.
Building a culture of Civil Protection through schools	Raise public education and awareness regarding the system and the activities of Civil Protection and Disaster Risk Reduction, informing pupils at schools and young citizens and contributing to change attitudes toward risks and the perceptions of risk.
Multiplatform alert system to deliver bulletins of meteorological and hydrogeological risk	Multi-risk alert system framework based on a web page and automatic sending of SMS and emails.
MEFYTU	Fire risk education and awareness program addressed to children, scholars and tea places, to enhance societal risk awareness, improve societal resilience against fire-crisis events, engage teachers and schools to risk awareness actions, foster knowledge.
PCF Clips	Communication campaign on wildfires, based on a set of art videos, to communicate in a friendly way knowledge of wildland fires, and to reach the community in a way that encourages reading and reflection.
Lessons on Fire platform	An online platform which encourages debates, sharing quality information, finding documents in an organized way, finding expert people, and asking a professional opinion about the integration of forest fires risk in the European landscape.

Wildfire risk communication toolkit	A set of communication tools for transferring technical knowledge on forest fires to different target groups (society, journalist and media, community and municipalities, children, youth and teachers) were developed in the framework of eFIRECOM project (see Annex 2).
Forest picture contest raising awareness of forest fires	Forest picture contest corresponding to the fire season dates to raise awareness about the fire-prone period.

Table 6. Best practices and operational tools on Civil protection, emergency and post-disaster management.

Name	Summary
Personal protective equipment for wildfire fighting (testing & standardization)	Recommendations on the best compromise between thermal protection, physical tolerance and ergonomics for wildfire fighting personal protective equipment.
Classification of the risk of forest fires	Definition of hazard and risk indices for the classification of regional and municipal fire risk.
Journal Club Program	They are held on the field "post-fire" with a topic related to a local/regional remarkable event. Guest are invited to actively present their knowledge and open the debate with stakeholders and local communities.
Post-fire platform database	The database gathers information on fire behaviour and effects to the ecosystem of multiple fire events. This information is then available to scientists, land managers, fire analysts, etc. A quality check is performed on the data.
Stodafor Technical Guide on Harvesting and Conservation of Storm Damaged Timber	It describes best practices for first measurements after storm events by providing information on mainly harvesting systems and log conservation.
The use of various types of chemical additives in suppression operations (France)	French national guidelines on the use and procurement of chemical additives in wildfire suppression operations.
The use of tactic fires in France	Presentation of the French approach to tactic fires (training, responsibilities, statistics).
Mobile App Forest Fire prevention (France)	"Prévention incendie" mobile application aims at saving time for forest fires alerts (quicker phone call, better localization, exchange of data) and providing basic advice to people confronted with forest fire.
The Regional List of Voluntary organizations	Process to register association in the Civil Protection system.

OTHER PROJECTS THAT COLLECT BEST PRACTICES

Other European projects collect best practices and operational tools in the area of DRR and forests, similar to the approach developed in NET RISK WORK, in particular:

CATALYST
CUIDAR
EDUCEN
eFIRECOM
ENHANCE
EUFOFINET
FIRE-IN
FLIRE
FLOODSITE
FRISK-GO
IN-PREP
MATRIX
NAIAD
PLACARD
PLURIFOR
SURE

Annex 2 provides more detailed information on all the projects.

To find more information see:
Report on tools and best practices on risk planning and management for wildfires, storms, floods and avalanches. NET RISK WORK project. Deliverable 4
http://netriskwork.ctfc.cat/wp-content/uploads/2018/05/Deliv-4_ActionB1_V1-29may2018.pdf

Chapter 5. Assessing forest risk impacts and interactions

SINGLE RISK AND RISKS INTERACTIONS ASSESSMENT

Why?

To assess the complex and changing risk situation in European forests across different natural hazards (i.e. wildfires, storms, avalanches and floods) the development of a novel risk assessment approach was required. The intention was to allow analysing and comparing risks independent of scale and location, as well as detecting any existing and novel risk interactions. For this reason, the developed risk assessment method had to remain at a rather general level, which also ensured the comparability across different types of risk and natural hazards.

How?

As identified in Chapter 1, risk is largely related to predefined management objectives. Consequently, all natural and human influences have to be considered in the light of the expected management outcomes. This perspective allows a general overview on the risk situation caused by different hazards and ensures comparability across various types of risk. Since hazards themselves are usually not influenceable, measures for risk reduction aim to reduce the vulnerability and exposure of the elements. Understanding the underlying factors that influence vulnerability and exposure is therefore crucial for successful risk management.

What?

Based on this premise, a harmonized risk assessment methodology has been developed. The so-called single risk assessments are conducted for each type of forest hazard (i.e. wildfires, storms, avalanches and floods) and management objective (i.e. income, nature conservation, protection, recreation). The goal is to identify natural and human factors and measures that influence vulnerability and exposure. Depending on the management objective, a factor can have positive and negative effects, or both.

The risk interaction sheets build on the previously filled single-risk assessments and detect already present and potentially new factors that emerge from the interaction of two hazards. Consequently, this allows the identification of new types of risk and the understanding of the interlinking relationship of risks.

An example of the templates used are available in Annex 3. Project website collect the assessment undertaken during the project.

Development / Filling

Starting from a rough idea, to the development of draft sheets, over several steps of testing and further refinement, a proper methodology to assess multi-hazard risk interaction could be developed. Next to the risk assessment templates, a guideline describing how to complete the sheets, as well as an annotated example was produced (all files can be downloaded from the project website). This facilitated the completion process. At first, the risk assessment sheets were completed only by the project partners, collaboratively reviewed and further refined. At a later stage, the concept was presented to a wider audience of experts during the 2nd risk knowledge exchange workshop in Cagliari, Sardinia (minutes available in the project website). Several experts showed interest in applying the method to their own work.

Difficulties / limitations

As the developed method was entirely new, naturally some initial difficulties arose during the development process. In the beginning, the scope of the assessment remained unclear and had to be discussed. Additionally, completing the sheets was a delicate balance between being specific enough to be able to identify driving factors and remaining as general as possible to allow drawing some common conclusions. With the definition of a "case" as combination of management objective and type of hazard, this could be clarified. Another challenge was to achieve a similar level of quality for the completed sheets. Depending on the thematic background of the partner organizations, the extent and level of detail for assessment sheets varied greatly. A collaborative review process clarified common misunderstandings and could solve this problem. Finally, the planned analysis of the assessments could not be conducted as originally planned, due to the lack of time and an appropriate method to synthesize the findings. However, a basic analysis and reflection on risk interactions was achieved.

Outlook / Potential

Clearly, the single risk and risk interaction assessment remains a rather abstract exercise. However, it can serve practitioners and managers of forest enterprises as a useful tool to assess their individual level of risk from an outside perspective and to identify the underlying factors and potential measures that influence the forest-related risk. The results of the assessment can facilitate further risk management activities, such as risk planning and implementation of mitigation activities. A suggestion for a potential improvement of the method is the prioritization of factors and measures, which would identify the most influential ones.

RESULTS

During the course of the project, 23 single risk assessments and 26 risk interaction assessments were completed. Each of them constitutes a stand-alone risk assessment for a particular scenario, a so-called "case" that is established by the combination of natural hazard and management objectives for a specific geographical context. In each, factors and measures that influence vulnerability and exposure were detected, which, when addressed pro-actively in risk management, help to mitigate the overall risk level.

The key findings of a basic analysis of the assessment sheets are presented in Box 5 of Chapter 12.

Chapter 6. Sharing knowledge and providing network

DESCRIBING NEEDS AND ADVANTAGES OF NETWORKING AND LESSONS LEARNED APPROACH

Global change sets new requirements for cooperation and knowledge transfer. In the context of climate change and its effect on hazards (i.e. increase of severity and frequency), a closer cooperation between state administrations, research institutions, as well as the private sector become more and more important. Especially across national borders, this cooperation requires informal structures beyond administrative hierarchies, yet they need their support. Networks therefore mostly form around a certain topic or common objective to reach, often out of the scientific community, but also more and more frequently directly from practice.

The concept of **communities of practice**, introduced by Lave and Wenger (1991) is the most recognized to implement the aforementioned needs. Communities of practice are groups of people who share a common concern or a passion for something they do and learn how to do it better through regular interaction. It is based on "an anthropological perspective that examines how adults learn through everyday social practices rather than focusing on environments that are intentionally designed to support learning" (Gray, 2004). Therefore, they differ from other communities in the following characteristics: First, they focus on a domain of shared interests. Second, they interact and learn together. Third, they develop a shared collection of experiences, stories, best practices etc.

Those communities of practice often develop on their own without even recognizing that they fit the criteria. But more and more communities form consciously and, with a supporting structure, recognize the necessity of different levels of participation and responsibility from a core group to active participants on the periphery. Although these communities are not without hierarchies, as informal groups they establish horizontal links mostly with other experts, sectors, regions, networks etc. It is shown that these informal structures are more likely to enhance learning processes than institutional structures based on top-down rule-based institutions (Benson et al., 2016).

Indicators of functioning networks have been analysed in several studies (e.g. Wenger, 1998; Lee-Kelley et al., 2014), but can mostly be summarized by the following three properties:

1. The development of a group identity based on mutual interests and respect.
2. The awareness of the knowledge of others based on the recognition of different fields of expertise and contribution potential.
3. A rapid information flow inside the group based on the aforementioned properties and the willingness to participate.

Based on these findings, running networks develop organically and are based on a shared domain of interest. They can still be initiated and supported by authorities by providing experts and professionals the opportunity of cooperation beyond traditional structures and to financially support networking initiatives such as sources of new ideas, knowledge and best practices.

Currently in Europe there are many existing communities of practitioners in natural disasters and risk management. For instance, they can be defined by geographic location, where links are established due to similar landscape characteristics, level of risk, language and culture. These communities are sometimes united by common needs, for example, fire-fighting services in different countries.

Those networks of practitioners have identified the need to connect the existing networks of knowledge in the

field of natural disasters. Recently, this need has also been identified by several European institutions. Those institutions have provided the means and tools to take a collaborative and coordinative approach that helps linking networks that apparently have little or no bonds. Also, the Priorities of the Sendai Framework promote cooperation between emergency actors in order to face the current and upcoming challenges on emergency prevention and preparedness.

Picture 3. Lessons learned exchange after a fire helps to develop risk community.
Journal Clubs organised by Pau Costa Foundation together with the Fire Service and other risk managers and stakeholders. (Author: E. Plana)

The knowledge belonging to a network or community is often in the form of publications in regional languages, management tools, regional or national events, etc. However, in the past 10 years, many initiatives have identified the expertise and knowledge belonging to those communities and have tried to bring them into larger communities and networks with the purpose of sharing knowledge among a larger number of users in different risks (e.g. FRISK-GO project, NET RISK WORK project, Wales and England Wildfire Forum, FIRE-IN project).

STRUCTURAL COMPONENTS OF RUNNING NETWORKS

Networks are an **alternative organizational structure** of hierarchies. They are joined voluntarily, and are connected, not to a reporting structure, but to peers. Networks are the connections that allow peers to work together. They do this by helping members voluntarily shed some of their autonomy – just enough to be able to successfully work with others.

In true partnerships, the relationship between partners is definitely not a reporting relationship where one controls the other. It is much more complicated and nuanced than that. The same is true for partnerships between two or more independent organisations. It is also important to note that if a third party were to impose on the collaboration, the connection between 'partners' would not be voluntary, and they would not be acting autonomously. In networks, there is **no external controlling force**.

It takes a lot of work to make such partnerships work. The NET RISK WORK project, supporting the establishment of the European Forest Risk Facility (see next sub-Chapter) and its network of nodes could collect lessons and experiences in this regard.

Clear communication is key, and, it is absolutely necessary to maintain healthy relationships. In this project it was realized that foresters and Civil Protection specialists are in most cases not natural communicators nor is there a specific training curriculum for it. Improving communication skills is therefore one relevant result of this project.

One of the key things discovered about networks is that it is not just about the partners, but about the relationship between them. In network theory, this is illustrated by a line connecting the dots (or "nodes") in the network graph. That line is the connection, or relationship, between partners. The relationship is the "net" that supports "work" in the network. Investing in that relationship results in work. Not investing in this skill and "art" means the ability to coordinate work deteriorates.

In networks, authority is distributed and agreed to voluntarily. There is no centralized power with final say over what does and does not happen or with the power to enforce compliance by network members. Power makes relationships work within a hierarchy. "I do what you say, ultimately, because I report to you". In a network of peers there is no "reporting" to any partner. Still, networks can be extremely productive and influential. In the NET RISK WORK project, the most important ingredients for productive networking were collected and described as follows:

- **Perspective and Vision**

"People don´t want to cooperate to build a wall, people want to cooperate to build a cathedral[4]."

This quote is expressing the importance of vision and direction. It also reflects that a network needs an objective and mission that is greater than each single member. Furthermore, it is of paramount importance that the network members and partners share and understand the motivation, the "WHY".

An aspect of social sciences is the need and desire of human beings to "belong". An in-depth analysis of this anthropological phenomenon was, however, not part of the NET RISK WORK project.

In terms of developing the trustful relationships in a network, three development stages could be identified, all of them equally important and time consuming. The first two steps lead to trust. This is a long process and the result is fragile and needs attention by all network members to be maintained.

- It is needed to:
  1. KNOW each other,
  2. LIKE each other,
  3. TRUST each other.

- **Trust**

Cooperation and mutual aid work better than competition and rugged individualism. With trust, we do things for each other, look out for each other and sacrifice for each other.

"Trust is like lubrication for a network. It reduces friction and creates conditions much more conducive to performance" (Sinek, 2014).

If there were no trust, then no one in an organization or network would take risks. Taking risks, and the assurance that also failure is a lesson, is important to try new ways, new thinking. Taking risks will bring an organization or network forward, which in return creates growth and development.

Not taking risks would mean no advancement of the vision as a whole. That is an interesting concept: only when individuals can trust the culture of an organization will they take personal risks in order to advance that culture and network as a whole.

It is a matter of biology and anthropology more than natural hazards and risk management. If certain conditions are met and the people inside a network feel safe among each other, they will work together to **achieve things none of them could have ever achieved alone.**

4 https://startwithwhy.com/inspire-your-audience/how-great-teams-pull-together

Box 1. Trust, collaboration and networking between flowers and bees.

Strange as it might seem, nature is full of examples of networks of trusted autonomous actors, working collaboratively with one another. Bees, for example" work" with flowers. Bees get pollen from the collaboration and flowers get fertilized. Bees and flowers are independent, autonomous agents. No one forces them to work this way with each other, but they do so anyway out of mutual self-interest. To say that flowers "trust" bees sounds almost as far-fetched as saying that bees trust flowers, but if it is looks at it with a certain perspective, they actually do.

Vulnerability is a key aspect of trust. When the bee relies on a flower for its supply of pollen, it becomes vulnerable. Continuing to remain open to collaborating in the face of this vulnerability requires trust – even if doesn't look like the kind of trust that humans normally understand. The same thing is true for a partnership between two organisations, when one supplies a critical component to the other's process, for example. In this sense, **trust is remaining open in the face of vulnerability**.

Trust helps organizations connect in an analogous way. Organizations that trust each other can safely set aside formal agreements and rigid processes and replace them with lighter weight ways of working together. They make it easier for their employees to coordinate with partner employees. In short, organizations that trust one another lower their barriers and shed a little piece of their autonomy in order to work more effectively within the network.

The network members must safeguard trust to ensure that autonomy is not abused in a network. Participants in a network voluntarily shed a bit of their autonomy in order to collaborate with other independent actors. When they do this, their openness exposes them to potential abuse. This vulnerability is one of the things that makes networks efficient, resilient and flexible. Vulnerability is a hallmark of a living network; it is what connects autonomous peers in productive relationships.

For networks to thrive, this vulnerability must be honoured and protected at all costs. Trust is the way this is done, and it is the important ingredient or "magic bullet" of living networks.

This is an important point:

- It cannot *tell* people to trust one or others.
- It cannot *instruct* people to come up with great ideas.
- It cannot *demand* that people cooperate.

Feeling safe and trusted is a result in itself. Network members then naturally share ideas, share intelligence and stress. Every single skill and strength are then amplified to perform better and advance the network's interest vastly more effectively.

- **Mutual respect**

Mutual respect is the bilateral flow of respect that opens people to new connections in a network. It is not based on what one person has, but on who they are. Networks address people by name, not title. When the respect to others is equal, and peer, it is keeping the door open to connecting with others in a way that maximizes the creative potential of our work together. When mutual respect is enshrined as a *core operating principle* of a network that connects people, all members and partners operate knowing that how they treat each other does not depend upon the circumstances of our birth or life experiences.

Mutual respect makes it easier for new connections to happen. Mutual respect keeps people open to finding talent and character where otherwise they might not. By fostering the potential to *connect*, mutual respect helps ensure opportunity for all.

There are many practices that the NET RISK WORK project identified that can help strengthen mutual respect in a network. Professional facilitation techniques are an excellent starting place and can be very helpful in catalysing a culture of mutual respect in a network. It is also critically important that the network develop a kind of 'immune response' to quickly and visibly root out breaches in its accepted principles. This is particularly true when it comes to breaches in respect and trust.

Summary points

- ✓ Trust builds living networks that are highly resilient, flexible and efficient.
- ✓ Networks are voluntary connections between autonomous peers.
- ✓ Networks are the connections that allow peers to work together.
- ✓ In networks, there is no external controlling force.
- ✓ The relationship is the "net" that supports "work" in the network.
- ✓ Trust is the lubricant that supports relationships and makes a network work.
- ✓ "Trust" is remaining open in the face of vulnerability.
- ✓ When mutual respect is enshrined as a core principle of the network, it is easier to make new connections happen.
- ✓ Safeguard trust to ensure that autonomy is not abused in a network.

"A movement only exists when people are inspired to move,
to do something, to take up the cause as their own."

DESCRIPTION OF THE EUROPEAN WILDFIRE RISK NODE AND THE *RISKPLATFORM* TOOL

Background and European Forest Risk Facility

From pests and insect damages to megafires and storm events, European forests are affected by diverse and often transnational disturbances, with profound impacts on forest ecosystem services and livelihoods. In response to these challenges the European Forest Institute (EFI) together with risk management stakeholders from all over Europe is establishing the **European Forest Risk Facility**, an innovative platform of exchange and knowledge transfer on forest disturbances, risk prevention and management. (Box 2) Connecting science, practice and policy, is one of the main objectives of the vision: "Resilient Landscapes – Adapted Communities – Adequate Response". The Risk Facility collects and distributes data and information for a better understanding of forest risks and facilitates the exchange of good practices, ultimately enabling better-informed decisions in natural resource management and policy.

The idea of creating a European Forest Risk Facility originated already back in 2011. This initiative led to the FRISK-GO project (www.friskgo.org) in which the basic elements for a Forest Risk Facility were developed. Following the 'connect-collect-exchange' principle, the project team and collaborators implemented a number of case studies, expert exchanges, training events, workshops, and delivered mutual support. The further development and establishment of a European Forest Risk Facility has been supported by NET RISK WORK project targeting the development and formation of regional and thematic network nodes and focal points, as the **European Wildfire Risk Node**.

For all the above functions, comprehensive, easy to understand and user-friendly communication and information exchange tools, as the *RiskPlatform*, are needed.

Box 2. Features and objectives of the European Forest Risk Facility.

The European Forest Risk Facility represents a networking platform and acts as an unbiased and neutral player for facilitating cooperation and exchange between existing communities that address or are affected by disturbances and risks to European forests. It, thus, needs a defined complementary role and an added value for the risk community:

- A European Forest Risk Facility represents a networking platform giving emphasis towards integrating disturbances into management in order to make forests and forest landscapes more resilient.
- A European Forest Risk Facility supports identifying needs and capacities amongst different domains, actors and stakeholders while stimulating cross-boundary exchange of knowledge and expertise on forest risks.
- A European Forest Risk Facility takes the role of an honest broker, stimulating collaboration at the interface between science, policy and operational management (science - policy – practice interaction).
- A European Forest Risk Facility mobilizes specialists and expert networks to provide the needed guidance and capacities where required or requested.
- A European Forest Risk Facility contributes to gathering and organizing comprehensive and up-to-date information related to damage and threats to forests, identifies gaps and communicates those to all relevant actors.
- A European Forest Risk Facility stimulates and supports the collection of lessons learned and good practice guidance as an essential input to stimulate further research, monitoring and management activities towards improved and adapted mitigation and provide for their communication. The availability of a permanent structure constitutes a basic requirement for providing continuity, organizational memory and for enabling trust - building with and amongst actors.
- A European Forest Risk Facility facilitates cooperation and exchange as an unbiased and neutral platform between existing communities that address or are affected by disturbances and risks to European forests.

Description of the European Wildfire Risk Node

The European Wildfire Risk Node (EWRN) has the purpose to become a network of networks; link the existing formal and informal networks and communities of practitioners that own the expert knowledge on wildfire risk. With this aim, the EWRN would strengthen and facilitate the optimal functioning of the existing networks and provide the services required to increase the functionalities and capabilities on the frame of forest fires.

The main objectives of the EWRN are:

- Lead an open and pro-active platform across networks.
- Definition of transversal standards of competences and capacities.
- Compilation of best practices, management tools, publications and other materials.
- Identification of expertise, definition of 'who is who' based on the competences and capacities.
- Create opportunities for the Exchange of Experts (EoE).
- Provide a global overview of outputs from projects developed within the different networks. Provide framework to adapt outputs to different European realities.
- Provide tools and necessary means to share experiences and lessons learned.
- Centralise all the needs and requests of the wildfire risk networks and transfer them to Pan-European institutions to influence governance and policy-makers on fire risk management (e.g. European Forest Risk Facility).
- Foster interaction of the wildfire risk networks with other natural risks (floods, storms, avalanches, plagues, pest, etc.).
- Provide tools to foster interaction between researchers and practitioners.

A node that is mainly dedicated to wildfire risk shall aim to interact with networks (or nodes) on other risks (e.g. floods, storms, avalanches). The interaction shall be promoted at a node scale, with the help of the European Forest Risk Facility, to facilitate knowledge and links with the networks when required.

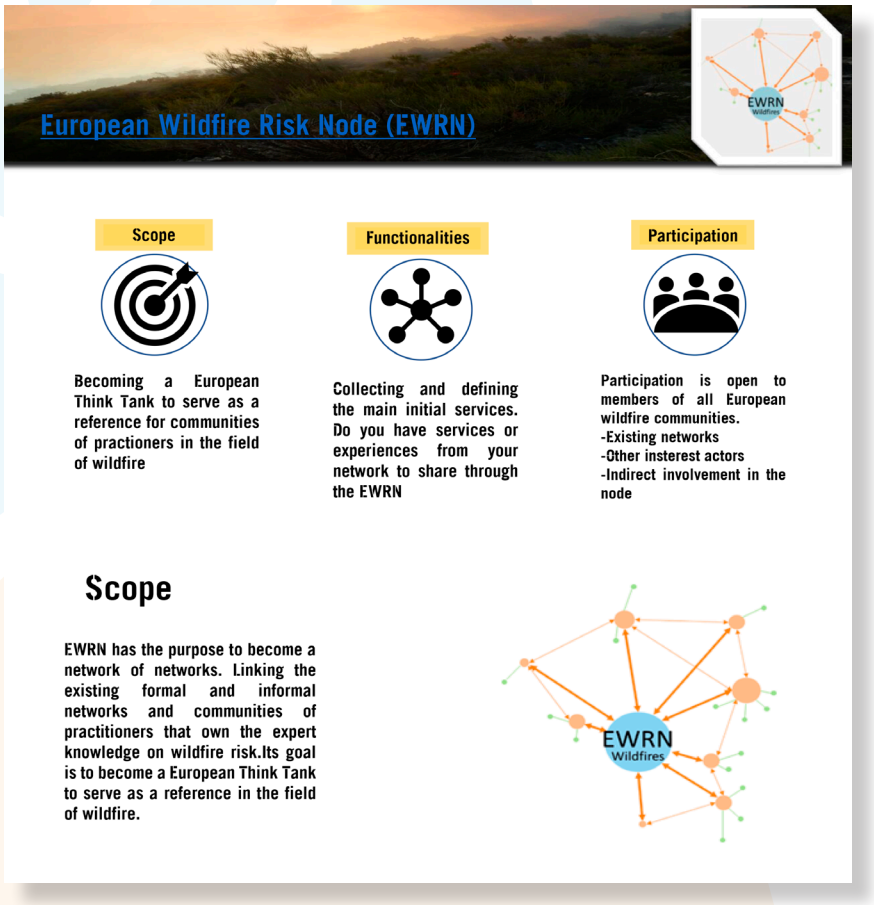

Figure 5. Screenshot of the European Wildfire Risk Node webpage.

The *RiskPlatform*: the tool

The *RiskPlatform* is a virtual communication tool for the European Forest Risk community (Figure 6). It aims to connect practitioners, academia and public stakeholders and initiates the discussion of risk-related topics and the exchange of best practices. Furthermore, members of the network can share documents, information on recent publications and events in a multidirectional way.

It is a web-based and mobile application tool to "connect-collect-exchange" within the vision of the European Forest Risk Facility: increase the resilience of European forests and related landscapes towards future global change impacts, promote prevention and intelligent risk and crisis management.

On the *RiskPlatform,* users can describe their professional profile and expertise. They can upload useful so called "use cases" (case studies, videos, reports, articles, statements, interviews, pictures or *www* links to other sources of information...) of forest risk management and mitigation from various regions and disturbances.

The use cases can be "tagged" with key words to make orientation and added value of the cases useful. Users can link and discuss with other users and share knowledge and expertise from scientific literature to operational practical information and information on training and capacity building needs. Assistance and support can be facilitated easier when actors / users have mutual relationships and know each other at least via the *RiskPlatform*. The Exchange of Experts (EoE Forest), a valuable tool of the Risk Facility, can be planned, documented and applied for using the *RiskPlatform*.

The platform should develop into a one-stop-shop hub where all landscape risk and disturbance information can be found or accessed, not only for academic users but for all risk managers.

It can be used on a computer and a smartphone or tablet to make it user-friendly and applicable for every day. All regional Risk Facility nodes as well as the Risk Facility secretariat are available to assist users and to feed information into the platform.

The *RiskPlatform* is online and functional. The URL *https://www.riskplatform.org* was secured during the NET RISK WORK project and a prototype platform tool was developed and tested by the project partners and the wider forest risk network. During this process a number of mistakes, dysfunctionalities and technical changes were adapted and modified, so that by September 2018 the project has delivered a functional and operational tool.

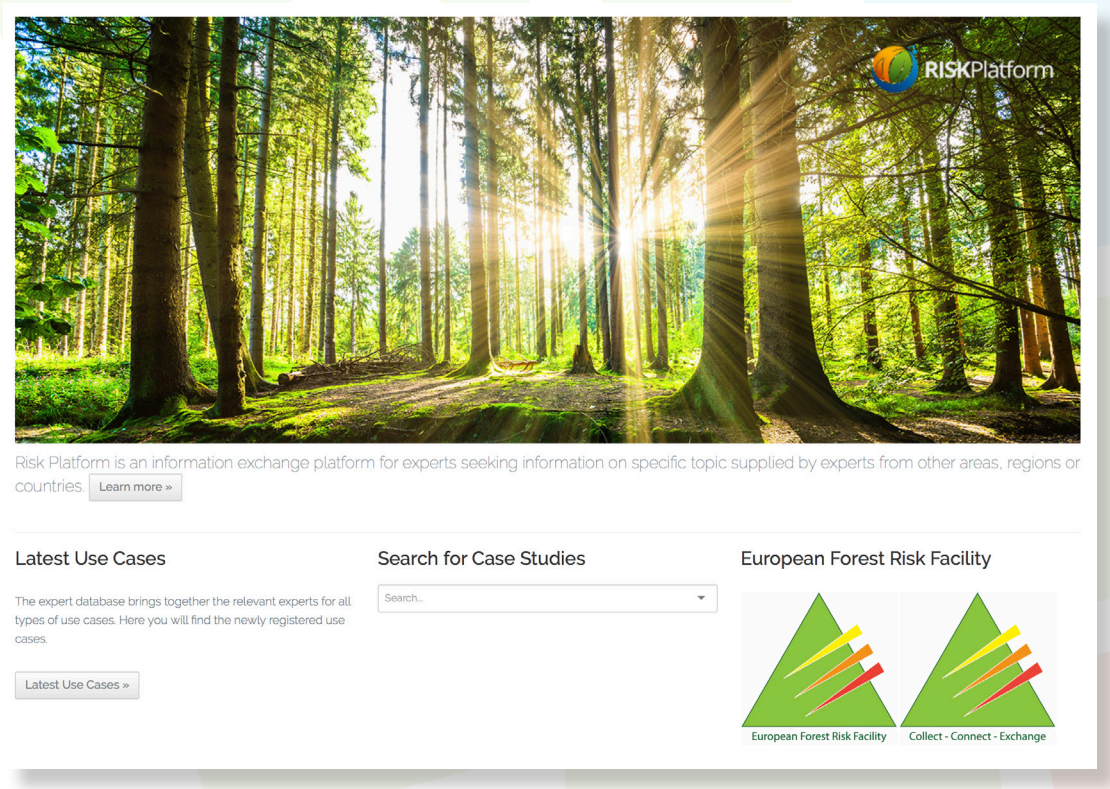

Figure 6. Screenshot of the *RiskPlatform* webpage.

So far, the *RiskPlatform* has been used by project partners and network members and a total number of over 31 use cases have been uploaded.

Further, all the users have direct contact access to each other and are virtually connected.

The *RiskPlatform* has evolved during the project duration towards a user-friendly tool and it cooperates also with other platforms, i.e. the *LessonsOnFire* platform of the FIREfficient project[5].

A communication and information exchange tool, even if it is technically sound and stable, is only as good as the users that use it. It has no own energy or motivation; it creates both only through active users. It is a challenge in the modern world to attract enough users to a new tool to create “critical mass” from which the number of users is a self-organising process.

5 http://firefficient.ctfc.cat/, http://lessonsonfire.eu/

How to attract active users? Firstly, the tool must be user-friendly and self-explaining. It should run on all devices, desktop and mobile and also have an offline function.

Secondly, it must provide inspiring content. The use cases must be relevant also for other users, scientifically sound and easy to understand and digest. Only if users feel immediate benefit of a "membership" or the use of this new tool they will use it and spread its use.

During the NET RISK WORK project, the numbers of registered users have been increased, but have not reached the above mentioned "critical mass" where the system becomes self-organising. It remains a task for the project and project partners as well as the wider network around the Forest Risk Facility to promote the tool and its use.

To find more information see:
Recommendations and experiences for enhancing cooperation and networking in risk management. NET RISK WORK project. Deliverable 10
http://netriskwork.ctfc.cat/docs/Deliv.n10&11_Recommendations_and_experiences_for_enhancing_cooperation_and_networking_in_risk_management.pdf

Chapter 7. Forest risk management requirements from Civil Protection system perspective

The changing context of risk and the increasing impact of hazards on life, properties and ecosystems

During the project workshops it has been stated that high uncertainty still exists with regards the effects of climate change in disturbances regimes. Nevertheless, for instance in Mediterranean areas, climate change seems to be acting as a wildfire risk multiplier (heatwaves, drought, etc.) which combined with demographic and ecological changes increase sever wildfires endangering residents' lives and the ecosystem. On the other hand, there is evidence of fire regimes shifting across Europe due to climate change.

These new scenarios in terms of Disaster Risk Reduction can entail new Civil Protection challenges by itself. The emergency services (Fire Services, Civil Protection system) in areas with little occurrence of large and complex forest fires in Central and Northern Europe, are not prepared to deal with wildfires that have never been experienced. This suggest the need for closer interaction between Fire Services from across Europe to learn from each other.

This extreme or unusual events beyond the "normal" patterns are normally understood as extraordinary and with low probability to be repeated. Nevertheless, in case of an event, social demands in terms of security and protection are the same, adding high pressure to Civil Protection and emergency services, up to political levels. Based on the risk assessment and the Early Warning, Civil Protection system can act pre-emptively.

Therefore, understanding of the natural risk jointly with an appropriate risk prevention strategy have several implications for the Civil Protection system in the response phase. For instance, emergency services will be able to carry out a safer deployment, reduce the uncertainty and increase the likelihood of success in protecting people, infrastructures and forests if the landscape is "prepared" for the potential (known and expected) impact of natural hazards on it.

Based on legal regulations, those responsible for Civil Protection are called upon to protect human lives, property and infrastructure. Under climate change conditions they have institutional responsibility to be transparent with citizens about the limits of risk reduction. Civil Protection system should provide people with tools, resources and experiences enhancing community engagement to create a more risk resilient future (UNISDR, 2018).

Picture 4. Building resilience starting with young people. (Author: C. Visani)

In this sense, a set of measures can be implemented as: create a risk register and hazard maps (planning measures), set up and operate measuring points and Early Warning services (organizational measures), develop and maintain protective structures and facilities (technical measures), and promote the protection function of forests (biological measures). It should be in the interest of Civil Protection system to keep the protection function of forests. It is also essential to identify activities aimed at enhancing the awareness of risks through information, training and education especially starting from the young, using efficient methodologies promoting self-protection and prevention measures.

The protection function of forests as a core element of Civil Protection system

Traditionally, forests were a source of resources, and management practices were common, in order to obtain renewable resources, meanwhile, providing protection services against natural hazards (e.g. avalanches, floods or wildfires prevention). With the abandonment of forest management, the protection function decreases, and new hazards arise, e.g. large wildfires in dense and continuous wooded landscape or avalanches in an unmanaged unstable forest stand. In parallel with the abandonment, recreational use has increased, becoming predominant. This has extended to Mediterranean forests for instance, which do not yet have appropriate management in place to keep citizens safe.

Therefore, in order to reduce the risk of natural hazards, management programs and actions addressed to promote healthy forests must be integrated into forest management and it should be understood as core elements of the Civil Protection policies. A sustainable forests management mobilising wood and biomass, the regulated cultural use of fire, the increase of forest diversity with native and broadleaved species, the control and eradication of invasive alien species, the reintroduction of wild herbivores and domestic grazing for certain environments or the creation of discontinuity in the forest and ecosystem mosaics, are actions that can enhance forest landscapes' resilience towards natural hazards and their protection function.

Recently, more attention is focussed on the role that bio-economy can play mitigating climate change and preventing risks (Martinez de Arano et al., 2018, M.R. Mosquera-Losadaa et al., 2018). Changes in land and forest management aimed at enhancing their protection function can be achieved through active land management. For instance, creating and improving the income and employment that the Mediterranean agro-forestry-pastoral resources can generate, will keep local populations and communities in the areas; interest, knowledge, care and cultural identity towards its territory are the best deterrents to the development of large forest fires and to the minimization of the danger of the safety of people.

Picture 5. Silvopasture management in the Mediterranean, providing forest structures resistant to wildfires.
(Author: E. Plana)

Although socio-environmental services are an intrinsic component of forests, maintaining forest functionality has a cost. Thus, a paradigm shift will be necessary, which sets priorities according to social values and implies socialization of risks management (from "protecting everything" towards "protect the crucial"). The guiding question could be "what value does society place on this landscape, what is it to preserve and why"? More and more, protection of citizens and goods should be a strong criterion for risk planning and management, providing the necessary resources to ensure protection function of forests.

Reinforcing the participation of exposed population in risk reduction

Although, traditionally, risk emergency and Civil Protection has been exclusively managed by public actors, in the face of new risk scenarios, individual responsibility and participation in managing it should not be overshadowed by administrations and agencies, and rights and duties should be clarified according to each situation. On the contrary, new vulnerability situations posed by climate or land use change should not be transferred only to individuals (homeowners in this case). Nevertheless, there is a need to empower citizenship in self-protection and prevention capacities.

Normally, by means of top down approaches Civil Protection agencies are transferring knowledge and tools to individuals, in order to implement the culture of risk among vulnerable communities. Everyone can play a role in creating adapted communities (grouping forest owners, land planners, residents and emergency services) improving risk safety. The adaptation/mitigation is an ongoing process and building resilient communities is a holistic approach to help communities be safe.

Therefore, participatory processes should be integrated into Civil Protection plans as a fundamental element for promoting the corresponding awareness and initiative based on own risk mitigation responsibility. The core of the process is local cooperation, planning activities and coordinated actions to lay out effective and shared strategies designed to evolve for co-managing risks.

Improving operational capacities can be strengthened by means of an increased community awareness, a collaborative synergy of all involved stakeholders and an effective dissemination of Civil Protection culture diffusion of adequate behaviour in case of emergency. Approaches, based on the real skills and resources of the territory, together with an increased awareness of the community, will produce, as a result, increased self-protection capacity and social resilience.

The use of innovative technologies, for instance, has improved the definition of multi-disciplinary scenarios and response plans, providing integrated assets to support emergency management, such as monitoring, modelling, situation and risk assessment, decision support and communication tools. Advances in technology (such as drones) and social media can lead to a more effective disaster risk information and assessment and an increased public awareness. However, technology can make things worse in the long run, because they can untie people from the reality.

Cost-benefit assessments can be valid tools to show there is the need for planning and raising awareness and preparedness. Cost-benefit analysis is, in fact, a good way of convincing people, since the risk culture is more developed when property comes into play.

In the medium and long-term, social processes aiming to reconnect populations to the natural environment and to develop consciousness, knowledge and concern, need to be encouraged and promoted.

Reviewing risk governance, planning and management

Since interaction of forests and society is increasing (urbanisation close to forests areas and infrastructures, increase of recreational uses, etc.), the potential of natural hazards impacting on citizens increases as well as the requirements for the Civil Protection system. In this sense, the active role of urban and spatial planning to reduce exposure and vulnerability becomes more and more necessary.

In parallel, risk planning should integrate, not only the existing risks, but consider the upcoming ones in climate and land use change scenarios. New disturbance regimes can overcome existing prevention measures giving a false sense of security, or let new areas become exposed to previously non-existent and unknown

risks. Efforts dealing with physical vulnerability should run together with initiatives promoting an updated risk culture, in the social vulnerability sphere.

Therefore, risk management agencies should include all actors related to the process of risk building and mitigation, from prevention to preparedness and response stages, including public and private ones.

Picture 6. Wildland-urban interface affected by a high-intensity forest fire in the region of Cagliari (Sardinia), field visit of the 2nd Workshop.
The lack of a specific urban planning with wildfire protection measures and emergency management facilities, increases the citizen's vulnerability. (Author: M. Serra)

On the other hand, successful emergency collaboration protocols at local-regional-national and cross-border levels should be extended to the risk analysis and planning phases, especially looking at the root causes of the risk up to the prevention stage. Since n*atural hazards* evolve across Europe, risk management needs more cooperation at all administrative levels, nationally and internationally, for data sharing and homogeneous risk assessment, as well as mapping procedures based on geographic limits instead of administrative boundaries.

The inertia of the legislative process can be a constraint on developing risk management, as, by the time the law or regulation comes into force and are implemented, new solutions can arise, and the addressed issue might already be outdated. The rhythm of risk appearance and development is different from the political/ legislative rhythm, as, the response to upcoming challenge in case of new risks or risk interactions is to change the legislation according to the new scenarios. These legislative changes are necessary to adapt the response and emergency capacity to real situations/scenarios.

After an event, the focus tends to be on getting new plans and funding, but rarely on developing more integrative processes. This can be related to the "political cycle", highlighting a preference for short-term actions with visible results, as well as structural measures being favoured instead of non-structural measures. Funding needs also to be allocated to "invisible measures", assuming the medium-long time-scale terms of the results of the mitigation measures of forest risks.

Communicating risk under uncertain scenarios

Providing adequate information to citizens in relation to the different risk levels present in a specific territory, in order to facilitate and reinforce they awareness, is a fundamental issue. In fact, people do not know enough about risks and need to be trained regarding self-protection measures and self -protection assistance. Prevention actions and communication about risks are not deemed sufficient, and it is difficult to manage a crisis situation if citizens do not know what to do. The objective is not to convince: the priority should rather be on education and collective learning instead of an only-one-direction communication. It is necessary to work on awareness, avoiding top-down processes, with a paradigm shift from a top-down to a bottom-up approach and from authority to responsibility. People have to be part of the process to feel acknowledged; they have to trust in the actions they can do by themselves.

On that sense, it is important to be open about the consequences of uncertainty of risk planning, communicating to the people that risk occurrence estimation is based on probability, and therefore it is not possible to eliminate uncertainty. Forecasts are one thing; the operational aspects of the plan are another thing. If there is an alert and nothing happens, decision makers can be the object of many protests. This requires effective and honest communication between decision makers and the general public where the nature of the decisions and the strengths (and weaknesses) of the risk information are transparent and understood by all. It is necessary to act on the three levels of awareness to create such momentum: cognition, affect, and behaviour (Figure 4). As risk will never disappear completely, the introduction of the "acceptable risk" concept, which indicates the risk that people collectively and individually are willing to accept, is needed. There is no single simple recipe for communication and collaboration; alliance with the media has to be found (journalists should be trained about the communication of risk, e.g. through workshops).

Another important issue is to not over-inform people, as risk communication has to be clear, precise and understandable. Different narratives and frames are needed according to the target audience. Information needs to fit people's priorities. Being credible, inspired and confident are core elements of risk communication and awareness. Once again, local institutions or familiar actors can help to make the message more effective in changing attitudes.

SECTION II.

ADDRESSING MAIN CHALLENGES OF FOREST RISKS MANAGEMENT IN THE CONTEXT OF CLIMATE CHANGE ACROSS EUROPE; WILDFIRES, STORMS, AVALANCHES, FLOODS AND THEIR INTERACTIONS

Background

This Section summarises the assessment and case studies developed during the project for each single forest risk (Chapters 8-11) and their interactions (Chapter 12). Described is a general review of the current situation and the tendencies of wildfires, storms, avalanches and floods in a context of climate change and the corresponding risk management achievements and challenges with a special emphasis on Civil Protection issues.

The contents of this Section include the results from the networking and knowledge exchange activities organised throughout the project. Two initial meetings about methodological issues plus two international lessons learned exchange Workshops were held, mobilising around 100 experts from 36 intitutions of 12 different European countries of different disciplines and fields of expertise on forest risks assessment and management.

- **Kick-off meeting** (Barcelona, February 8-9th 2017): A two days Kick-off meeting started planning and discussing the methodological frame for a common multi-risk assessment, taking into account the need to harmonise definitions, approaches and methods across different forest risks, and within the different stages of the Disaster Risk Management cycle to undertake an integrated prevention-preparedness-response and cross-sectoral approach.
- **Risk information pre-assessment meeting** (Freiburg, May 8-11th 2017): Field visits and presentations were combined with the objective of, firstly, organising the review and exchange of existing knowledge for each risk studied, secondly, to set up the templates for the single risk and risk interaction assessments, and, finally, to share the basics of running networks and regional nodes under the European Forest Risk Facility frame. External experts on forest risk management and Civil Protection were invited.

Picture 7, 8, 9 and 10. Risk information pre-assessment meeting.
The meeting was organised by Forest Research Institute of Baden-Württemberg (FVA) and two field visits to the Flood. Prediction Office (HVZ) in Karlsruhe and about storm effects in the black forest where included.
(Authors: DGPCRAS, E. Plana, FVA)

- **1st Workshop on Natural Hazard Risk Management: Managing forest risks towards disaster reduction: the case of wildfires, storms, avalanches and floods** (Solsona, 4-6th October 2017): The workshop provided a meeting and discussion space on experts' knowledge to: (1) identify the main risks' management and reduction strategies challenges in a climate change context, (2) explore how different risks are interacting and what can be used from lessons learned between regions and other risks' best practices and operational tools, (3) highlight the fundamentals for facing an inclusive risk cycle management under the Civil Protection objectives, and (4) promote networking and knowledge exchange on different natural hazards at European level. In this workshop, cross-sectoral components of Disaster Risk Reduction strategies of risk assessment, risk planning and cost-effectiveness where discussed. Representatives from networking projects (PLACARD, PLURIFOR and FIRE-IN) at European level were invited. A total of 45 experts represented 10 different European countries, coming from Switzerland, Andorra, Germany, France, Lithuania, Bulgaria, United Kingdom, the Netherlands, Italy and Spain.

Picture 11, 12, 13 and 14. 1st Workshop on Natural Hazard Risk Management.
The meeting was held in Forest Science and Technology Centre of Catalonia facilities. Field visits about challenges of sustainable forest management and wildfire risk mitigation in the Mediterranean were included. (Authors: M. Serra, A. Clemenceau, E. Plana, C. Bellera)

- **2nd Workshop on Natural Hazard Risk Management: Emergency management and risk governance towards resilience societies** (Cagliari, 10-13th April 2018): The workshop gave continuity to the 1st workshop, providing a meeting and discussion space for expert knowledge about cross-sectoral components: emergency management, community involvement, risk communication and policy development topics, following the specific objectives from the previous workshop. A total of 40 experts representing Switzerland, Germany, France, Denmark, Portugal, the UK, The Netherlands, Italy, and Spain were mobilised.

Picture 15, 16, 17 and 18. 2nd Workshop on Natural Hazard Risk Management.
The meeting was organised by the Civil Protection General Directorate of Autonomous Region of Sardinia. Participants visited a flood area and the Emergency centre. (Authors: E. Plana, A. Clemenceau, DGPCRAS)

The agenda, presentations, list of participants and proceedings of the meetings and Workshops are all available on the project website.

An extended version of the results of the assessments are included in a specific report available online: "Report on transverse risk assessment on wildfires, storms, floods and avalanches and crosslink interactions in a climate change context" (Deliverable 6 of the NET RISK WORK project, see below).

Contents of this Section are not intended to conform to a scientific document. Scientific facts that are mentioned have been described based on experiences and knowledge of all experts involved throughout the exchanges.

To find more information see:

Minutes of the Risk information pre-assessment meeting. NET RISK WORK project. Deliverable 5
http://netriskwork.ctfc.cat/docs/Deliverable5_Minutes_Meeting_Freiburg_END.pdf

Proceeds of 1st Natural Hazard Risk Management Workshop. NET RISK WORK project. Deliverable 8
http://netriskwork.ctfc.cat/wp-content/uploads/2018/03/NET_RISK_WORK_Deliv_n8_Proceeds_1workshop_natural_hazards_risk_management_CTFC.pdf

Proceeds of 2nd Natural Hazard Risk Management Workshop. NET RISK WORK project. Deliverable 9
http://netriskwork.ctfc.cat/wp-content/uploads/2018/07/Proceeds_2Workshop_Cagliari_2018_final.pdf

Report on transverse risk assessment on wildfires, storms, floods and avalanches and crosslink interactions in a climate change context. NET RISK WORK project. Deliverable 6
http://netriskwork.ctfc.cat/docs/Deliv.n6&7_report_tranverse_risk_assessment_wildfires_storms_floods_avalanches_and_crosslink_interactions_in_climate_change_context.pdf

Chapter 8. Wildfires

GENERAL REVIEW AND TENDENCIES IN THE CONTEXT OF CLIMATE CHANGE

The combination of climate change together with land use changes from socioeconomic scenarios, such as rural depopulation, increases wildfire risk due to the combination of more intensive heat waves and drought jointly with an increase of fuel biomass from land abandonment. Therefore, an increase of fire severity and intensity, and an enlargement of territories affected by fires as well as of wildfire risk season (occurring extreme events out of common periods) are expected across Europe. New disturbance regimes can jeopardize existing mitigation measures and protocols or let new areas become exposed to previously non-existent and unknown wildfire risk.

Under this evolving risk context, fire suppression system has to deal with unprecedented fire behaviours that "overcome" suppression capacity compromising the emergency management capability. Since the potential of wildfires impacting on citizens and urban areas increases, response stage becomes more critical and complex, requiring extra efforts and updated resources, training and protocols to ensure Civil Protection, both in fire-prone areas as in new regions under risk.

Consequently, within global change context, acting without modifying fuel load distribution, fire severity and intensity will keep at high levels, and "megafires" as were seen in Portugal, Chile, Canada and USA in 2017 will still running. This makes wildfire risk management, as complementary to fire suppression and defensive prevention measures, a matter of forest and land management - not allowing reach continuous and dense forests' landscapes - as well as spatial planning issue - reducing the fire exposure of urban areas and infrastructures (Plana et al., 2015).

Picture 19 and 20. Different strategies to prevent wildfires.
Left, defensive fuel breaks around the road, without decreasing the vulnerability of the forest to high-intensity fire. Right, resilient open forest stand, self-resistant to wildfires. (Author: E. Plana)

Beyond physical changes of structural factors, wildfire risk under climate change influence will also have important implications on the social sphere. In terms of risk culture, either because the increasing exposed population to unrecorded extreme events even in traditional fire-prone areas, or because they are facing a new unknown phenomenon; e.g. wildfire risk in alpine regions. In both cases, population will have to deal with uncertainty on how to act and react in the face of the event. Consequently, efforts in risk awareness and communication are becoming the cornerstone of Disaster Risk Reduction (DRR) practices related to wildfire risk. In particular, with special attention when promoting responsible behaviours into risky areas aiming to reduce fire ignitions, enhancing public awareness on prevention and self-protection measures implementation around endangered property into wildland-urban interface areas, as well as ensuring a safety reaction during a crisis in terms of confinement or evacuation.

In summary, this changing risk context makes necessary to update risk management protocols, from prevention to preparedness and response phases. Without reducing the level of vulnerability of the forest landscape to burnt in high intensity, preparedness and response actions has to be able to deal with the impact of sever events into urban areas, and to react accordingly.

With regards to wildfires and other natural hazards interactions, a major concern on risk cascade effects is related to the loss of the existing forest cover -especially in the case of forest with protection function which prevent snow avalanches, flash floods, landslides and rock falls risks among others- making necessary to joint multi-risks assessment protocols at once, aiming to manage, adapt and perform forest resilience to the new risk scenarios (see Box 4, Chapter 10).

RISK MANAGEMENT ACHIEVEMENTS AND CHALLENGES

Achievements

Together with the first fire theory models (e.g. estimating surface fire's spread models) and daily fire risk assessment, recently have appears the fire patterns concept, which assumes that in similar conditions of terrain and weather we can expect similar fire behaviour, being more or less intense according to the present vegetation type (Costa et al., 2011). The approach allows for better estimates of landscape exposure and vulnerability, and address cost-efficiency assessment of mitigation measures, including different landscape pattern and climate change scenarios.

From a cost-effectiveness approach, when investing more in prevention and preparedness, less efforts on response are necessary. Social and political recognition about the need to modify fuel loads at landscape level to tackle wildfire hazard, is enhancing the role of bioeconomy into wildfire risk management strategies, linking the consumption of local products (such as firewood, or derivatives of extensive livestock farming) to wildfire prevention.

Moreover, potential wildfire impacts on forest functionality (e.g. protection forest against avalanches in mountain areas, landscape provision in tourist areas or water provision in wooded watersheds) should motivate environmental services beneficiaries to ensure healthy forest conservation. Economic sectors mobilising citizens into forest lands (such as touristic resorts in many coastal areas along the Mediterranean) should be aware of preventing risk, ensuring protection of people and having emergency plans ready.

Into national/regional wildfire risk management strategies, root causes of wildfire risks are normally well identified. It describes separately ignition and spread risks, and includes mitigation measures at prevention, preparedness and responses stages. The approach based on fuel management at landscape level is increasingly common across fire prone regions. Current strategies should allow integrate increasing risk

scenarios and to assume cross-sectoral wildfire risk management through coordinating forest and agricultural policies or spatial and urban planning with wildfire prevention and suppression services under multi-agencies governance models.

Recurrence of wildfire events helps media to evolve narrative towards the root causes of wildfires, including the natural role of fire in the ecosystem and prescribed fire as a tool for fuel and wildfires management. Having environmental groups involved in the same message makes it stronger and credible. As far as forest fires are recognised as one of the most environmental problems perceived by citizens, a better social understanding of the phenomenon helps to move from "zero risk" to "living with wildfire risk" scenarios and consequently, the need for reducing both individual and collective vulnerability and exposure to risk. Since wildfires are increasingly affecting urban areas, risk culture becomes more relevant in highlighting the importance of strategic communication into DRR strategies.

The evolving level of risk is posing the need for improving an efficiency response by means of reducing vulnerability and exposure, into an integrated prevention-preparedness and response approach, as is stated in RescEU initiative. Emergency management protocols are being updated, with special attention to civilians' safety evacuations and confinements. Once wildfire risk is being extended across Europe, emergency collaboration protocols at local-regional-national and cross-border levels are being implemented. At international level, cooperation procedures to facilitate the exchange of human and technical resources to face severe events are being developed into Civil Protection Mechanism of the European Commission.

Recovery and post-disaster stages offers a chance to exchange lessons learned and improving risk management taking advantage of the political commitment. As far as more consensus exist on the necessary updates of the DRR strategies among sciences-stakeholders and practitioners, more easily they will be mainstreamed to the political system.

Challenges

As far as fuel accumulation is directly related with fire intensity, large wildfire risk is highly human-influenced according the landscape pattern. Consequently, wildfire risk assessment and planning should integrate prevention and response capacity together as communication vessels (reducing the hazard of extreme fire behaviours through less fuel management efforts in suppression should be necessary). In most areas with high exposure and vulnerability, prevention, preparedness and response actions should run simultaneously, demanding huge amount of resources temporarily.

On that sense, since wildfire are impacting on urban areas, effective integration of wildfire risk into spatial planning - as it is already done with other natural hazards such as floods or avalanches – becomes totally necessary, updating when necessary the legal frame and planning procedures adapting risk assessment to land planning requirements. Mitigation measures should be balanced with the level of exposure according to potential fire severity in the area, far from applying common rules in all situations that in many specific circumstances can be inefficient or even unnecessary and are time and resource consuming.

Therefore, risk management strategies must be based on a good understanding of the functioning of wildfire risks, putting the attention on the underlying factors of the "hazard build-up process" under cross-sectoral, short-medium-long term perspective able to connect the socioeconomic and land use patterns trends generating-mitigating hazard. Risk assessment and planning process through participatory approaches can be used to involve local communities on understanding the risks situation they have, giving them a role within DRR strategies. Moreover, knowledge capitalization platforms and exchange across Europe should help to face forthcoming wildfire risk challenges derived from climate change.

Picture 21 and 22. Landscaping wildfire risk, from linear to creative design.
A fruitful collaboration with the International Master in Landscape Architecture of University of Barcelona is offering challenging opportunities with regards the integration of mitigation measures into land planning (left). A conventional preventive infrastructure against wildfires in the wildland urban interface (right).
(Author: E. Plana and Source: Google maps)

From financial point of view, visualisation of trade-offs between efforts on prevention-preparedness-response and recovery, and avoided costs, should help decision making processes, overall about long term prevention actions. Wooded lands with a proper fuel distribution can play a "wildfire protection" function and could be legally recognised as has been done with protection forests against rock falls or avalanches. Insurances sector can play a role motivating social awareness and own responsibility in managing risk according the individual level of exposure and vulnerability.

In terms of risk governance, since wildfire risk management requires cross-sectoral approaches, multi-agencies bodies extending the traditional wildfire risk managers community to all the actors related with prevention-preparedness-response stages should facilitate integrated approaches. Upcoming levels of risks and new risks interactions under climate and land use change scenarios should be considered. In many cases, reinforcing legal frame to facilitate prevention measures implementation will be necessary.

Regarding risk culture, success dealing with low-medium intensity fires reinforce the perception that all wildfires can be controlled, motivating a false sense of security based on the "technological myth". Threshold of mitigated risk and risk level which are not able to be reduced even with all available resources should be precisely defined and communicated to exposed populations. "Responsible citizen" concept, i.e. in the active role of supporting wildfire prevention or being prepared to face emergency could support public policies. "Temporary" exposed communities; i.e. visitors and holiday tourists, add concrete difficulties that will need specific measures. All in all, new vulnerability situations posed by climate or land use change should not be transferred exclusively and directly to individuals (i.e. as far as urban planning has co-participated to exposed housing model in wildland urban areas). Empowering citizenship in self-protection and prevention capacities and responsibilities, transferring knowledge and tools to individuals and promoting education versus prohibition approaches (e.g. access regulation in forest massifs due to fire risk) should accelerate societal engagement to DRR strategies.

Response and emergency capacity should be updated to upcoming risks scenarios. Training protocols of self-protection and emergency management (safe confinement or evacuation) and strong collaboration with local administrations with more close contact with local inhabitants, can help to better management of the emergency. Special attention has to be done on citizens' mobilisation in case of wildfire, regulating the transit to avoid entrapments. Prior identification and preparation of safety routes for evacuation or safety place

for confinement could improve emergency management as, in extreme fire behaviours events, fire spread velocity can overcome formal decision-making process.

Climate change impacts will bring new wildfire behaviour and frequencies in areas that are not use to deal with. As such, the interaction between the Fire Services from across Europe should be promoted intensively in order to learn the best practices and lessons learnt from other national/regional Services.

Box 3. Challenges integrating wildfire risk into spatial planning.

Natural hazards are acting as "land managers" since spatial and urban planning must assume the corresponding corrective measures or even the incompatibility of urban development in high-risk areas. Therefore, landscape should be managed under the influence of natural risks, e.g. do not building in the river beds is easily assumed once the risk is clearly perceived.

For an effective integration of natural hazards into spatial planning, it is absolutely necessary to deal with all the components of the risk (i.e. hazard, exposure, vulnerability and response capability), understanding how risk management actions interact as communication vessels (e.g. reducing the vulnerability of exposed elements to fire impact, less efforts defending them will be necessary). Therefore, joint actions must be taken in order to, ideally first, reduce the hazard (not always possible dealing with natural risks as storms), avoid the exposition of goods and services by proper planning, reduce the vulnerability of exposed elements and, increase response capability accordingly the level of risk.

To face the cross-sectoral dimension of natural risks management, spatial planning is presented as a discipline capable to address transverse approaches since how settlements, infrastructures and no urban areas interact and the classification and qualification of "what goes where" are among its competences. Nevertheless, still nowadays spatial planning not fully integrate willfire risk management, among other reasons, because it does not have the necessary information and/or tools to be able to plan or implement the mitigation actions.

In Catalonia, for example, the current legislation foresees protecting goods and services against natural hazards, having the operational capacity to do it (and, therefore, to establish more specific regulations) as long as the required analysis information for spatial planning is available (Figure 7).

Figure 7. Example of transportable flood risk information to spatial planning .
(Source: Catalan Water Agency)

What can spatial planning contribute in the management of wildfire risk?

First, about the hazard of fire ignition, spatial planning can influence the location of infrastructures, land uses and activities in determined places with the aim of avoiding putting risk elements in vulnerable sites. For instance, a road, train line or electric lines crossing wooded land at high risk could have extra prevention measures. Additionally, a changing perspective where infrastructures are not only risk generators but also elements that can help mitigate this risk could be easy develop into spatial planning. For example, constructive measures in the roads to use them as possible extinction, evacuation or even safety confinement infrastructures could be foreseen.

Secondly, about exposure and vulnerability, interact between wooded lands and urban areas could be properly planned, e.g. integrating the maintenance of crop lands as natural fire breaks or the active fuels management in the surrounding areas of sprawl urbanism to reduce the likelihood of high-intensity fires impacting on it, into wildfires prevention policies.

Thirdly, with regards to the response stage, special attention should be paid to the protection of populations exposed to risk. Having safety evacuation and confinement sites pre-defined, will make easier to include them into land planning and to improve the response capacity. Land and their infrastructures have to be planned to be able to cope with the impact of wildfires.

In order to make these capacities effective, it is crucial that spatial planning has the necessary information to analyse and determine the compatibility of land uses and regimes (urbanizable, non urbanizable, urban) with the wildfire risk.

As in most fire services or fire prevention units, detailed information about wildfire risk is available. Normally, this information responds to specific operational needs of prevention and suppression. However, the necessary tools (descriptive and operational) adapted to spatial planning competences and procedures are lacking. In addition, some of the wildfire risk assessment outcomes (i.e. cartography or plans) do not have legal status or are not officially recognised, which hinders their integration into the planning.

Also, wildfire risk has the difficulty of being delimited in a territory as in the case of floods (reference flooding areas and return periods concepts, Figure.7). Two factors influence the random distribution of fires: (1) the locations of ignitions is highly influenced by human behaviour, and (2) the spread capacity of fires is according to the availability of fuels. The combination of both factors makes it difficult to define the statistical probability in a specific site. However, it is possible to predict how the fire will behave, and therefore, the level of potential fire exposure and vulnerability of the territory can be estimated.

Regulations applicable to spatial planning stating that "it is forbidden to urbanize and build [...] in risky areas"[6] should be applied to all natural hazards officially recognized as risks in Catalonia. Nevertheless, from the moment that specific delimitation of these "risky areas" cannot be figured out, or this information lacks legality, the capability of planning the territory, taking into account this risk, is limited.

Thus, it is important to bear in mind that wildfire risk management needs a transverse approach to face the interaction of different sectoral policies (fire prevention and extinction, forestry and rural development, urban planning, Civil Protection, etc.), distributed among different administrative units and involving many actors, both public and private. This cross-sectoral management is complex in itself. In this aspect, spatial planning discipline deals with a diversity of actors and administrative units. Its hierarchy, competences and scales of work offer an effective foundation to integrate risk analysis at different territorial levels, since it is deployed from the regional to the local level, considering the level of detail needed for each case. The planning process also deals with different sectoral policies to broaden its analytical base managing the territory taking into account its different components. Therefore, spatial planning is well positioned to deal with the necessary transverse approach of wildfire risk management.

Source: The contents of this Box are based on a research topic from Forest Policy and Risk Governance department of CTFC, dealing with wildfire risk governance and planning. More details can be found in the MSc thesis *SERRA, M., 2016.La integració del risc d'incendis forestals en el planejament territorial i urbanístic de Catalunya: anàlisi de la situació i propostes de millora. Treball Final de Màster en Plans i Polítiques per a la Ciutat, l'Ambient i el Paisatge (2014-2016), Universitat Autònoma de Barcelona* (only available in Catalan).

6 Article 9 of Urbanism Law of Catalonia (2010).

Chapter 9. Storms

GENERAL REVIEW AND TENDENCIES IN THE CONTEXT OF CLIMATE CHANGE

Windstorms are a major disturbance factor for European forests. They originate from strong extratropical cyclones and most commonly occur in the autumn and winter months across the continent of Europe. The month with the most windstorms is January. On average, there are 4.6 windstorms per season.

The occurrence of windstorms cannot be prevented, and their spatial distribution and intensity cannot be influenced. While the cycle of recurrence at a single location is long, the damages of major windstorm events affect large areas and can have disastrous environmental, economic, and social impacts. The disaster statistics of the European Forest Institute (EFI) attribute windstorms a 10%-share of overall forest related disasters, while these account for 75% of damaged timber volume. These high quantities of damaged timber volume have major implications for the forestry sector and downstream industries.

In a climate change context, the occurrence of storms is very likely to increase in frequency and severity across Europe. Projected changes in extreme wind speeds are indicated to rise in Central and Northern Europe, while slightly declining over the Mediterranean region. This is likely due to a poleward shift of midlatitude storm tracks. Consequently, areas that were previously untouched by severe windstorms will have to face this risk.

Additionally, there is an increase in the occurrence of local extreme weather events, such as heavy precipitation, hail storms, and tornados. However, compared to the impact of winter storms, the potential threat of these events for forests is substantially smaller. Nevertheless, the local devastation of these types of new weather events makes them worth to be considered. In the following, we concentrate on heavy winter storms as these are most relevant for the forestry sector.

Picture 23. Wind breakages of trees after tornado in the Black Forest. (Author: C. Leutner)

The potential impacts of a storm event can be categorized in two groups: first, there is an immediate threat for human lives, objects, and infrastructure from falling trees during, or shortly after the storm event. This hazard is directly emerging from the forest. Second, there are long-term damages, notably from losses in timber value, as well as clean-up and recovery costs. In order to prevent damages, and better manage those that cannot be prevented, it is important to address storm hazard proactively and prior to the event. Therefore, efforts should be focussed on the preparedness and prevention phases within the risk management cycle to effectively mitigate impacts and avoid damage.

Picture 24. Uprooted rootplate after storm.
(Author: T. Weidner)

Picture 25. Uprooted trees after storm.
(Author: C. Leutner)

RISK MANAGEMENT ACHIEVEMENTS AND CHALLENGES

Achievements

The main achievement within the project is certainly the creation of a platform to connect experts for different types of forest-related risks across Europe. Within the project several tools and best practices have been identified and developed to directly or indirectly address storm risk for a specific area. As a first step, conducting a risk assessment provides the necessary information of the particular risk situation. Subsequently, this enables taking active risk management decisions for risk planning and to successfully implement mitigation and prevention measures.

An innovative risk assessment approach is the "Goal oriented risk management with the ICE (Influence-Change-Exposure) method" (Figure 1), which has been developed by the Forest Research Institute (FVA) in Germany. The method is centred around the idea that different management goals require different types of measures. The overall risk is formed by the three risk components: hazard, vulnerability, and exposure. With this method, forest owners and enterprises can assess their individual risk factors, based on individual management goals and priorities. The ICE method served as an underlying principle of the risk interaction assessment (Chapter 5), which has been developed within the NET RISK WORK project.

In a second step, risk planning integrates risk management into a forest enterprise's management and planning. Risk planning proactively addresses storm risk and increase the overall preparedness. Adapting management goals to the identified risk situation can also be a way of reducing risk.

Tree species suitability maps are a decision support tool to help forest managers selecting tree species adapted to future climatic conditions. These maps have been developed for the German federal state of Baden-Württemberg and indicate the suitability of four tree species (i.e. Norway spruce, European beech,

sessile oak, and silver fir) in a future climate scenario (IPCC scenario B2). Selecting site- and climate-adapted tree species helps to reduce the storm risk and is an effective mitigation strategy. Being able to identify changes in future growth conditions today, helps to prevent hazards and mitigate risk in the future.

However, risk planning also needs to take place at a governance and policy level to set the necessary framework and provide security for the state of uncertainty. Following a major storm event, such measures can include direct subsidies or tax reductions for affected forest owners to cover short-term losses. In the long-term, this can be setting up funds and research projects that identify underlying drivers of risk and develop risk management strategies for the affected sector.

In a third step, identified mitigation and prevention activities are implemented. At the stand- and forest level, the overall forest resistance and resilience can be increased. Long-term silvicultural measures, such as forest conversion towards mixed forests with site-adapted tree species (e.g. identified by tree suitability maps) have proven useful to increase forest resistance to storms, while short-term technical preventions have shown to be ineffective. Addressing storm risk at the enterprise and policy level is an even more effective risk reduction strategy, as it sets the necessary framework and provides security for a general state of uncertainty. Coming up with clear procedures, such as a preliminary operation plan for the emergency case, increases the overall resilience of the enterprise. Risk awareness among local authorities and government bodies can help to generate sufficient external support to affected forest enterprises and facilitate recovery. Following a major storm event, such measures can include direct subsidies or tax reductions for affected forest owners to cover short-term losses. In the long-term, this can be setting up funds and research projects that identify underlying drivers of risk and develop risk management strategies for the affected sector.

Furthermore, the analysis of past storm events offers valuable insights in the occurrence of storm damage. This has helped to improve storm risk management and to develop measures and methods that can help to mitigate future storm damage. Sharing and exchanging this knowledge is crucial. The recently established European Forest Risk Facility fulfils this task through its principles: connect-collect-exchange.

In the course of the project, several Exchange of Experts on risk management in general and storm risk specifically took place. A successful case of cooperation connected to storm risk, has been the European Forest Risk Facility assistance following an ice sleet / snow break event in 2014 in Slovenia. German experts provided their experience in the management of crisis response.

Challenges

Addressing storm risk faces difficulties, as the hazard itself, in particular, its return period, the potentially affected area and location, and its intensity, cannot be influenced and is highly variable. The rare appearance of catastrophic windstorm events makes it difficult to create constant awareness about this natural hazard and to establish a social risk culture among forest owners and citizens. Regularly, following a storm event, premature actions aiming at overcoming the most visible effects as soon as possible, causes injuries and casualties among forest workers and private forest owners. Training of forest workers in felling techniques for storm damaged timber, as well as establishing standardized professional certificates, ensures that only well-trained personnel conducts the highly dangerous work. Consulting external experts and investing in proper planning and professional disaster management, can prevent common mistakes and ultimately avoid casualties and injuries. Good connection to local media and news, as well as prefabricated emergency messages and texts on the dangers during and following the storm event, help to communicate fast and effectively during the crisis.

Often the response and recovery phases receive most public attention and resources. The hazard has happened, the devastation is visible and immediate action to respond and recover from such a shocking

event is started. However, and in particular in case of storm damage, most of the damage occurred within forest stands, away from urban centres and therefore not visible and of interest for most of the public. The full extent of the damage usually only becomes visible a few weeks after the event. This poses challenges of affected landowners to receive financial support. Additionally, there are long-term damages from losses in timber value, as well as clean-up and recovery costs. Generally, the public awareness for storm risk as an immanent natural hazard gradually decreases over the years following a storm event.

Picture 26. Storm damaged trees.
(Author: C. Leutner)

Picture 27. Cleared and replanted area one year later.
(Author: C. Leutner)

Natural hazards do not stop at a country's border. Therefore, cross border exchange and international collaboration on risk management need to be fostered. However, national legislations and different administrative responsibilities may hinder this development.

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Chapter 10. Avalanches

GENERAL REVIEW AND TENDENCIES IN THE CONTEXT OF CLIMATE CHANGE

The winter of 1950/51, with its unprecedented avalanche casualties and losses, in the Alpine space is generally seen as the catalyst when avalanche risk management started in a coordinated and planned way. Subsequent winters with heavy snowfall and high numbers of avalanche incidents were further milestones in this development. Switzerland and Austria are by far the leading nations in Central Europe in the field of avalanche risk management and related research. In this project it is, therefore used Switzerland and Austria as references and, also, because both countries are open to share their expertise and lessons learned. All information collected, exchanged and analysed during the lifespan of the project, is freely available.

Regarding to avalanche risk management, a good example for other natural hazards like fire, windstorms and flooding was found. The different development stages of avalanche risk management, the related research, the lessons learned and conclusions drawn can serve as use cases for other natural hazards. Interestingly, in avalanche risk management, elements of the Sendai Framework are found to be well represented, and that long before Sendai Framework came into existence.

Technical avalanche protection measures and services have evolved, and specialized mountain rescue services have been created. Sometimes, in contrast with other natural hazard management, in addition to creating more and effective response capacity, a lot was invested in a more holistic risk management process.

Meteorological data collection and systematic analysis of snow cover and its properties in relation to the terrain have led to effective Early Warning systems to predict avalanche risk. This improvement on snow properties and analysis, has also facilitated a much better "understanding" of the risk which is, again, a critical element in the Sendai Framework.

Picture 28. Forest with avalanche protection function in Iceland. (Author: M. Font)

In addition to Early Warning and technical protection measures in and below the avalanche release areas, it is widely accepted and understood that the vast majority of areas in the Alps are protected by forests. The role of protection forests in avalanche risk management cannot be overstated.

Consequently, the management of protection forests receives great attention in alpine countries. Given their spatial distribution and the manifold benefits of forests it is a clear conclusion and recommendation of this project that forest management is increasing the wellbeing and resilience of protection forests and should receive highest political attention.

Picture 29. Structural measures and forest protection against avalanches.
Upper the tree line barriers are complemented by the conservation of the protection forest below.
(Author: E. Plana)

A last point that is worth mentioning is the fact that in avalanche risk, an additional element of risk management has become an important element: spatial planning. Whereas the role of spatial planning, for instance, in wildfire risk is still widely neglected, in avalanche management it has become a core element.

As stated above, forests are the preferred avalanche protection "measure". This, however, means that climate change and its implications on forest disturbances will play a major role in the future. These disturbances include fire, storm, drought, pest and disease, ungulates, as well as the corresponding risk interactions.

Predictions in the various climate models indicate less snow cover for the alpine space, so in theory the avalanche risk should become lower over time. However, the models also predict a greater variability and uncertainty, i.e. more frequent and more severe extreme weather events. That will of course include heavy snowfall and subsequently high avalanche risk, and also in areas that so far have no expertise to deal with avalanche.

As a consequence, in this project, is concluded that forest management based on increased diversity and resilience remains the critical challenge and task for the future. It is a logical consequence that the Civil Protection sector that is mandated with avalanche risk management should have a serious interest in well managed forests.

Box 4. An approach for assessing the vulnerability of avalanche protection forests to wildfires *(Font, et al. 2018)*

In the context of climate change, in general terms, forest avalanche risk might decrease due to the combination of a lower snowpack accumulation capacity and an altitudinal increase of the protection forest surface, as a result of the warmer conditions. Nevertheless, this warmer environment could lead to favour the occurrence of wildfires, which could seriously threaten the avalanche protection role's viability. Compared to fire-prone regions, Alpine coniferous forests are especially vulnerable to high-intensity wildfires because tree species do not have effective fire-adapted mechanisms to resist severe fire's effects (resistance) nor to ensure success of the post-fire forest recovery (resilience). Consequently, an unprecedented avalanche situation could become activated, especially on south slopes, which might require the implementation of costly structural defense/preventive measures until complete forest cover replacement is reached.

Complementarily to existing protection forest assessment tools (e.g. NaiS (Frehner, et al. 2005)), the availability of further approaches aiming to cope with risks cascading effects scenarios, is a major concern to forest managers and Civil Protection services. In this sense, forest management focusing on minimising the vulnerability of protection forest to wildfire risk, should pay attention to: (i) to reach the major forest development stage, which provides an acceptable avalanche risk mitigation, and (ii) to diminish the likelihood of the occurrence of high severity fires in the release area. This approximation is very relevant due to the fact that the best forest structure for avalanche mitigation is, in turn, the most vulnerable to high-intensity wildfire. Therefore, wildfire prevention in the avalanche release area is a crucial issue to be tackled. Besides this, fire behaviour within the protection forest stand, also depends on the surrounding forest structure with special attention to the avalanche track and run out areas. As a result, it is necessary to differentiate the potential fire behaviour of each avalanche area and how it can affect and interact with the other ones, in order to establish a strategic forest management objective.

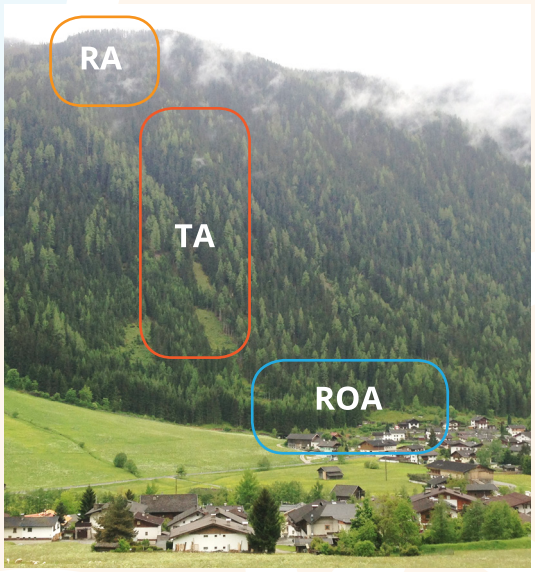


Figure 8. Conceptual avalanche areas in an avalanche protection forest of the Austrian Tyrol.
(Author: M. Font)

Release area (RA): corresponds to the area of the snowpack accumulation and avalanche release. Forests in these areas minimise the likelihood of an avalanche formation as a result of canopy snow interception, snow layer metamorphosis, tree trunks and understory snowpack anchorage and increased surface roughness. In this sense, the majority of protection forest management guides, highlight the convenience of reaching an uneven-aged stand with a canopy cover up to 70%, a basal area above 30m2/ha and managed by selective clear-cut. As a consequence, the forest stand is highly vulnerable to crown fires, for both active and passive canopy fires. If the fixed objective is to maintain the uneven-aged stand, the RA might need, firstly, to address fuel arrangements through minimising the ladder fuels, and, secondly, to envisage its confinement with regards to the surrounding forest, by means of an external low fuel load buffer. This could avoid the outside crown fire transference and generate an opportunity for suppression tasks. However, if the desired forest structure corresponds to an even-age stand; which could thereby facilitate the wildfire risk mitigation, it might be necessary to undertake further researches on the minimum tree density

Transit area (TA): In this area, the forest is not considered as avalanche protection, even if small events could be stopped by the forest. Furthermore, in the TA, both avalanche and wildfire experience an acceleration, but in opposite directions; i.e. upstream for wildfire, downstream for avalanche. In this sense, fire behaviour could worsen, in terms of spread, intensity and flame length, which could facilitate the transference of fire from the surface to the crowns. As such, spotting fire dynamics could appear, and new fire ignitions could take place in the upper forest endangering the defense of the RA. Forest management should envisage fuel treatments aiming to minimise crown fires. This could be achieved, for instance by a mature even-aged forest presenting a canopy cover around 50-60% and without ladder fuels.

Run out area (ROA): The area is characterised by the avalanche deposition zone which normally matches the wildland-urban interface. Consequently, it is the place with the most social vulnerability of avalanche impacts, as well as the main fire ignition source due to human activities. The main focus should be to limit the wildfire development, through forest structures which hinders the fire spread, and facilitates fire suppression. Indeed, forest structures with dense canopies might promote high ground shadow rate which limits the surface fuel development, as well as maintains higher duff and fine fuel moisture levels. In addition, low shrubs fuel loads may be considered progressively as they approach settlements, especially if highly inflammable species are prone in the RA. Complementary to the forest factor, other actions aiming to minimize potential fire ignitions, with special attention those resulting from human careless activities and behaviours, could be recommendable. In such, promoting the social awareness of the wildland-urban interface inhabitants and regular users, could promote the sense of a shared responsibility in protecting forest to wildfires.

RISK MANAGEMENT ACHIEVEMENTS AND CHALLENGES

Achievements

In the most avalanche prone countries in the Alpine space, namely Austria and Switzerland, the management of avalanche related risk has developed since the winter 1950/51. Over time, the risk management components prevention – preparedness – response and recovery have been developed to a level where we can safely state, that in terms of the Sendai Framework, the understanding of this risk is on a high level.

Here is needed to mention the core elements that contribute to this better understanding of the risk.

Protective infrastructure against avalanches and the related engineering are well established. The collection and analysis of data like weather, terrain, snow cover and snow properties as well as post incident data provide an excellent source and input for risk prediction and early warning. Avalanche services are established and also, a crucial element for mitigation and prevention, avalanche risk is reflected in the spatial planning.

Forests cover the majority of area in the alpine space and fulfil a protective function against natural hazards like avalanche, rock fall and flooding. The spatial extent, the traits associated with forests and the fact that a healthy forest is a very cost effective, self-regenerating protection system explain why a strong focus in avalanche risk management needs to be on forest management and forest functions. In addition, forest deliver a wide range of other ecosystem services to society.

Challenges

Climate change and its effects on forest disturbances are becoming a reality and faster than expected. Disturbances like fire, storm, insects, invasive species, etc., are predicted to increase in frequency and severity. In addition, new diseases like Ash Dieback must be considered.

Positive attributes of forests as a protection measure against avalanche are described: Forest ecosystems provide protection to the majority of the affected terrain and as a benefit compared to technical measures, forests are permanently available and have no “life span” like an iron protection fence for instance. However, that is only true in theory as in the majority of forest stands the self-regulation and natural regeneration of species-rich mixed mountain forest is challenged by selective browsing (ungulates like chamois, roe deer, red deer and sometime even fallow deer), according to forest inventories.

The combination of factors like silviculture, ungulate densities, forest disturbances under climate change is, obviously, a mixture of challenges for the future avalanche risk management.

The maintenance of healthy, robust and resilient (protection) forests is the main challenge for the future, both for forest managers and the Civil Protection sector.

Changing snowfall patterns could result in new areas affected by heavy snow cover and avalanches. The active exchange of expertise, lessons learned, skill and technology is a tried and tested effective tool to fast forward experience and to create competencies. The Exchange of Experts is also supporting the building of networks that can assist in case of emergency.

Chapter 11. Floods

GENERAL REVIEW AND TENDENCIES IN THE CONTEXT OF CLIMATE CHANGE

Floods have become more severe during last recent decades. Generally extreme weather events are expected to escalate in likelihood and intensity as a result of climate change, contributing to an increase in the adverse impact of flood events. Pluvial floods and flash floods, which are triggered by intense local precipitation events, are likely to become more frequent throughout Europe. However, quantitative projections of changes in flood frequency and magnitude remain highly uncertain.

Beyond present effects, most of the consequences of global change are at mid- to long-term time scales, and not all impacts of climate change, for instance, are already visible. The potential time lag of risk effects due to global change is not yet integrated into Disaster Risk Reduction (DRR) strategies, as so far, commonly, the social focus is more on what is happening now.

In terms of social and economic impact, flood risk is probably the most important natural hazard at European level, as the distribution of floods is normally situated in areas with more human activity (urbanisation, industry, agriculture or strategic infrastructures). Hydrogeological and hydraulic risk is, as a consequence, not only a natural one, but also a «human-induced risk» and social processes are consequently subsequently not negligible in risk hydrogeological assessment. Increase of exposure caused by urban sprawl and inappropriate territorial and urban managements are key causes of hydrogeological and hydraulic risks: urbanization makes land use changes near rivers and seems at least as important as climate change in terms of consequences on the modification of disturbance regimes and natural hazards impacts.

Picture 30. Flood impact risk is influenced by the policies and urban planning. (Author: P.P. Pittau)

Picture 31. Flood impacts caused in Villagrande Strisaili (Sardinia) in 2004. (Author: P.P. Pittau)

Managing flood risk implies the adoption of a combination of structural and non-structural measures. Forests play a crucial role in the regulation and mitigation of flood risk in flood plains and upstream regions. In fact, among the major ecosystem types, forests have a large potential for water retention. Forests retain excess rainwater and help to moderate run-off patterns, preventing extreme run-offs. This, in turn, reduces damage from flooding and also helps to mitigate the effects of droughts.

In a changing risk context, however detailed our management strategies may be, flood risks can never be reduced to zero: it will always be a risk of flood that can only be reduced to an acceptable level.

RISK MANAGEMENT ACHIEVEMENTS AND CHALLENGES

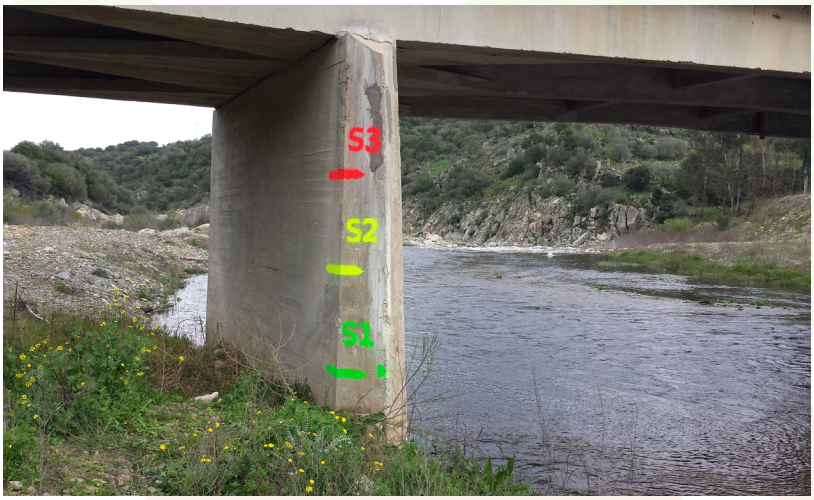
Achievements

Across Europe, for floods risk mapping, the common standards are based on experiences and data from past incidents, geography/morphology of the terrain, and the frequency of an event. One of these common standards is the definition of "flood return period". Knowing the stochastic occurrence, distribution, and intensity of floods offers significant advantages for risk mapping and allows the benefits of prevention measures to be connected to the avoided risk impacts. For this reason, vulnerability mapping and flood risk assessment is less contested compared to other risks and this can lead to a better acceptance of the mitigation measures proposed.

With reference to flood mitigation, it can reasonably be said that this action cannot be absolute and must be ensured through structural measures, such as protective works (e.g. levees), and non-structural ones, in which the monitoring, forecasting, and management of the emergency plays a key role.

The strategies of hydraulic defence are changing in favour of one more modern engineering approach to hydraulic risk and a more correct management of the fluvial systems: while in the past the soil defence policy was basically based on structural measures, the most recent trend is more oriented towards non-structural measures, attributable to knowledge and study actions, active maintenance of the territory, redevelopment, relocation, monitoring and prevention.

The standardization of the alert messages for flood risk has brought the whole Civil Protection system communicating better to citizens. With using the same language, in terms of colours, symbols, visual codes, all linked to an expected behaviour, people develop a memory of the messages after repeated events, and also between risks.



Picture 32. A simple real-time monitoring and warning system. (Author: P.P. Pittau)

Challenges

Due to social changes, people are less connected to the land and its dynamics, which also include the natural hazards, than they used to be (Figure 9). A profound social process is necessary to reconnect populations to their natural environment and therefore develop consciousness, knowledge and concern, and finally encourage accountability and responsibility. Social sciences are central in that aspect.

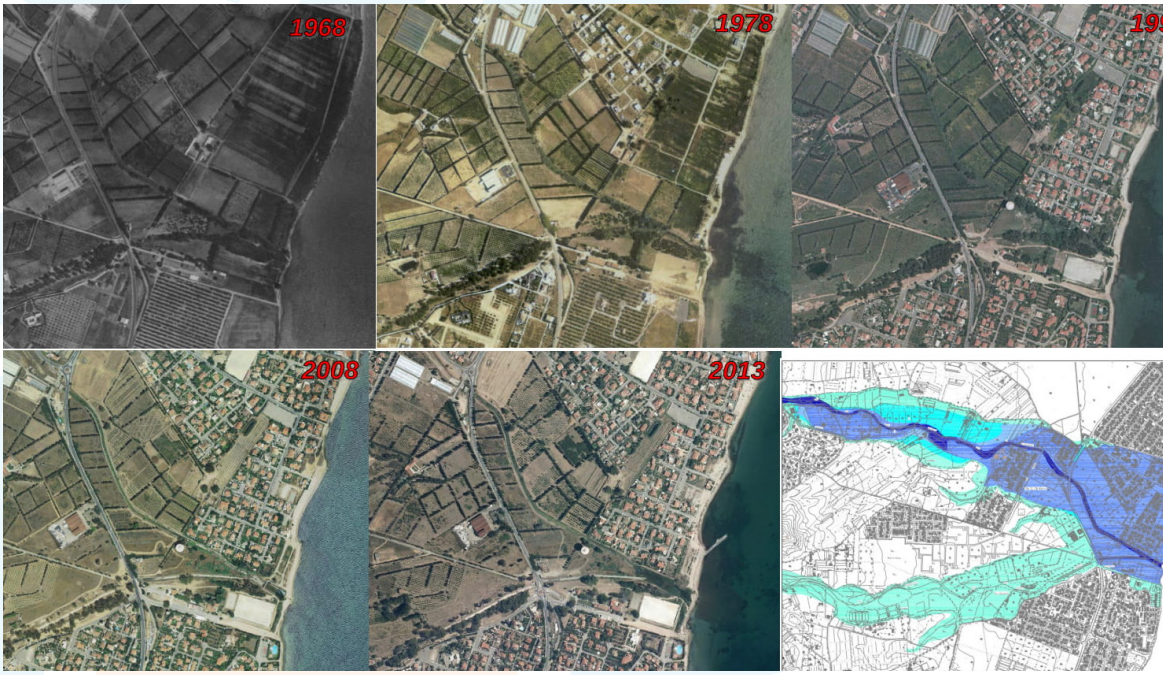


Figure 9. Appropriate urban planning policies can minimize the situation of uncontrolled urban development without considering flood risk and the consequent increase of social exposition. (Source: SardegnaGeoportal)

There are significant gaps in the communication between emergency services and citizens. Often risk of flooding is not well communicated to the potentially affected communities, but any person has participated in a flood emergency drill. Not all the municipalities have adopted flood plans, or have plans that are regularly updated. In fact, often local authorities make plans as requested by the law, but they do not really internalise the procedures that they have to apply in case an event occurs. They are not well trained on the practical application of the plan. Populations should be more involved directly in the training of how to react in case of flooding and be ready and prepared to be put on flood risk. Intermediary (territorial) level can probably deliver a more effective communication, helping to fill the gap.

Participatory processes should be integrated into Civil Protection plans for floods as a core element for promoting the corresponding awareness and initiative based on the own risk mitigation responsibility.

Uncertainties posed by a climate change context can also be tackled through participatory approaches along the flood risk planning process. Societal participation also offers an opportunity to make visible the benefits of mitigation strategies, in comparison with the avoided costs derivate from the potential damages.

In order to reduce the risk of floods to communities, economies and environments, it is important to learn and not to forget lessons from past floods. In this sense, it is important to invest efforts on ensuring a multigenerational transference of hazards, the historic events, the lessons learned and cultivating memories to manage future risks scenarios. This could be achieved through activities at school, municipality Civil Protection simulation exercises, journal clubs, informative articles, picture books, etc.

Finally, also referring to flood risk, most of the time windows of opportunity appear after a catastrophe (“the big one”). To make the most of this momentum, proposals and advice need to come quickly after the event, and therefore, should be prepared beforehand. In case of events with smaller magnitude and higher recurrence, it might become difficult to open a real window of opportunity, though the cumulated damage over time may be higher.

Chapter 12. Dealing with forest risk interactions across Europe

As it has been stated in the previous Chapters, forest disturbances are strongly influenced by climate (change) and are predicted to increase in intensity and frequency. However, our understanding of disturbance dynamics remains incomplete, particularly regarding large-scale patterns, interaction effects and dampening feedbacks.

Warmer, drier and windier conditions facilitate wildfire, drought and insect disturbances, while warmer and wetter conditions increase disturbances from wind and pathogens. Widespread interactions between agents are likely to amplify disturbances, while indirect climate effects such as vegetation changes can dampen long-term disturbance sensitivities to climate (Seidl et al., 2017).

Generally, some interactions of disturbances in European forests are well observed in practice and well understood in research, i.e. increased bark beetle risk after storm, or increased wildfire risk after large scale bark beetle infestations. These amplifying effects are a logical consequence of cause and linear effect and, therefore, can be explained. However, there remains great uncertainty both in practice and in science on the changing disturbance regimes due to a changing climate.

Interactions between different disturbance agents can also result in strong and non-linear effects of climate change on disturbance activity. In contrast, climate-mediated vegetation changes can dampen the climate sensitivity of disturbances.

In the NET RISK WORK project and its thematic focus on the dynamics and interactions of wildfires, storms, floods and avalanches we experienced the above listed challenges. It was relatively easy to describe the linear effects of amplifying or dampening processes. When touching the complexity of non-linear effects, the discussion and conclusions become more diverse.

The project developed a risk interaction assessment (Chapter 5) to enable forest risk managers to assess risks and their interactions in a practical and time effective way.

In the following Box 5, the key findings of a basic analysis of the risk assessment sheets are presented.

Applying single risk assessment or risk interaction assessment on the different affected levels, namely; the forest stand level, the forest enterprise level and the national or societal level, results in complex outcomes. Sometimes contradicting results of a specific risk and its interaction with other risks has a negative effect on the stand level, but maybe a positive effect on the view point of the general public/society.

The next level of complexity is added when relating the risks to the forest management objective, which, in turn, will define if a risk has a negative or a positive effect. (i.e. a wind-blow has negative effect on forest economic objectives, but positive effects on forest biodiversity objectives)

Future changes of disturbances caused by other agents, such as drought, wind and snow, will be contingent on changes in water availability, which can be expected to vary more widely locally and intra-annually than temperature changes. Wind disturbance, for instance, which is currently the most important disturbance agent in Europe, is expected to respond more strongly to changes in precipitation (and the corresponding changes in tree soil anchorage and tree growth) than to warming temperatures.

Disturbance change is expected to be among the most profound impacts that climate change will have on forest ecosystems in the coming decades (Lindner et al., 2010). Future changes in disturbance are likely to be most pronounced in coniferous forests and the boreal biome and, particularly, in mountain protection forest of the Alpine area. We conclude that both ecosystems and society should be prepared for the future of forests to be increasingly disturbed.

We recommend investing in further research on risk interactions in a changing climate, with a clear focus on the relevant risk and forest management levels; i.e. the stand level, the forest enterprise level and the societal level with respect for pre-defined objectives.

From a Civil Protection perspective, we recommend closer cooperation between Civil Protection and forest / landscape managers as well as joint research.

Picture 33 and 34. Temporary protection measures to recover an Alpine coniferous avalanche protection forest affected by a wildfire in the municipality of Trin (Switzerland).
(Left) Fence protection to minimize tree damaged caused by predation, (right) Snow rackets to minimize the avalanche formation in the starting zone, while the forest is recovering. (Author: E. Plana)

Box 5. Key findings of a basic analysis of the risk assessment sheets.

Most risk assessments analysed the existing and predominant risk situations related to the field of expertise and the greater geographic context of the project partners. Clearly, it is straightforward to assess a case that one is already familiar with. However, to detect new types of risk in locations that potentially can be affected due to climate change, it is of interest to also assess unconventional cases. Furthermore, the intensity of the analysed hazard (e.g. low intensity fire, high intensity fire) had a large influence on the outcomes of the assessments.

The analysis showed that the predefined management objectives mostly influenced the outcomes for the single risk assessment, with the largest divergence between the objective "income" and "nature conservation". While the management objective "income" is largely related to timber production and relies on undamaged trees, the management objective "nature conservation" focus on biodiversity and natural processes, which may benefit from a hazard, as the natural disturbance regime leaves features, such as standing dead wood, forest gaps, and openings. For the risk interaction assessments, the interaction and properties of the two hazards were more influential than the management objective.

The extent of the effects of the risk interaction is largely related to the time interval between the two hazards. The longer the period in between two hazards, the less pronounced are the effects of the interaction.

Climate change impacts are addressed in factors of natural influence on vulnerability and exposure. For instance, a shift in precipitation patterns results in an extension of the wildfires season in the Mediterranean. Such effects will likely increase their influence on the overall risk situation in future.

SUMMARY OF RISK INTERACTIONS

General

In detail, the interaction of two hazards was analysed. A particular focus was on the impacting factors and measures that emerged from this interaction.

As a general observation it became noticeable that successful post-disaster management following the first hazard event is crucial to avoid the build-up of additional risk drivers. As mentioned earlier, the time interval between the two hazards determines how well that can be achieved.

Another general effect of hazard interaction is that the first hazard will generate some sort of erosion and degradation of the soil or stand. Addressing this issue is important to prevent further damage (e.g. through leaching of ashes into streams) and to ensure a fast regeneration (e.g. natural regeneration or replanting). The fast reestablishment of ground cover with site-adapted tree species should be one of the principle goals.

Additionally, and depending on the impact, the previous hazard event demonstrated the imminent risk and will most likely increase the general risk awareness. It, hopefully, contributes to a public discussion on risk and disaster management at all levels and initiates the implementation of preventive and preparedness measures.

Wildfires

Fuel: The previous hazard impacts fuel availability, quantity and type. For instance, there is an increase of fuel from debris and dead biomass after flooding. Following a wildfire, the remaining fuel is drier, but likely less in quantity. However, fast regrowth of shrubs due to favourable nutrient availability and more light reaching the ground, will generate additional fuel.

Access: Following a hazard, there is limited access due to damage of the previous hazard. For instance, flooding may have destroyed bridges, or a storm event may have created blockages of roads. This makes it harder to access the site for prevention and suppression actions.

Awareness and preparedness: The previous hazard clearly visualized the inherent possibility of a hazard and its potential disastrous effects. Emergency authorities and citizens have been "trained" in a real life example, learned from mistakes, and are, hopefully, more aware about the next potential hazards and can initiate preventive, as well as preparative measures.

Resilience: The previous hazard may have created a mosaic forest structure, which limits the severity of subsequent fires. Additionally, a change in species composition with more species adapted to fire will naturally regrow. This increases the overall resilience.

Storms

Changes in forest stand structure: The previous hazard may create abrupt edges within remaining stands (e.g. avalanche tracks, fire fronts). These offer weak points in the stand for the following storm. In contrast, the previous hazard can also naturally diversify stand structure and decrease the overall storm risk in the long-run by transforming even-aged stands into multi-layered stands.

Chance to adapt: The previous hazard event offers the chance to regenerate forests with a better (i.e. site-adapted) species composition and diversified stand structure, either through planned reforestation or natural regeneration. The remaining trees may be better adapted and potentially regenerate themselves, creating a more resilient forest in the long-run.

Decrease of stability: Remaining trees may be damaged by the previous hazard and are more susceptible to the following hazard. Damaged root systems and stems affect tree health and offer entry points for other pests and diseases. Water-logged soils after flooding decrease rooting and stand stability.

Change in nutrient availability: The previous hazard may increase the nutrient availability (i.e. after fire and flooding in plains), which increases soil fertility. In contrast, it can reduce the soil layer due to erosion (i.e. avalanches and flooding in mountains) and increased run-off. Here, post-disaster management after the first hazard can mitigate the negative effect.

Picture 35 and 36. Windstorm effects on forest stands.
In this case, a prior too intense thinning (left) makes vulnerable the stand to a next windstorm occurred some weeks later (right).
(Author: E. Plana and P. Barbens)

Avalanches

Destabilization: The previous hazard likely caused damage to stands and trees. As a result, there is further decrease of tree health due to pest outbreaks and fungi infestation. The understory layer is affected (e.g. due to fire). This destabilizes the stand structure and reduces the avalanches retention capacity of affected forest stands.

Reduction of retention capacities: Clearance of the area following a hazard event can reduce the retention function of the forest and increase the likeliness of the occurrence of avalanches. Post-disaster management needs to address this issue by not completely clearing the affected area but cutting rooted tree trunks at breast height and placing logs parallel to the slope. Furthermore, a quick regeneration, protected from animal browsing, has to be established to recover forests' protective function.

Avalanche release areas: The previous hazard will create gaps and patches with lower crown cover and limited shrub layer, which function as avalanche release areas and increase the overall avalanche risk. Fostering fast regeneration of these areas or constructing avalanche barriers, are means to mitigate this risk.

Floods

Erosion: The previous hazard most likely negatively impacted the existing plant cover, which reduces water holding capacity and limits infiltration. Consequently, the amount and speed of stream run-off, as well as peak flow levels increase. Additionally, an increase in soil erosion is expected, which will affect water quality. For instance, the leaching of ashes from a previous fire can contaminate streams and affect aquatic life.

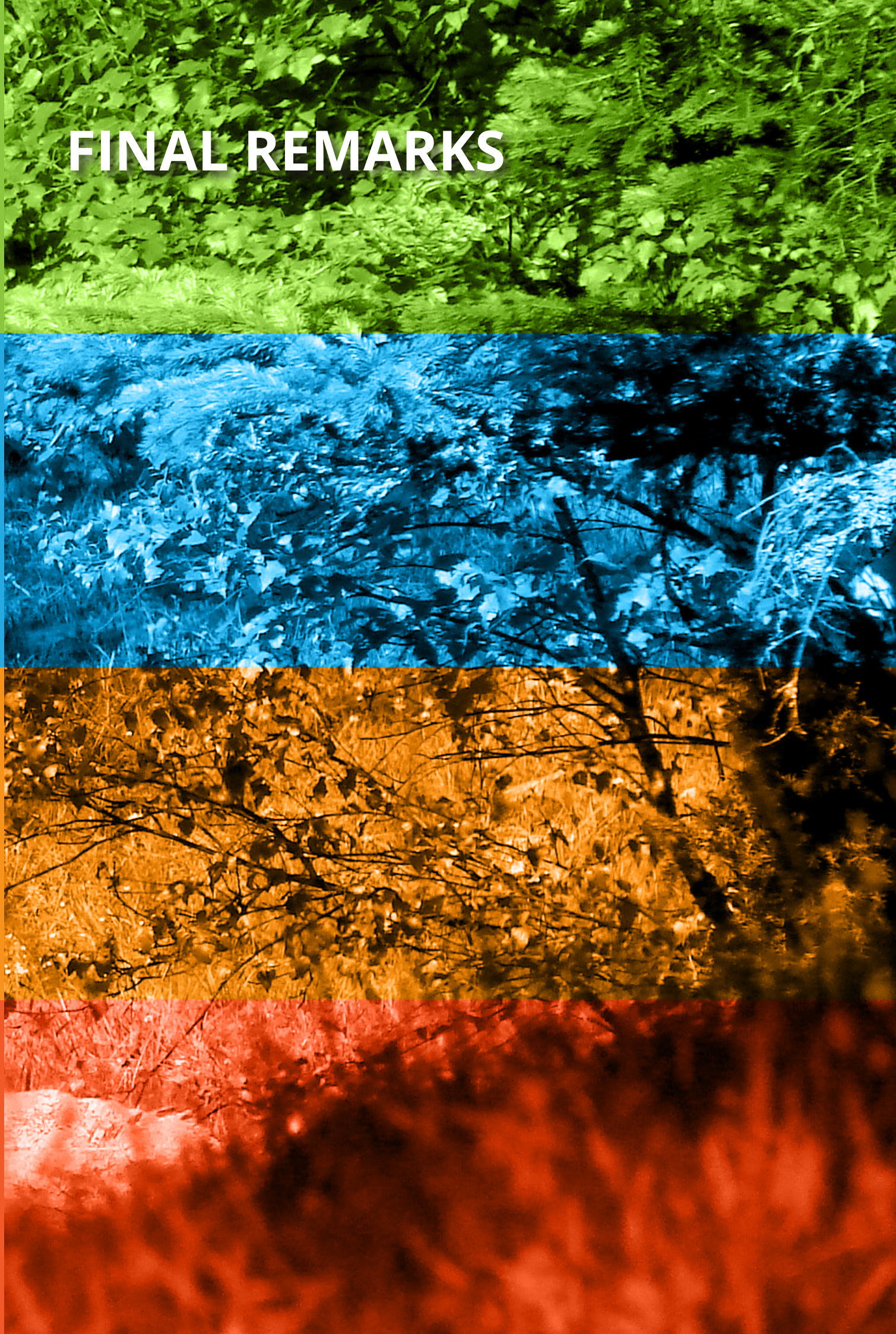
Regeneration of forest cover: The natural or artificial regeneration of areas affected by a previous hazard facilitates soil infiltration and reduces erosion. To re-establish a stand as fast as possible, it is important to limit deer population and animal grazing, as well as selecting site-adapted tree species.

Debris: The previous hazard generates high quantities in debris, such as dead wood, which may block creeks and gullies. The sudden release of large water quantities, when these dams break, can create unpredictable flash floods and damage infrastructure, such as bridges. To prevent this, clearing gullies and creeks during post-disaster management is necessary.

Construction: Building retention ponds, dams, and diversion elements that regulate the stream helps to reduce run-off speed and mitigate the erosive force.

Risk awareness: Update Civil Protection plans for the new risk situation after a previous hazard, as well as informing the potentially affected population, are additional risk reducing measures.

FINAL REMARKS



Final remarks

- √ Forest risks and their interactions will apparently increase in a climate change context, reinforced by the ongoing land-use changes process, which will have important implications at multiple levels, with special attention being paid to the dimension of European Civil Protection.

- √ All potential risk interactions are not yet fully identified and further efforts have to focus on their dynamics and characteristics in order to improve risk assessment at the Pan-European level. In this sense, trans-national and multidisciplinary forest risk R+D projects are becoming an effective tool to develop a shared view across Europe, able to cope with common challenges posed by climate change, and reinforcing, simultaneously, European initiatives such as the Disaster Risk Management Knowledge Centre (DRMKC) or the recently established rescEU initiative.

- √ When dealing with forest hazards, it has been demonstrated that it would be useful to link risk analysis to specific forest management goals, with the intention of differentiating between specific ecosystems' functions and/or endangered assets. The implementation of the "Goal-Oriented-Risk-Management" approach with the "Influence-Change-Exposure Method" facilitates this purpose.

- √ The new knowledge to be developed, needs an integrative prevention-preparedness-response approach, together with a holistic understanding of disasters (i.e. including the physic and social dimension), so as to ensure that all requirements of risk management components and stakeholders demands are considered and well-balanced.

- √ Normally, this makes necessary to develop a common definition of risk and risk management components to undertake a process of lessons learned exchange where different regional contexts, disciplines, fields of expertise and competences meet.

- √ Structured discussions through applying together the risk management cycle (i.e. prevention, preparation, response and recovery), as well as cross-sectoral components of Disaster Risk Reduction strategies (e.g. risk assessment and planning, governance, communication or emergency management), facilitate the identification and comparison of the main achievements, existing gaps, and remaining challenges of risk management.

- √ There is a clear need to connect existing knowledge and lessons learned on forest risks, and to promote formal and informal structures, which facilitate the sharing and dissemination of it. Networking provides an interface to achieve this efficiently, acting as an accelerator for adaptation of new risk contexts.

- √ The development of new regional/thematic knowledge exchange networks can be improved by taking advantage of pre-existing initiatives, which highlight both the key successful points and the main operational difficulties. The European Wildfire Risk Node developed during the project, for instance, has been partially designed around the experiences and lessons capitalized by the "Competence network climate change, crisis management and transformation in forest ecosystems" (KoNeKKTiW) and the European Forest Risk Facility initiatives.

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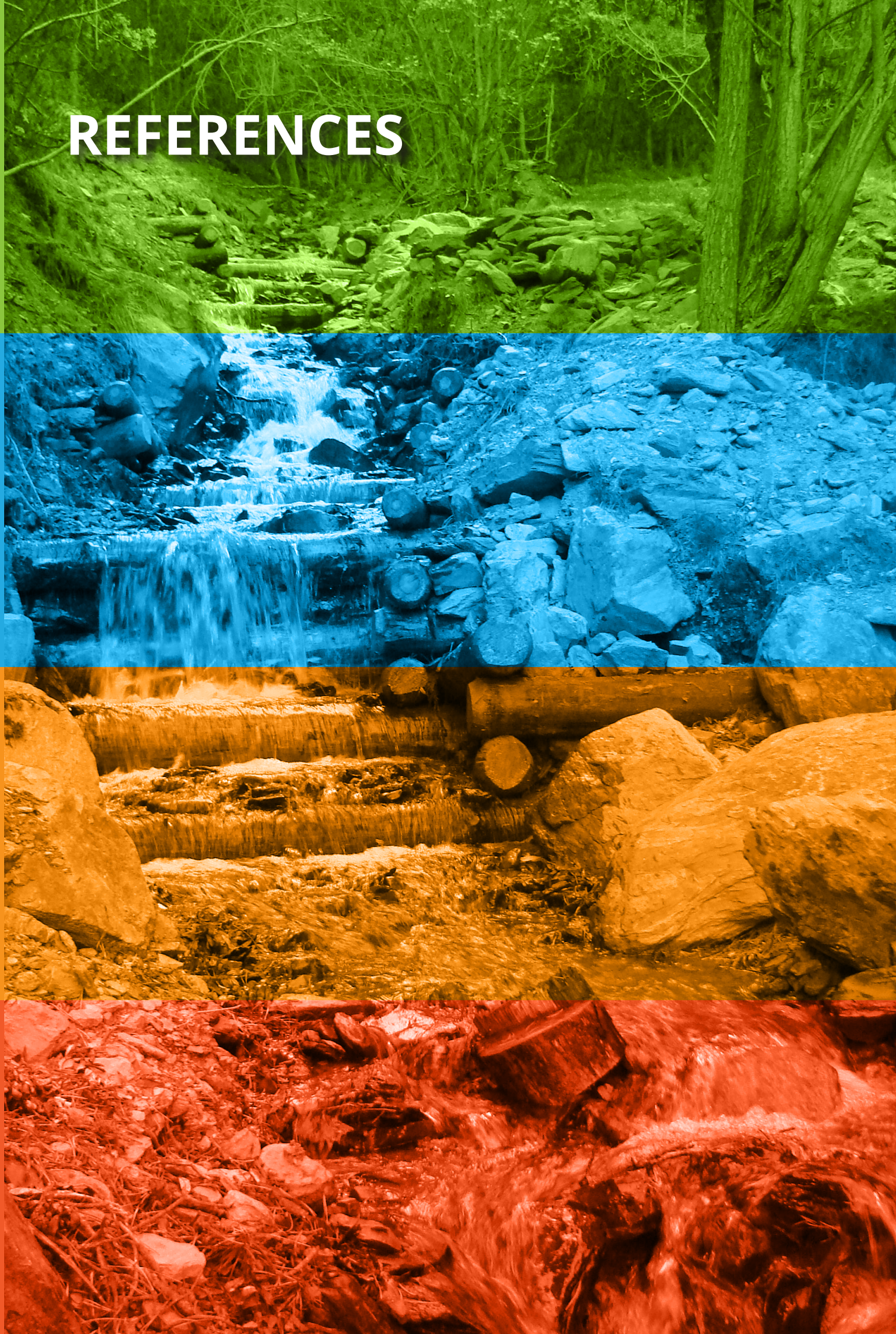

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ANNEXES

Annex 1 -Template for best practices and operational tools identification

Common template for risk assessment and management operational tools and best practices identification (Action B1)

Title: Operational Tools and Best Practices for Risk Assessment and Management

The identification of tools and best practices on risk assessment and management helps providing an idea of the state of the art in the field. By completing this form, the best practice will be included in the knowledge repository platforms and available for the practitioner community to use. We encourage the user to complete as many fields as possible from the template in order to provide the most relevant information needed to apply the best practice to other practitioners. Instructions:

- **Blue boxes are mandatory fields**
- **More than one item can be selected in multiple choice boxes**

Document classification

Title	
Description *[1 sentence]*	
Country, location	
Date	
Contact e-mail	
Institution	
Net Risk Work Partner	Choisissez un élément.
Document type	Choisissez un élément.
Language	☐Catalan ☐English ☐French ☐German ☐Italian ☐Spanish ☐Other
Source/origin	☐Partner's expertise ☐Expertise from the network ☐Other (internet)

Topic

Area	☐Risk assessment	☐Risk Planning	☐Risk Management
Risk	☐**Wildfires**	☒Fire behavior patterns and typologies ☐Fire ignition and spread models ☐Wildland urban interface	☐Fuel management ☐Fire service needs ☐Prescribed burning ☐Other *[Introduce which ones]*
	☐**Storms**	☐First measures after storm ☐Work safety during salvage logging ☐Timber storage and cost containment ☐Forest protection and pest control	☐Regeneration and afforestation ☐Preventive sylvicultural measures ☐Other *[Introduce which ones]*
	☐**Avalanches**	☐Technical protective measures ☐Maintenance of protection forests	☐Other *[Introduce which ones]*
	☐**Floods**	☐Prevention through land use management ☐Technical protective measures	☐Other *[Introduce which ones]*
	☐**Other**		*[Introduce which ones]*
Cross-sectoral topics	☐Risk and vulnerability assessment and mitigation ☐ Cost-effectiveness assessment	☐ Risk planning, governance and policy framework ☐ Community involvement and risk communication	

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	☐ Civil protection, emergency and post-disaster management			☐Other: [Introduce which ones]		
Level	☐Local	☐Regional	☐National	☐Cross-border	☐EU	☐Global
DRM cycle phase	☐Prevention	☐Preparedness		☐Response		☐Recovery
DRM domain	☐Policy making		☐Early warning system			☐Disaster response
Sendai priorities	☐Priority 1: Understanding disaster risk ☐Priority 2: Strengthening disaster risk governance to manage disaster risk ☐Priority 3: Investing in disaster risk reduction for resilience ☐Priority 4: Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction					
Contribution to Sendai Targets	☐Reduce global disaster mortality ☐Reduce the number of affected people ☐Reduce the direct disaster economic loss ☐Reduce disaster damage to critical infrastructure ☐Increase the number of national and local disaster risk reduction strategies ☐Enhance international cooperation to developing countries ☐Increase availability of and access to multi-hazard early warning systems and disaster risk information and assessment					

Description and analysis

Summary: quick presentation of the Good Practice *[Objective: summarize in a few lines the key elements of the good practice]*
Place in national/regional policy *[Mentioned in the law/regulation/guidelines? Mandatory? Recommended?]* *[free text – 5 lines max]*
Goals and achievements *[Objectives, goals and the achievements of the Good Practice]* *[free text – 5 lines max]*
Actors involved *[Explain who is involved in the development: practitioners, stakeholders, educators, ...]* *[free text – 5 lines max]*
Implementation stage *[Is it operational? Since how long? Is it a pilot experiment?]* *[free text – 5 lines max]*
State of technical knowledge *[state of the art and technical background of the Best Practice]* *[free text – 5 lines max]*
Context *[regulatory, socio-economic, political]* *[free text – 5 lines max]*

Detailed Characteristics [*Objective: detail the implementation conditions of the Good Practice]*
Description of the implementation steps *[different stages in the implementation process, duration]* *[free text – 5 lines max]*
Governance *[responsible authority and roles of the different actors involved]* *[free text – 5 lines max]*
Necessary means to implement the Good Practice in efficient conditions *[human resources, materials, financial...]*

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[free text – 5 lines max]
Challenges encountered during implementation and solutions incurred *[free text – 5 lines max]*
Priorities identified for successful implementation of the Good Practice *[free text – 5 lines max]*

Impact of the Good Practice *[Objective: evaluate the impact of the Good Practice].*
[Added value on decision processes, on national policies or regulations, on relationship with stakeholders, etc.] *[free text – 5 lines max]*

Future developments *[Objective: understand the follow-up perspectives]*
[Continuation, future improvements,] *[free text – 5 lines max]*

External resources *[Objective: provide further information]*	
Attached materials	*[include format (document, photo, video…) and name of the file]*
Web links	
Contacts	

[Additional information - optional]

Lessons learnt *[Objective: compare the results obtained to the objectives set at the start of the Good Practice]*
Evaluation process, if exists (internal or external) *[free text – 5 lines max]*
Assessment of results (quantitative and qualitative) and comparison with main goals *[free text – 5 lines max]*
Negative aspects identified *[free text – 5 lines max]*
Unexpected consequences (short / mid / long term) and corrective measures implemented *[free text – 5 lines max]*

Durability and transferability *[Objective: evaluate the integration of the Good Practice and its sustainability, give recommendations for transferability]*			
Is this information:	**Replicable** ☐	**Measurable** ☐	
Regulatory Framework			

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[free text – 5 lines max]
Stability of the human environment *[Stability of partnership, structures, population enabling successful implementation and positive impact in the long term]* *[free text – 5 lines max]*
Financial requirements *[business model]* *[free text – 5 lines max]*
Success factors *[political, technical, human, financial…]* *[free text – 5 lines max]*
Risk factors *[legal, financial, safety…]* *[free text – 5 lines max]*
Additional and non-formal experiences contributing to the implementation of Good Practice *[free text – 5 lines max]*

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Project		Objective	Type of best practices	Link
CATALYST	Capacity development for hazard risk reduction and adaptation	To narrow the divide between researchers' and practitioners' understanding of natural hazard and disaster risk and the prevailing forces driving economic development that have made disaster risk reduction and adaptation a low priority among policy makers and development experts.	• Creation of an interactive website including an online forum for knowledge and information Exchange • Development of web-based archives comprised of best practices and case studies • Publication of policy briefs and a best-practices handbook.	http://www.catalyst-project.eu/index.html
CUIDAR Cultures of Disaster Resilience among children and young people	Culture of Disaster Resilience among children and young people	Understanding children's perspectives has been demonstrated to be a vital part of the process of building resilience: children have the potential to play an important role in shaping more effective responses to disaster at local and national levels. CUIDAR's participatory approach will encourage emergency plans which can build on the experience and meaning of events in children's lives.	• 5 stories from CUIDAR (best practices from the Project)	http://www.lancaster.ac.uk/cuidar/en/
EDUCEN City - Culture - Catastrophe	European disasters in urban centres: a culture expert network	European expert platform focusing on the role of culture in disaster management and risk reduction	• 8 case study manuals to report using the same template on different case studies	http://www.educenproject.eu/
eFIRECOM	Efficient fire risk communication for resilient societies	eFIRECOM aims at enhancing the resilience of citizens to wildfires in interface areas from the Mediterranean region, through effectively promoting and increasing awareness and participation on the culture of risk with updated knowledge and best practices.	• State of the art on fire related communication initiatives	http://efirecom.ctfc.cat/
enhance Partnership for Risk Reduction	Enhancing risk management partnerships for catastrophic natural hazards in Europe	ENHANCE aims at developing and analysing new ways to enhance society's resilience to catastrophic natural Hazard (heat waves, forest fires, flood, drought, storm surge, and volcanic eruptions) impacts through new multisector partnerships (MSPs) between public and private sectors, with an important role for the financial sector (e.g. insurers).	• The project is designed around 10 selected participatory case studies on risk reduction of catastrophic events taking place at different geographical and spatial scales in Europe. The potential for each is explored and resilience measures and policies will be tested and disseminated	http://enhanceproject.eu/index.html

Project		Objective	Type of best practices	Link
EUFOFINET	European forest fires network	The aim of EUFOFINET is to support good practices sharing and implementation in the area of forest fires	• A template for good practices is developed • Good practices are described and exchanged	http://www.interreg4c.eu/projects/project-details/index-project=120-european-forest-fire-networks&.html
FIRE-IN	The first European fire and rescue innovation network	The ultimate objective of the FIRE-IN project is to raise the security level of the EU citizens by improving the Fire & Rescue services capabilities to address various forms of hazards, natural or manmade.	• Not really best practices, but rather the identification of the capability gaps, experienced and expressed by the Fire & Rescue practitioners.	https://fire-in.eu/
flire	Floods and fire risk assessment and management	FLIRE is a demonstration project aiming to the development of an integrated Decision Support System (DSS) for both flash floods and forest fires risk assessment and management.	• No collection of best practices, but public consultations and extraction of transferable lessons to ensure the project's uptake in other regions	http://www.flire.eu/en/
FLOODsite	Integrated flood risk analysis and management methodologies	The project science will support policy development, implementation and practice in flood risk management	• Redaction of a best practices guide on flood risk assessment and management	http://www.floodsite.net/
	Towards a European Forest Risk Facility (FRISK-GO)	The main aim of the FRISK-GO start-up project is to define and elaborate in detail the core work pillars of a European Forest Risk Facility and develop a corresponding operational business plan and structural framework for the implementation of such a facility.	• Draft guidelines, standards and showcase examples have been produced to demonstrate the role, actions and added value of a future European Forest Risk Facility.	www.friskgo.org/
MATRIX	New Multi-Hazard and Multi-Risk Assessment Methods for Europe	The main objective of MATRIX is to develop methods and tools to tackle multiple natural hazards within a common framework.	• Review of existing assessment procedures	http://matrix.gpi.kit.edu/
NAIAD	Nature insurance value	NAIAD is an ambitious attempt, to operationalise the insurance value of ecosystems for water related risk mitigation, by developing and testing concepts, tools and applications on 9 demo sites across Europe, under the common concept of Nature Based Solutions (NBS).	• Identification of Nature Base Solutions on 9 demonstartion sites	http://naiad2020.eu/

Project		Objective	Type of best practices	Link
	Platform for climate adaptation and risk reduction	PLACARD's (PLAtform for Climate Adaptation and Risk reDuction) mission is to be the recognised platform for dialogue, knowledge exchange and collaboration between the Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) communities.	• Facilitate and guide knowledge exchange and mobilisation between CCA and DRR	https://www.placard-network.eu/
	Transnational plans for the management of forest risk	The aim of PLURIFOR is to help with the development of regional and transnational risk management plans for forest areas susceptible to biotic and abiotic hazards.	• Transnational training workshops aim to exchange know-how about forest risk management between partners and associated partners of the PLURIFOR project. In these technical sessions, participants will learn how to use state-of-the-art tools for forest risk management, with the possibility of adapting and applying them to their own regions.	https://plurifor.efi.int/es/
	Sustaining and enhancing resilience of European forests (SURE)	SURE is aiming at enhancing forest resilience and addressing disturbance related risks as an integral part of sustainable forest management through facilitating networking, learning and capacity building.	• Sure is centred on fostering cross-border exchanges and highlighting best practices	https://sure.efi.int/

Annex 3 - Templates of single risks and risk interaction assessment

Single Risk Assessment

General Information

Author	*FVA (Forest Research Institute Baden-Württemberg), Germany*
Management Objective	**Category of management objective:** Recreation
	Specification: *The overall management objective is to maximize the value and possibilities for recreation of citizens and tourists.* *The goal is to create and maintain diverse and open structured forest with good accessibility for the public.* *The performance of this goal is measured by visitor counts and surveys.*
Hazard type	**Hazard analyzed:** Storm
	Specification: *Wind speed > 120 km/h, gusty* *Possible consequences: Blow-down of large patches of forest, blockage of major roads and trails, area becoming unattractive*
Area of applicability	Please describe regional limitations etc. *South Western Germany*

Impact on Vulnerability

Natural Influence	Description	Effect on vulnerability
Low stand stability	Trees are less robust to withstand storm and fall or break.	Increase
High stand stability	Trees are robust enough to withstand storm.	Decrease
Trees standing next to roads and trails	Possibility of blockages and casualties.	Increase

Human Influence	Description	Effect on vulnerability	
Diversification of stand structure	Mixed stands less susceptible to storm and more attractive to people.	Decrease	☐
Leaving high amount of deadwood	Danger of falling branches and trees. Risk of injuring visitors.	Increase	☐

Impact on Exposure

Natural Influence	Description	Effect on Exposure
Location of recreation areas	Recreation areas often situated in scenic parts of the landscape (e.g. viewpoints on top of hills). Particular topography is more susceptible to wind.	Increase

Human Influence	Description	Effect on Exposure	
Hazard Communication Plan	Allows to effectively communicate increased risk after hazard and prevent casualties	Decrease	☐

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Risk Interaction Assessment

General Information

Author	*Forest Research Institute Baden-Württemberg (FVA)*
Management Objective	Category of management objective: Income
	Please specify: *The overall management goal is to maximize income through timber production*
Hazard type	Hazard analyzed: Storm Previous hazard: Wildfire
	Please specify: (time frame, hazard impact etc.) *Wind speed > 120 km/h, gusty*
Area of applicability	Please describe regional limitations etc. *Central Europe*

Impact on Vulnerability

Natural Influence	Description	Effect on vulnerability
Shallow soils	Tree roots less effective to anchor tree	Increase
Deep soils	Trees form strong coarse root system and provide stability	Decrease
Loamy soils	Tree roots formation at optimum and provide stability	Decrease
Soil dryness	May negatively affect overall root growth, yet encourages trees to root deeper. Depends on species	Increase
Topography	Steep slopes and hill sides, facing to main wind direction	Increase
Topography	Valleys and lower slopes,	Decrease
Degree of normal wind loadings: low	Trees are less adapted to wind and more susceptible to storm events	Increase
Degree of normal wind loadings: high	Trees are adapted to wind exposition and can tolerate higher wind speeds	Decrease
(Natural) reforestation	Reforestation after wildfire -> young and still small trees	Decrease
Standing deadwood	Deadwood after wildfire	Unknown
Exposed forest stands	Sharp edges between fire destroyed stands and spared out forest stands	Increase
Ash	Nutrient-rich Ash (could be blown away) could build a base for valuable forest stocks	Unknown

Human Influence	Description	Effect on vulnerability	$_1$
Natural reforestation	Letting natural processes unfold	Unknown	☐
Planting	Planting adapted tree species after fire	Decrease	☐

Impact on Exposure

Natural Influence	Description	Effect on Exposure
Young growth (natural regeneration) under mature stand	Facilitates regeneration of stand at lower costs and less risks	Decrease

Human Influence	Description	Effect on Exposure	$_2$
Raise awareness in public	Generating awareness in public that fire can be caused by human mistake	Decrease	☐

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Available at: http://netriskwork.ctfc.cat/risks-identification-tools/

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