Project Deliverable D12

Summary of best practices learned in water management to improve fire prevention measures

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Table of Contents

List of Figures

Executive Summary

This deliverable is an outcome of work package 2 of PyroLife Innovative Training Network. It is a summary of best practices learned in water management to improve fire prevention measures. This document contributes to Task D12. It will focus on the best practises from water management and some applications. Some of the lessons learnt are already implemented in fire prevention. The work includes two projects. It is a summary of article in progress:

- Hugo A. Lambrechts, Robijn Brongersma, Spyridon Paparrizos, Fulco Ludwig, Carolien Kroeze, Cathelijne Stoof. 2022 (in preparation). Going Dutch: Living with fire like the Dutch live with water.

And a master's thesis at Wageningen University supervised by PhD candidate:

- Brongersma, R. 2021 Lessons learnt from Dutch water and flood risk management: a wildfire prevention perspective.

We identified three main lessons with sub lessons that can be learned from Dutch water management that can be applied to wildfire management: (1) a holistic and integrated approach, (2) adaptive management and (3) resilient landscapes through stakeholder participation.

1 Introduction

In the recent past there has been plenty of media coverage about the dramatic increase in wildfire causing large damage to properties across the world. In Europe the number of wildfires is increasing and this is not only the case in the fire-prone Mediterranean countries (Giannakopoulos et al., 2011; San-Miguel-Ayanz, 2020; San-Miguel-Ayanz et al., 2013), but also in less fire-prone countries, especially in the northwest of Europe. Although good practices in wildfire management have been well described through Integrated Fire Management (Moore, 2019), it is further highlighted that the predominant focus currently remains on readiness and response (firefighting). Often when the focus is on suppressing wildfires not enough attention is given to preventing wildfires and thus there will be increasing negative impacts on society and ecosystems due to damage as a result of wildfires that could have been prevented with prevention measures in place (Moreira et al., 2020; Tedim et al., 2015). There needs to be a better balance between firefighting and preventing fires through long-term risk reduction (Moore, 2019; O'Connor et al., 2016; Rigolot et al., 2009; Tedim et al., 2015). In the Netherlands, increasing resilience to climate change by combining prevention, protection, and preparedness to current and future water safety risks is already at the heart of policy making (Ludwig et al., 2014; Zevenbergen et al., 2013). To achieve this, the country made a shift from fighting water to learning how to live with water(Zevenbergen et al., 2013).

Water and fire are contrasting elements, but just as water management is often a spatial problem, this is also the case for fire management. The Dutch have been living with water for centuries and centrally managing it since the 1700's (Lintsen, 2002). In the Netherlands water management has shifted to integrated water resource management which includes adaptive water management (Commission, 2015; Correljé & Broekhans, 2015; Reinhard & Folmer, 2011). Adaptive water management is proactive and embedded in the landscape. It follows an holistic approach to managing landscape resilience using adaptive management based on the pillars of social equity, economic efficiency and ecological sustainability. Adding to this, there is a strong focus on adaptive, bottom-up and participatory approaches also.

1.1 History of Dutch water and flood management

There are three important events that have shaped the Dutch approach to water management since the start of the 20th century. In 1953 a storm surge hit the southwestern part of the Netherlands and lead to a flooding event breaking more than 150 dikes and leading to 1853 fatalities. The first Delta

Commission was established 17 days after the disaster event and lead to the implementation of the Delta Plan. Then in 1993 and 1995 near-disaster events lead to another shift in the approach. Although in the end the dikes did not breach during the event in the 1990s and there were no casualties or major damage, people started to realize that floods can never be completely prevented and that flood risks are increasing due to climate change and socio-economic development. The 1990's floods created a shift from water resistance to resilience (van Buuren & Warner, 2014). People realized that dikes cannot be raised infinitely and that floods cannot be fully prevented (Roth & Warner, 2009). A single approach to prevent all flooding would not work. The new goal was to anticipate rather than react to risk (Klijn et al., 2015), thus shifting towards adapting to and living with water (Figure1) and not controlling it (Correljé & Broekhans, 2015; Janssen et al., 2006). These pivotal events respectively caused a shift in thinking from flood resistance to complete protection to resilience and ultimately accepting that the Dutch need to live with water (Roth & Warner, 2009).

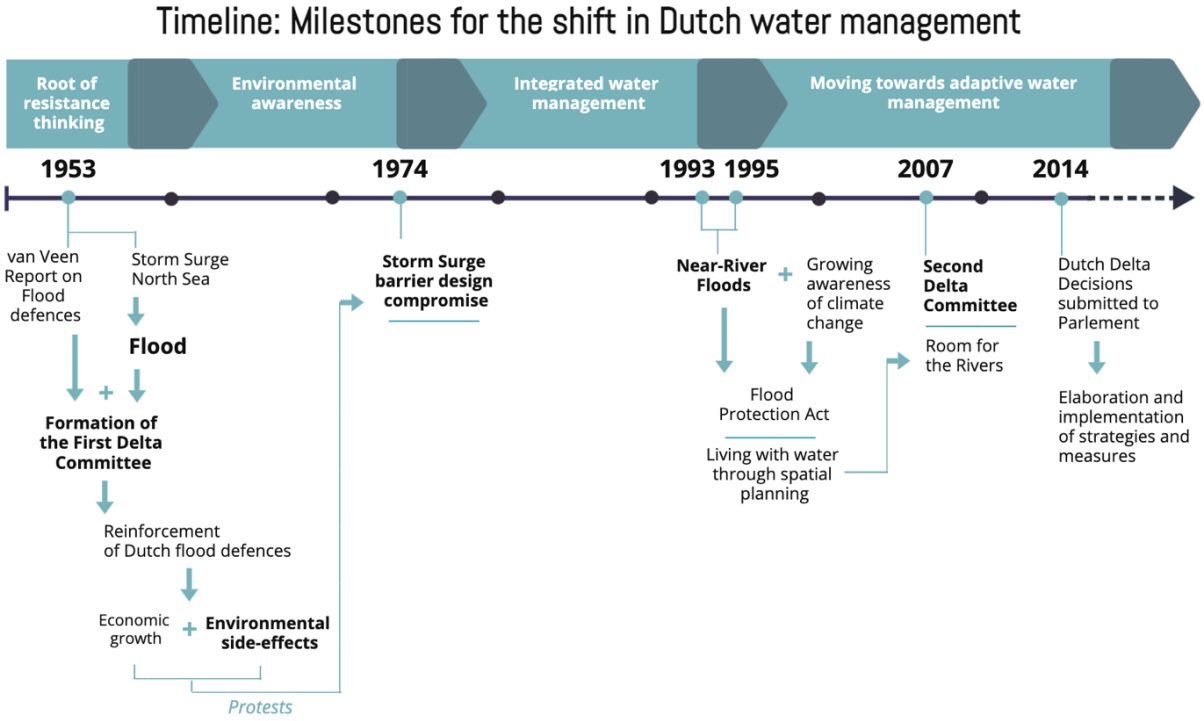

Figure 1: Milestones for the shift in Dutch water management.

1.2 Lessons on 'living with water'

This Dutch approach to water is a core export product of the Netherlands (Laeni et al., 2021), and as such has been implemented worldwide (Zevenbergen et al., 2013) e.g. to support Louisiana's new Coastal Plan and New Orleans's Water Plan (USA), Mekong Delta Plan (Vietnam) and the Bangladesh Delta Plan (Bangladesh). Efficient wildfire management necessitates social acceptance of wildfires and the cooperation between different stakeholders (Moore, 2019; O'Connor et al., 2016). In the Netherlands the Dutch have been able to make a shift from disaster management to prevention (disaster risk management) and make their country and communities more resilient by making space for flooding in the landscape. As the Dutch have had to learn how to live with water through adaptive water management, fire management can learn from these lessons on how to live with fire. We identified three main lessons that can be learned from Dutch water management that can be applied to wildfire management: (1) a holistic and integrated approach, (2) adaptive management and (3) resilient landscapes through stakeholder participation.

2 Summary of best practises learnt from water management for improving fire management:

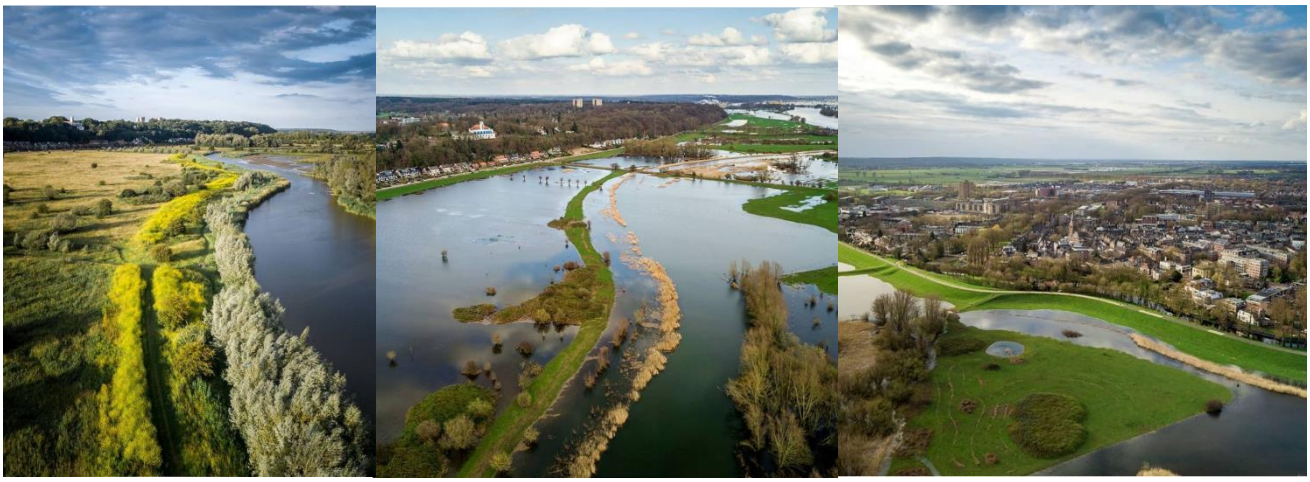

Figure 2: Uiterwaarden at Wageningen as example of the Room for the River Programme (dronewageningen, 2022).

2.1 Holistic approach

2.1.1 Collaboration

Collaboration between the different levels of government and private sector are necessary to adapt to long term climate and water related risks. This involves collaborative governance and integrated thinking at different levels. To increase resilience a holistic approach is taken for water resources and flood risk management. This consists of multilevel governance, legal enforcement and financial resources for flood protection while adapting to long term climate and water related risks (Commission, 2008; Van Alphen, 2016; Zevenbergen et al., 2018). The Dutch water sector shifted to an adaptive and integrated approach from a sectoral approach (van Herk et al., 2015). All the silos of water management are considered at the same time – flood risk, sewerage and water management. To achieve flood risk reduction objectives multiple agendas from other sectors are connected to address the water agenda. (Rijke et al., 2012) observed that in terms of integrating multiple objectives and spatial scales the Delta Programme design and multi-level governance processes have enabled the establishment of integrated plans and designs through working with stakeholders.

In Integrated Fire Management a similar approach is needed where stakeholders in the landscape collaborate with the multiple levels of government to find common objectives and develop integrated plans and measures in the landscape. Although wildfire prevention is also contained in Integrated fire management, a shift still needs to be made with a greater focus on wildfire prevention than on suppression as currently there is a big focus on fire fighting and less on prevention of impacts.

2.1.2 Risk-based approach

In the Dutch management of flood risks, a risk-based approach is followed and an acceptable standard of safety is calculated for the whole Netherlands. Measures are put in place for high-risk areas to also have an acceptable measure of risk exposure. These safety standards are calculated for all flood prevention measures in the Netherlands and re-assessed on a regular basis (every 6 years). More investment in risk reduction measures in high risk areas and lower investment in lower risk areas. Space was provided for lower-level authorities to attain these norms through alternative measures with the input of local stakeholders that were potentially impacted by these measures.

What fire can learn from this risk-based approach to floods is that more investment is needed in areas with high wildfire exposure to do fuel management whether it be through rural development, funding good forest management or fuel management initiatives.

2.1.3 Multiple layers of safety approach

An approach of prioritizing flood risk management is the multi-layered safety approach (MLSA). In addition to prevention, this approach focusses on integrating different types of measures into Dutch flood management and through this reducing the probability and consequences of floods. The implementation of this approach required collaboration among different public authorities with different taskings, legal competencies and resources (van Popering-Verkerk & van Buuren, 2017). Prevention is still the basis (and first layer) of this approach. This is done by improving defence systems such as dikes and by creating more space for water through a range of measures of which the Room for the river project was one example. The second layer focuses on spatial solutions - through adaptive spatial planning and adaptation of buildings, the potential consequences and losses of floods are limited when floods do occur. The third layer focused on organizational preparation for crisis management. This includes the development of disaster plans, risk maps, early-warning systems, evacuation plan, temporary physical measures (e.g. sandbags) and medical assistance.

From a wildfire perspective, in the 1st layer, risk reduction measures in the landscape, on a community level and individual level still needs to be the first priority. This includes education, awareness and measures to reduce ignitions, but also implementation of measures in the landscape to reduce the risk and spread of wildfires. Fire breaks and low fuel buffer zones need to be incorporated into the landscape around communities. On a second layer, new developments should only be built in high risk areas if these developments are resilient to wildfire, house hardening and defensible spaces are implemented and there are measures in the landscape that reduce the wildfire risk and spread. On the 3rd layer, communities need to have access to information and planning regarding wildfires. They need to be warned about wildfires through early warning systems, they need a source of information if a wildfire occurs, whether they should evacuate or stay at home during a particular fire. There is a need for this information to be accessible by the public i.e. www.overstroomik.nl where the public can see the potential of their house flooding in case of a flood event. They can then make an informed choice if, when and where to evacuate. They also need information about how they can reduce risk around their properties like FireWise in the USA.

2.1.4 Cost-benefit analysis

In the Netherlands, all new water-related projects are started by doing a cost-benefit analysis in flood risk management (dikes, engineering, landscape interventions). The future risk is monetized and is forward looking – in flood risk management projections of future socio-economic cost is taken into consideration when implementing risk reduction measures. Therefore, the greater the future socio-economic risk, the greater the motivation for implementing risk reduction measures. The cost of prevention/risk reduction is considered, while the cost of recovery is not. The Netherlands determines the potential impact of damage to infrastructure, financial and societal losses for the user of an infrastructure, which includes nature and human lives, expressed in monetary values.

Likewise, this approach needs to be applied when implementing risk reduction measures/projects on a landscape, WUI , community and individual level. Large scale fuel management needs to be applied to make the landscape more resilient and this task needs to be justified by greater benefit in the future due to lesser social, economic and ecological damage. Policy makers needs to take adopt this long-term view to make society more resilient to wildfire over the long-term.

2.1.5 Window of opportunity / disaster events

When there is more attention to flood risk due to a disaster event and motivation is high and memory clear, action needs to be taken like in the event of the 1953 flood, 1990's near-flooding event and after hurricane Katrina when shifts happened as with the Dutch case. With crisis or disaster events more attention is focused on the problem, the perception of the problem changes and although this is temporary it could change the urgency of political action and possibly change policies in the long-term (Kaufmann et al., 2016). Policy windows can be of short duration, but also cast long shadows

(Zahariadis, 2014). After a crisis or event is the time to have plans in place and push for policy to change.

Therefore it is important to have plans available already that in the event of wildfire disaster, plans are already available and ready to be put into action and policy.

2.1.6 Waterboards

Water boards play a crucial role in water management and flood protection on a regional level. Water boards are the oldest democratic organizations in the Netherlands. Parties within interest in water management (quantity and quality), like landowners, residents and wastewater dischargers (businesses and households), elect members to the waterboards, but also bear the cost of services delivered by the waterboard. These bodies started through a participatory approaches. They operate according to the principle of 'interest-pay-say'. Waterboards are entitled to raise tax and are financially self-supporting. At least 80% of the annual costs of water management in the Netherlands are financed via local and regional levy structures" (OCDE, 2014). Dutch Regional Water Authorities benefit from a dedicated financial institution, the NWB Bank, which provides stable, predicable low-cost finance required for water-related investment (OCDE, 2014)." The bottom-up and democratic approach gives legitimacy to the funding and measures put in place and will install a greater degree of trust in the tax investment.

There is an opportunity for communities that live in or alongside the WUIs to raise funds to put risk reduction measures in place. This would enable greater participation, trust and knowledge in protecting and reducing the impact of wildfire to communities in the WUI. This could be implemented as a private collective community incentive or as a tax by local/municipal government. Organisations like these also creates a network through which knowledge sharing, learning and collective action can be fostered.

2.1.7 Long-term approach

One of the novelties of the Dutch Delta Programme is that key decisions and regional strategies have been developed with a long-term perspective. The period up to 2100 was taken into account. This long-term perspective stimulates the combination of investment agendas of different policy fields or authorities (Zevenbergen et al., 2017). A six-year review cycle is used to assess whether adjustments are needed. By doing so the results indicate that Dutch water management aims to anticipate and stay ahead of disasters by adjusting strategies based on climate developments and future scenarios. After the 1953 flood, policies started to develop and finally a national framework was adopted based on the approach of adaptive water management.

The is long-term approach is also needed to make a shift from fire suppression to prevention/ living with fires as interventions in the landscape need to be implemented over a long period of time in contrast to wildfire suppression which is a short term solution. To adopt this long-term approach, adaptive management needs to be incorporated into Integrated Fire Management.

2.1.8 Adaptive management

To deal with uncertainty, adaptive water management was introduced to increase the flexibility of water management. Adaptive water management explicitly acknowledges the uncertainty and complexity of water management and is a response to the limitations of water management strategies that focus on full control (Pahl-Wostl, 2007, 2020).

Adaptive Water Management has been adopted by the Dutch government as part of the Delta plan. Adaptation to this is not only determined by what is known or anticipated at present, but also by what will be experienced and learned as the future unfolds, as well as by policy responses to social and water events (Haasnoot et al., 2012). van Buuren et al. (2018) describes the six components of Adaptive water management:

1.)**Accept future uncertainty** by developing scenarios and assessing the robustness of policy strategies. The future cannot (in all situations) be based on what has been learnt in the past when we accept full uncertainty.

2.)Together with these developed scenarios there needs to be more **learning by doing**. Show people good examples through information services and expand these experiments to bigger scales. The focus should be on learning on small scale not just sharing knowledge, but also starting to experiment. Local governments are crucial to implement important in this aspect as various lower-level authorities have proved more willing to new adaptation strategies as part of adaptive management (van Buuren et al., 2018).

3.) The possibility of **future shock** needs to be considered too. Create awareness that multiple sets of measures are needed to manage the risks and create/buy safety margins in additional to that. The adaptation strategies for the future need to be **reversable and flexible** if they do not work. Options need to be tested and if they do not work, change them following the adaptive pathway approach.

4.) **Soft measures** (awareness and education) needs to be implemented **in addition to hard measures** (landscape and physical measures). These strategies need to be implemented stepwise and must be able to change as the future unfolds.

5.) **Unnecessary lock-in's need to be avoided** e.g. building cities in areas that become vulnerable to climate change impacts (more flooding) in future. Pathways need to be developed presenting when and how to implement future policies. The focus needs to be on win-win options.

6.) **Capitalize on no regret options**. Increasing system robustness by taking easy-to-take measures that reduce risk or increase adaptive capacity and do not harm other public interests.

Adaptive water management is as much a social as a scientific process, because it requires the cooperation of stakeholders at all levels of society to be able to implement and react to change (Engle et al., 2011; Zevenbergen et al., 2013). Therefore in wildfire management we need to incorporate adaptive management to adapt to future uncertainties:

1.) We need to accept it is not possible to prevent all fires and we need to become more resilient to wildfires.

2.) We need more learning by doing especially when it comes to interventions in the landscape to reduce the fuel hazard and thus wildfire risk.

3.) Even though future scenarios have been created to anticipate changes in climate and wildfire danger, the possibility and impact of major fires need to be accepted and resilience increased. Create awareness that multiple sets of measures are needed to manage the risks and create/buy safety margins additional to that. We need to account for future (extreme) events that we have not seen in the past.

4.) The adaptation strategies for the future need to be flexible and reversable and flexible. The different options need to be tested and if they do not work, change them following the adaptive pathway approach (Haasnoot et al., 2012).

5.) Adaptation pathways have been developed and can be useful for fire management especially with a complex and large set of measures that need to be implemented. The approach can be as qualitative and qualitative as is needed.

2.1.9 Resilient landscapes through stakeholder participation

2.1.9.1 Room for the River Programme

Living with water is engrained in the landscape of the Netherlands. The Room for the River project was started as a national plan to adapt to living with water and reduce the risk of flooding. " The "Room for the River" program had a budget of more than 2 billion Euro and consisted of 39 different projects located along all the main branches of the river Rhine (Rijke et al., 2012). The project was started in 2007 and completed in 2015. The main idea to give the rivers back the space that was lost to development during the past centuries when floodplains became occupied by industries and residential areas and reduce te amount of people in these areas and thus the risk. Instead of heightening the dikes, the dikes were moved further away from the river to make more space for the river by creating additional flood plains limiting the risk that dikes would break or overtop. In addition to reducing flood risks the Room for the River Program had many co-benefits. The floodplains are high in biodiversity, are used for recreation in summer and support animal grazing. Resilient landscapes were created by adapting the land use to current and future flood risks. Areas with low flood risk can be used for high value activities and human settlement while in high flood risk areas the activities are limited to lower value activities such as agriculture and seasonal camping grounds.

In Integrated Fire Management we need more focus on implementing low fuel load zones in the landscape on a large scale to limit the spread and severity of unwanted fires in the landscape. These zones can be multi-purpose and also serve in addressing the recreational needs of the communities and conserve biodiversity. Common objectives of the different stakeholders involved need to be identified and work towards.

2.1.9.2 Collaborative governance

The Delta Program is using Room for the River as an example for organizing collaborative governance and how to deliver integration of objectives across spatial and temporal scales (Rijke et al., 2012; van Herk et al., 2015). The Room for the River Programme adopted a multi-level governance approach in which NGO's and private stakeholders in different disciplines (e.g. water safety, planning, agriculture, nature) and authorities at national, regional and local levels are actively collaborating to reduce the flood risk and to increase the spatial quality by creating more space for the river (Van der Brugge et al., 2005; Zevenbergen et al., 2015).

2.1.9.3 Stakeholder engagement

One of main successes of the Room for the River Programme is its stakeholder engagement. The Dutch government takes full responsibility for flood protection in the Netherlands and therefore funds flood risk reduction measures out of tax funds. The Ministry of Housing, Spatial planning and Environment and Ministry of Agriculture, Nature Management and Food Safety also have partial water management responsibilities. Waterboards are responsible for flood risk reduction measures and managing water levels. At local level, municipalities are responsible for spatial planning and management of the sewerage system. The twelve provinces ensure that national and provincial policies on water and spatial planning are implemented by regional and local stakeholders/parties. To bring all these layers and collaborative stakeholders together stakeholder engagement is necessary. In Room for the River this was done through making information available to stakeholders adding to transparency and building trust. Due to interest of the stakeholders in this area, they had to be involved in the projects as they would have to live with the results of the programme every day. Therefore it was crucial to engage with the stakeholders to find situations that the stakeholders were content with. Therefore, much attention was given to information and consultation meetings with local administration and stakeholders.

Where large scale interventions in the landscape need to be taken (e.g. controlled burning, creation of buffer zones, deciding on placement of interventions in landscape) to reduce wildfire hazard and

spread, the stakeholders participation is important, to find common objectives and solutions to potential problems and challenges.

2.1.9.4 Knowledge sharing

The local government worked closely with the local residents of each project location in the Room for the River Programme. Together they tried to answer the questions: “how do you want to achieve the required reduction of the water level?” During this participative process, some solutions were found with which all stakeholders were content with. During this process the role of information and local knowledge was crucial to the success of the project (Marchand et al., 2019). A Decision Support System, called the Planning Kit, was developed to handle the information and was successful in supporting joint planning with stakeholders (Van der Most et al., 2018).

In Integrated Fire Management, we need sharing of information, but also a participative process to find solutions to fuel management issues in the landscape. This is important to include local knowledge in interventions and exchange knowledge with scientists and include this a the planning of such interventions in the landscape.

3 Conclusions

Just as the Netherlands has learnt to live with water, fire-prone regions and less fire-prone regions need to learn how to live with fire and adapt to become more resilient. To increase wildfire prevention in Integrated Fire Management, we need an integrated and holistic approach with a focus on collaborative governance, adaptive management and resilient landscapes through stakeholder participation. This needs to be done through a long-term adaptive approach with learning through learning-by-doing on a large scale in the landscape. There needs to be more shared responsibility and initiatives between science, practice and society. There needs to be independent organisations that can coordinate between the landowners, government and civil protection. Integrated fire management needs to focus on all layers of safety with cooperation between government, NGO’s, society, landowners, civil protection The window of opportunity after wildfire events need to be take advantage of to persuade policy makers to implement prevention policies (with plans already developed to be implemented). A long-term perspective needs to taken by policy makers with more policy and investment focussing on prevention in additional to suppression to make society more resilient to wildfire. Integrated fire management need more community initiatives to raise funds and implement risk reduction measures in the landscape and WUI and more use of nature based solutions e.g. Prescribed fire, fire breaks, buffer zones, landscape interventions to reduce risk. Fire Management needs greater participation of stakeholders and collaboration between stakeholders to share responsibility and knowledge to make wildfire prevention more attractive and implementable by society, landowners, civil protection and policy makers.

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