

# Operational tools for improving efficiency in wildfire risk reduction in EU landscapes

## FIREfficient

### *Social factor and territorial dimension of wildfire risk management: managing societal involvement and cross-sectoral planning*

#### Action A3.1

**“Developing a set of procedures, tools and methodologies for enhancing  
planning capabilities to mitigate large wildfire risk”**

**Report on questionnaires and interviews in social perception of fire risk**

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## *Preface*

Wildfire risk planning can be understood as a tool to establish anticipatory firefighting and preventive strategies, but its mission is increasingly intricate as land-use planning tools are unable to keep pace with rapid rates of social and environmental changes. For instance, as more people begin to live and build a house into the wildlands, wildfires are likely to be more severe and our homes less defensible, solutions become more complex because we must take into consideration nature, human being and balance needs of both.

The success to adapt to this new dimension of risk is largely induced by social factors such as fire risk perceptions, capacities to face increasing levels of risk or identification of relevant social actors to come into play. Therefore, wildfire risk problem must be addressed by incorporating perspectives of knowledge arising from the influence and impact of socio-structural forces, traditionally excluded in the management of the phenomena or set aside after biophysical concerns. This makes necessary to move towards a reconceptualization of the relationship between fire/wildfire and society, which implies a higher degree of social and political commitment.

The dissertation exposed in the next pages will then involve an array of social challenges that will be up for discussion while focusing on managerial aspects related to risk assessment, preparedness and mitigation as well as organizational aspects like coordination, assignment of responsibilities and communication enhancing the good governance and societal and institutional – assuming the cross-sectorality of the phenomena - involvement to achieve an efficient wildfire risk management and mitigation.

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## 1. Report's aim and methodology

### 1.1. Objective

This report wants to show elements for a better wildfire risk integration in the territorial, forest and urban planning scope by means of communication, community involvement processes and transfer of knowledge. Two key factors are identified to tackle the problem in a practical way:

- innovative tools and practices of communication and transfer of knowledge need to be explored in order to promote an efficient fire risk culture, and,
- relevant public and private actors from different planning levels (from institutions to individuals) need to be targeted to share responsibilities throughout wildfire prevention and risk management processes.

It should be noted that the adopted approach transcends the forest management to have room for a territorial-scale management that, although it suggests a complex solution, certainly brings the problem into a broad perspective and meets the need to tackle it from different land planning scopes. To make it possible, it will be necessary to establish the guidelines of a comprehensive communication model that takes into account the wide array of existing actors and wildfire associated perceptions in order to achieve a message consistent with the essential triple criterion: conciliatory, clear and convincing.

This report targets specific actors to whom management suggestions and communication strategies are convenient to be addressed. Hence, in accordance with to the overall objective two types of target audience are classified:

- *Residents of wildland urban-rural interface areas* as stakeholders actively engaged in risk management decisions: it will be questioned to what extent residents living in fire-prone communities are likely to take proactive steps to safeguard their homes and properties.
- *Land planners* as actors responsible for landplanning, land-uses and regulation of activities: it will be questioned to what extent they are aware of the risk to conduct an adequate management from their planning scope.

Moreover, under the umbrella of the overall objective a set of specific challenges are aimed to provide some insights about the following aspects:

- Better understanding about the human behaviour with respect to wildfire risk.
- Public motivation to adopt self-protective behaviour.
- Capitalization of the knowledge achieved so far about prediction of potential fire events into land-use planning.
- Successful transfer of knowledge and operational techniques to enhance cooperation among different land planning actors involved in the decision-making processes.



## 1.2. Methodology

The preparation of this report draws on two main sources: literary, as a result of a comprehensive review of papers related to fire risk perception and communication; and oral, as a result of interviewing experts in the realm of forestry and land planning. Further information has been acquired by seeking expert advice. Several relevant actors in land planning and fire management were interviewed<sup>1</sup> with the purpose of characterizing social weaknesses and opportunities for fostering wildfire planning (see box 1)

Nevertheless, the whole collected information includes the documentation of opinions and specific studies that have been obtained by attending conferences, seminars, workshops or other professional sessions developed in the frame of the FIREfficient project;

- “Workshop on integrating wildfire risk in the urban and spatial planning: Review of knowledge and practices”. Solsona, June 12-13th 2014. More information: <http://fireefficient.ctfc.cat/?p=123>
- Seminar “Wildfires in the urban interface; towards a wildfire risk integration into land planning” organised by CUIPMB and Pau Costa Foundation with the support of the FIREfficient Project. Barcelona, October 25-27<sup>th</sup> 2014. More information: <http://fireefficient.ctfc.cat/?p=150>
- High level expert workshop on “Wildfire risk integration into land planning” at national pilot site level. Barcelona, February 25<sup>th</sup> 2015. More information: <http://fireefficient.ctfc.cat/?p=171>
- April 7-10th a Mission to UK organised to exchange knowledge and lessons learned at EU level with the participation of all partners. It includes the Seminar “Wildfire research and its impact on Policy, Planning and Operations: The Swinley Forest Fire” host by University of Greenwich. More information: <http://fireefficient.ctfc.cat/?p=207>

### Box 1. List of actors in land planning and fire management interviewed

David Caballero. Head of Forest Fire Department. MeteoGrid (Forestry and Fire Risk Consulting Company)  
David Pérez. Technic staff. Member of ADF's (Forest Protection Associations) Bages Federation Board & Environmental Department of Bages County Council  
Pere Frigola. Responsible for Forestry Programs in the region of Girona Agricultural Ministry of the Government of Catalonia  
Edgar Nebot. Technician in UT GRAF (Technical Unit of Forest Actions Support Group). Fire Service of the Government of Catalonia  
Esteve Canyameres. Chair, Service of Forest Fire Prevention. Agricultural Ministry of the Government of Catalonia  
Ferran Pauné. Environmental consultant. Ferran Pauné Consultant (Private Company)  
Jordi Pagès. Technician in UT GRAF (Technical Unit of Forest Actions Support Group). Fire Service of the Government of Catalonia  
Ricard Farriol. Head of Forest Planning. Forest Ownership Centre of the Government of Catalonia  
Roser Rodríguez. Professor at Department of Physical Geography and Regional Analysis. University of Barcelona  
Xavier Navalón. Chair, Unit of Municipal Wildfire Prevention. Regional Council of Barcelona

<sup>1</sup> The interview model chosen were “semi-structured interviews” including a set of predefined open-ended questions in which interviewees were expected to share their own knowledge and experience and had freedom to contribute with additional relevant topics that strayed from the interview initial guide. As is evident, interlocutors were asked a number of questions consistent with their specific field of knowledge and professional background

## **2. Socio-environmental dimension and cross-sectorality of wildfire risk management**

### **2.1. Analysis of the causal frame of wildfires under a socio-environmental perspective**

#### **2.1.1. The socio-environmental dimension of wildfire risk in a global change context**

Wildfire is a natural phenomenon with relevant ecological, economic and social impacts. Due to this, landscape management and fire impacts understanding are extremely important, especially within the context of socio-environmental global changes. Changes in land use and climate change are the major inducers of new forest fires. Evaluation approaches must be understood from a broad perspective of global change as present society belongs to a generation in which ecological and social transformations exhibit unprecedented and transcendental dynamics where wildfire must be understood as the result of these changes. Referring the issue that concerns this report, this circumstance brings alterations on fire regimes aggravating and diversifying the range of associated impacts and meets a vulnerable society that could not be prepared to take such a magnitude of risk. This is why reducing the threat of wildfire requires understanding both the biophysical and the human social systems (BADIA et al., 2002; HOOVER and LANGNER, 2003; KRUGER et al., 2003; DENNIS et al., 2005; DANIEL, 2007; BOWMAN et al., 2009; PECHONY and SHINDELL, 2010). In the face of this challenging scenario, land planning is instrumental in a sound risk communication and must undertake responsibility for integrating the new relations between natural hazards and society.

All in all, given a scenario of global change, the central issue relies on the adaptive capacity: learning to coexist with fire must be an imperative since wildfire cannot be excluded from fire-prone environments and creative responses will be required to manage uncertain scenarios effectively (BURROWS, 2008; PAUSAS and KEELEY, 2009; FERNANDES et al., 2011). Likewise, creative responses will be required to manage these threats effectively: improvements in knowledge and technology can minimize socially disastrous fires although cannot make them disappear (GILL and STEPHENS, 2009). Scientific and technical knowledge are fundamental support tools but they are not enough to reach a high level of capacity. Definitively, it is going to be necessary to strengthen the social, economic and political spheres associated with the implementation of adaptive measures (LE GOFF et al., 2005).

Throughout the last decades social sciences have explored the causes of environmental problems, as well as their possible solutions, by obtaining a better understanding of the dual “nature-culture” (BOADA and SAURÍ, 2002). As SWYNGEDOUW (1999) avouched, the world is in a perpetual state of metabolism in which both natural and social processes are combined in specific historical-geographic forms resulting in a “singular (or historic) nature” which comes defined by biophysical, social, economic, cultural (among others) components. This assertion, might be taken just as it is when speaking about wildfire as there is no doubt that it constitutes a significant problem that, just as most of natural hazards, incorporates a natural and social reality, even though the interaction of society with wildfire is more recent than with other natural hazards. As a consequence of the frequency of wildfire occurrence

and the severity of impacts on health, economy, security and environmental, more recently this natural hazard has become a major matter of concern for the society and, more specifically, for distinct social actors who now meet the necessity to recognize and tackle land planning as a crucial aspect within wildfire risk management (decision makers, urban planners, firefighters, researchers...).

### **2.1.2. Assessment of vulnerability to wildfire risk**

Since throughout this report we analyse the wildfire risk management by focusing on preventive planning strategies, it is worthwhile defining the concept of vulnerability, particularly understood as a crucial aspect to be distinguished from the concept of risk exposure. While in short vulnerability can be defined as “the potential for loss”, beyond this broad definition a myriad of points of divergence arise amongst the scientific community when it comes to specify what sort of loss and whose loss it describes (CUTTER, 1996). Without deeply discussing the different interpretations about the concept of vulnerability, in the following lines we will just go generically through some of its aspects from the perspective on how we will deeper approach them further in this report.

Distinction of vulnerability from risk brings with it a set of implications for the policies of risk management dealing with wildfire events. In the realm of natural disasters, risk is commonly expressed as the interaction between natural or human-induced hazards and vulnerable conditions. As an example, DANIEL et al. (2003) defined wildfire risk as the “value” of lives, property and environmental resources exposed at risk (the vulnerability level) multiplied by the probability of the occurrence of a fire of sufficient intensity to cause damage or loss (the hazard level). Likewise, potential for risk disaster decreases as communities or societies expand their capacity to cope with the potential negative consequences (UN/ISDR<sup>2</sup>, 2009).

Risk management must promote proactive policies and practices in order to save lives and protect properties and resources before the hazard occurs, while dealing with fundamental practices of mitigation, preparedness, response and recovery. Thus, risk can be attenuated with properly prevention (avoid the disaster) and mitigation (limit the disaster) strategies, leading communities to minimize their vulnerability, or amplified in the absence of same. The combination of agroforestry and livestock activities, which promotes a landscape mosaic, as well as the urban and territorial planning, which includes urban settlements and risk infrastructures, all will affect the overall vulnerability of the territory (UN/ISDR, 2009; PLANA, 2011a; PLANA, 2014).

Vulnerability can be conceived in many ways as it has always associated economic, social, organisational, cultural or educational dimensions, amongst others. CERDAN (2002) advocated for a hybrid approach of vulnerability concept which integrated both economic and social aspects while speaking about wildfire risk. For this author, economic conceptualization of vulnerability is crucial because risk can affect the economy of the territory since the destruction of the forests decreases its profitability and could negatively affect forestry expectations during the period after fire. Likewise,

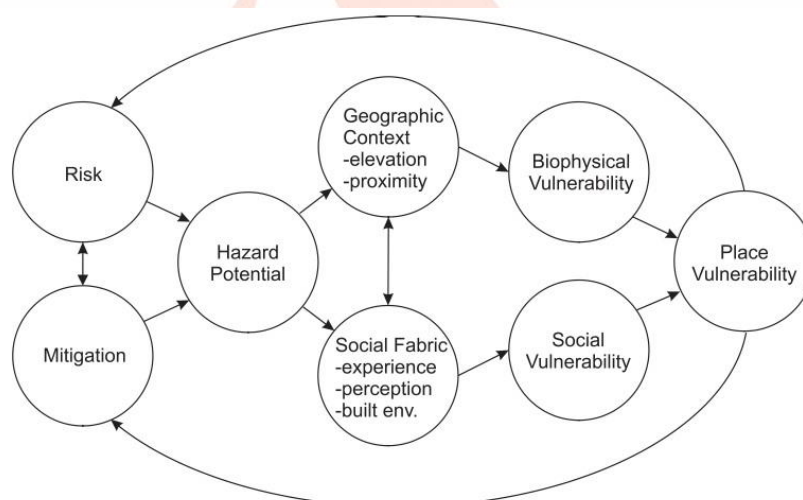
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<sup>2</sup> United Nations International Strategy for Disaster Reduction (UN/ISDR)



population living in areas of friction with forests (later discussed in Wildland Urban Interface chapter 2.1.6) have as such a high degree of vulnerability which is turn increased by their lack of capacity to mitigate the potential of wildfire risk. This social incapacity to undertake subsequent self-protective measures is an essential issue when it comes to assess levels of vulnerability.

While speaking about vulnerability of overall natural hazards, CALVO (2001) highlighted two basic characterizations of this, one focused on the potential risk exposure and another focused on the social response to dangerous situations. In a quite parallel<sup>3</sup> formulation, CUTTER (1996) distinguished between social vulnerability, referring to social susceptibility to potential losses after a hazard occurs, which is largely associated with structural weaknesses of social communities affected by forest fires, and biophysical vulnerability resulting from the interaction of society with biophysical conditions<sup>4</sup>, which includes the resilience of the environment to hazards and the adaptability of society to those impacts. Furthermore, CUTTER gave remarkably attention to spatial outcomes –which can concern both social and biophysical vulnerability– and constructed a heuristic understanding about the diverse of dimensions regarding the vulnerability of places (Figure 1).



**Figure 1. Hazards of place model of vulnerability.** Source: CUTTER (1996).

Hazards of place model suggests that hazard potential is affected by a “geographic context” leading to biophysical vulnerability, referred to site and situation of the place, and a “social fabric” leading to social vulnerability, referred to those people who are most vulnerable. Combination of both results in the overall place vulnerability, that must be understood as a dynamic concept as it is not static but it changes in function of the risk, implemented mitigation strategies and hazards contexts (CUTTER, 1996, 2003). In line with CUTTER’s theory, CERDAN (2002) highlighted that cartography may be the most practical way to establish the degree of vulnerability in a certain place, as, by means of this, people and

<sup>3</sup> Social susceptibility that CUTTER described would be somehow related to social response that CALVO highlighted, whereas biophysical vulnerability would be related to potential risk exposure

<sup>4</sup> When speaking about non-natural hazards, such as floods and chemical accidents, instead of biophysical vulnerability we would refer to technological vulnerability

goods exposure to natural hazards would be easier to be territorially delimited. As this author described, wildfire simulators are useful to establish a classification of the territory according to its risk levels as they provide information about fire spread and behaviour as a function of relationships among present fuels structure, topography and the most likely weather conditions. Hence, once wildfire scenarios have been forecasted, we will be able to accurately assess different levels of vulnerability concerning the population, infrastructures and other material goods all across the territory.

### 2.1.3. Collapse of rural systems and land-use changes

Even though in the causal analysis of large wildfires<sup>5</sup> approaches focused on direct (or imminent) causes are most conspicuous, some studies address the issue from the socio-environmental perspective, emphasizing the socio-structural forces as natural conditions responsible for a scenario highly exposed to wildfire event (BADIA et al., 2002). It is becoming more evident that the conjunction of a number of socio-structural factors is favouring the likelihood of a fire being ignited and spread resulting in an uncontrollable and more damaging event. Accordingly, PLANA (2007) argued that structural causes (also called underlying causes) can be explained by way of two key processes intrinsic to the forest fire phenomenon: the probability of ignition and the potential for spread. On one hand, the increased risk of ignition is due to a greater attendance of urban population in rural areas and an increased number of high risk infrastructures, such as power lines or road paths, to meet this urban demand for rural areas. On the other hand, the increased risk of spread is compounded by fuel accumulation and loss of passive (or indirect) prevention, understood as the detection or immediate suppression, the knowledge of the territory or the maintenance of paths by the resident population once the land is abandoned or poorly managed.

In most EU sites, the massive rural exodus in the last century has led to the abandonment of traditional managed lands and its gradual afforestation<sup>6</sup>. While ancestral activities kept reasonably low fuel loads in the forest and helped to fix the presence of people on rural systems, the lacking of a permanent land management has contributed to the creation of homogenous landscapes with poor structures and an increasing accumulation of biomass (PLANA et al., 2002; ESPELTA et al., 2004; RODRÍGUEZ et al., 2014). As PLANA (2007) said, increased fuel loads in abandoned territories occurs both horizontally (abandonment of farmland and grazing practices as well as loss of landscape mosaic) and vertically (densification of forests because of abandonment of silvopastoral exploitations). We are ultimately facing a new scenario very different if compared to some decades ago when forests maintained its functions and structure thanks to the more periodic removal of trees and clearings of shrub and herbs. The dichotomy nature-human being, where the human being is a spectator rather than an active agent, is accentuated. The ecological dynamics generated by the abandonment of traditionally primary

<sup>5</sup> Designation of large wildfires takes into account the intensity, the amount of goods and people in threat, and the severity. (According to the Spanish official statistics, Large Wildfires are referred to those forest fires with an extension that exceeds 500 hectares)

<sup>6</sup> It should be noted that while the gradual reforestation of forests is largely attributed to natural recolonization of vegetation, the influence of planned afforestation should not be diminished, that is replanting initiatives in farmland usually encouraged by local policies

activities are leading to thinner and less vigorous tree structures, with higher levels of necromass and combustibility and increased difficulty of mobility and transitability of people and domestic animals through them. As a result, we have got vegetation much more inflammable and sensitive to forest fires.

Within a basically city dweller society, a fresh tendency to occupy rural areas strongly emerges. However, unlike earlier times, present-days trends have led to new styles of occupancy: residential and touristic land uses have become increasingly popular at the expense of primary and secondary sectors (RODRÍGUEZ et al., 2014). On one hand, the so-called neo-ruralism is a recent phenomenon of repopulation of rural areas. Neo-rurals are considered those people who leave the city and move to the countryside in search of an alternative lifestyle (NOGUÉ, 1988). On the other hand, a rising demand for rural areas as tourist destinations results in increased transient population seasonally occupying them.

This socio-economical context leads us to reflect on the following situation: in the past we had got people living in the forests and managing the territory; nowadays, we have got many people living in rural areas or developments within forested areas without making any use of the territory. As one can perceive, there is a loss of link between population and its environment and of a reliable knowledge on how to manage and prevent forest fires. This fact makes that people moving to rural systems with typically little knowledge of the forest environment sometimes provoke accidental small fires (by smoking, cooking...) which, due to current forest conditions, can easily turn into large forest fires. This also happens with rural citizens, which to some extent do the same practices in the traditional use of fire (smoke for getting the honey, controlled fire for vegetation cleaning for improve the hunting areas, elimination of rest of crops vegetation, etc.) which now can easily provoke a wildfire.

This circumstance is aggravated as a consequence of widespread construction of infrastructures to attend to a larger population size (houses, roads, railways, power lines, campgrounds, etc.). Particularly, power lines and roads have been recognized as having a noteworthy causal role in forest fires in the European countries. Power lines are a potential source of ignition but they are also a major hazard while executing suppression actions as it forbids, for instance, aerial drops of water. On the other side, the construction of new roads provides people easier access to remote areas even in the forest land, so it turns more difficult for forest managers and firefighters to control people flows, to be aware of their whereabouts and to intervene when necessary (XANTHOPOULOS, 2004, EUROPEAN COMMISSION, 2014<sup>7</sup>).

The use of fire as a management tool might be a good paradigm that reflects how new urban societies forgot and lost the traditional knowledge of the territory and best practices to conduct land management (MIERAUSKAS and PEREIRA, 2013). As a consequence of the widespread mind-set hold by new urban societies, the “idiosyncratic role” of fire in the traditional management decays and in some societies any use of fire and fire as a natural component of the ecosystem is criminalized. As less people from rural areas conducts controlled fire for multiple uses such as enhancing forage for domestic

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<sup>7</sup> The European Forest Fire Information System (EFFIS) – Joint Research Centre (JRC). <http://forest.jrc.ec.europa.eu/effis/>

animals, controlling pests, easing travel or improving conditions for hunting, together with the increased risk of propagation and the social threat, in many places fire has changed from being reckoned as an useful resource, to become a controversial issue whose utilisation is strictly regulated (CASTELLNOU et al., 2010).

#### 2.1.4. The fire suppression paradox and fire statistics understanding

According the “fire suppression paradox”, typically, most of fires burn small areas, whereas a minority of fires are responsible for most of the burned area (table 1). Usually, with the technological response in suppression efforts, the ratio of fires that could be controlled during its initial stage and burn few hectares increase. This means that we have got an effective firefighting system (due to high investment in suppression resources) whose ability to rapidly extinguish most of fires has been improved over the last decades, but reveals that particular large fires occasionally burst and exceed our extinction capacity. Consequently, unsuccessful years in fire suppression objectives helps the next seasons in terms of burnt area and successful suppression years pose more vulnerability to the forest for the next seasons, increasing the potential for larger wildfires. Vast burned areas in critical years offers a mosaic of low fuel loads that helps next period controlling fires. Therefore, efficient interventions carried out by fire suppression systems represent a short-term solution for forest fires at the same time as they contribute to aggravate a long-term problem, as policies based on the identification and rapid suppression of fire are overtaken by critical events and favour the fire suppression paradox (PLANA, 2007; CASTELLNOU et al., 2010).

**Table 1. Number of fires and burned area in Catalonia (northeast of Spain) by fire sizes and time periods**

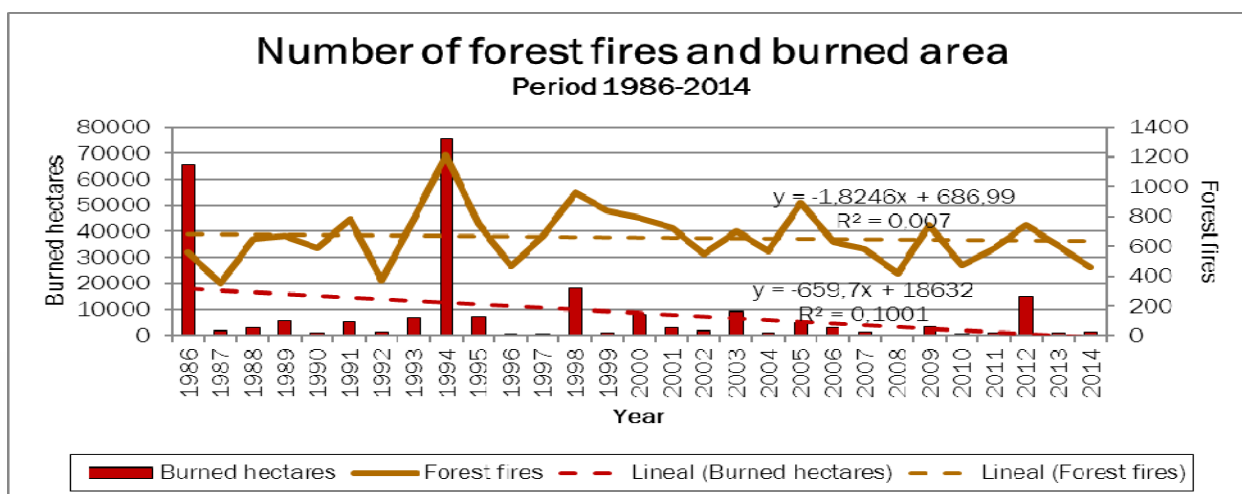
| Fire size<br>(ha) | Period 1983-1992 |      |                   |       | Period 1993-2002 |       |                   |       | Period 2003-2012 |       |                  |       |
|-------------------|------------------|------|-------------------|-------|------------------|-------|-------------------|-------|------------------|-------|------------------|-------|
|                   | Nº               | %    | Area (ha)         | %     | Nº               | %     | Area (ha)         | %     | Nº               | %     | Area (ha)        | %     |
| < 1               | 2.866            | 50,9 | 710,11            | 0,54  | 5.988            | 77,21 | 978,65            | 0,78  | 5.395            | 85,05 | 781,68           | 1,89  |
| 1-10              | 2.168            | 38,5 | 5.946,89          | 4,49  | 1.452            | 18,72 | 3.807,55          | 3,03  | 752              | 11,86 | 2.106,16         | 5,1   |
| 10-100            | 463              | 8,22 | 12.996,16         | 9,82  | 223              | 2,88  | 6.403,4           | 5,1   | 141              | 2,22  | 4.347,32         | 10,52 |
| 100-500           | 90               | 1,6  | 19.300,8          | 14,58 | 61               | 0,79  | 14.478,7          | 11,53 | 38               | 0,6   | 7.981,26         | 19,32 |
| > 500             | 44               | 0,78 | 93.437,4          | 70,58 | 31               | 0,4   | 99.872,38         | 79,55 | 15               | 0,24  | 26.090,03        | 63,16 |
| <b>Total</b>      | <b>5.631</b>     |      | <b>132.391,36</b> |       | <b>7.755</b>     |       | <b>125.540,68</b> |       | <b>6.341</b>     |       | <b>41.306,45</b> |       |

Source: Department of Agriculture, Livestock, Fisheries, Food and Natural Environment – Catalanian Government.

<http://agricultura.gencat.cat>

The “occasionally” (figure 2) of critical wildfire events as well as the connexion between “bad” and “good” years in terms of burnt areas makes difficult the statistic interpretation about the risk management improvement on the one hand, and, on the other to highlight the “latent” risk within periods of no many surface burnt which will affects citizens but overall policy makers awareness.





**Figure 2. Number of forest fires and burned area per year in Catalonia (northeast of Spain) during the period 1986-2014.** Source: Department of Agriculture, Livestock, Fisheries, Food and Natural Environment – Catalanian Government. <http://agricultura.gencat.cat>

### 2.1.5. The human alteration of the natural fire regimes

Fire regime refers to the characteristic parameters of forest fire: frequency, intensity, seasonality and type. Natural regimes have historically always existed in fire-prone ecosystems, and they have never been static but they are a result of natural evolution dynamics influenced by certain factors among which the weather has historically played a major role. However, the human being is altering the natural fire regime and the magnitude of recent above commented changes such as land-use and management and fire suppression has led to a fire regime that exceeds the natural patterns bringing a more patent dimension of risk (CASTELLNOU et al., 2007; PAUSAS and VALLEJO, 2008; PAUSAS and KEELEY, 2009).

Note that the alteration of fire regimes has been far from being uniform all across the world. Human caused burning has increased fire frequency in tropical regions where fire-sensitive ecosystems dominate. In temperate regions, fuels load and structure has changed (shrubs have been replaced by annuals grasses and colonizing trees) contributing to the increase intensity in regions that earlier were used to experiencing regimes of frequent and low-intensity fires. These ecosystems appear to be modified to a great extent by fire suppression policies as they are those that support more abundance of fuel. On the other side, in Rocky Mountain lodgepole pine forests from United States high severity fires every 100-300 years are ecologically positive and they have not been extensively impacted by fire suppression (CARROLL et al., 2007; PAUSAS and VALLEJO, 2008; GILL and STEPHENS, 2009).

Management approaches to restore fire-adapted ecosystems require active treatment or removal of fuels load (mechanical thinning, prescribed fire...) since excess fuels provokes higher intensity and severity fires. For instance, in regions with a regime of frequent fires, higher density of trees and large load of surface fuel may provoke more incidences of large-scale crown-fires. Accordingly, forest management best practices should be aimed at restoring ecosystems to previous conditions where non-lethal low-intensity fires were common and crown-fires which burn over vast areas were rare (CARROLL



et al., 2007). The issue to solve at land planning level is if that forest structures resistant to the natural fire regimes (for instance, high and low dense trees stands) are suitable for the ownerships and the forest industry.

#### **2.1.6. Wildland Urban Interfaces; the meet of wildfire and individuals**

Over the last decades, wildfire phenomenon is increasingly becoming a safety issue. Urban and forest expansion are two contemporary facts. Urbanization has spread areas previously occupied by crops where forest has growth later on. This has brought an expansion of friction zones between urban and forest areas, known as “Wildland-Urban Interface” (WUI henceforth), which have a high exposure to fire risk and require urgent attention to strengthen security (WINTER and FRIED, 1998; LINCH, 2004; CABALLERO, 2008; GRILLO et al., 2008; GILL and STEPHENS, 2009; PAUSAS, 2010).

Currently, inherent wildfire risk within WUI is one of the most controversial and problematic issues for fire suppression and emergency services. Human life and urban houses are the focal point and fire suppression becomes more complex and expensive. New societies living in rural areas or developments within forested areas are not self-protected as farmers traditionally were. As CASTELLNOU<sup>8</sup> said at the workshop on “Wildfire risk integration into land planning” (see Methodology), forest fire is not the problem; the actual problem is having many people living in fire prone environments. That’s why, without minimizing the impacts of wildfire, the urgency of the problem results from the increasing people moving into wildland areas exposing their lives and properties to serious risk. People perceive seducing amenities (aesthetics, privacy, touch with nature...) to settle in zones where fire-prone and landscapes are dominant; consequently, the challenge of managing ecosystems and people to reduce fire risk increasingly grows in view of the fact that potential conflicts appear to be more feasible, severe and complex (MCCAFFREY, 2004).

In recognition of these circumstances, development of strategies focused on fire-prone WUI must expand, resulting from current context of increasing population likely to experience wildfire. As GILL and STEPHENS (2009) pointed, socially disastrous fires occurring in WUI might never have a completed solution since shifts in social and biophysical systems change over time in line with non-static processes such as population growing, cultural changes and vegetation and climatic shifts. In any case, innovative policies must be targeted to create successfully community preparedness for wildfire and community resilience to bounce back from fire impacts and solutions should be addressed in long-term system improvements rather than short-term fixes. If this fact would be ignored, incidence of wildfires is likely to get a dimension where it is most likely to be an element of contentious human and social risk (CORTNER et al., 1990; HOOVER and LANGNER, 2003; JAKES et al., 2003; CARROLL et al., 2007; COHN et al., 2008; GILL and STEPHENS, 2009).

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<sup>8</sup> MARC CASTELLNOU is head of fire analysis and strategy for the Fire Service of Catalonia

### **2.1.7. Climate change; adding severity, risk areas and uncertainty**

Collapse in rural systems and land-use changes of the pre-fire forest landscape are per se a major problem, but their effects can even get worse because of the climate change. Climate is a major factor that shapes fire regimes over long time scales and generates short-term weather that drives fire events. Recent research indicate that number, frequency and intensity of forest fires are likely to increase in the forthcoming decades due, in part, to shifts in climate, so creative responses will be required to manage uncertain scenarios effectively. Strategies to confront future uncertainties must recognize the potential for greater variability and directional changes in future climates in order to reduce social and ecological vulnerability to changing fire regimes (MACGREGOR et al., 2008; PECHONY and SHINDELL, 2010; RAFTOYANNIS et al., 2013).

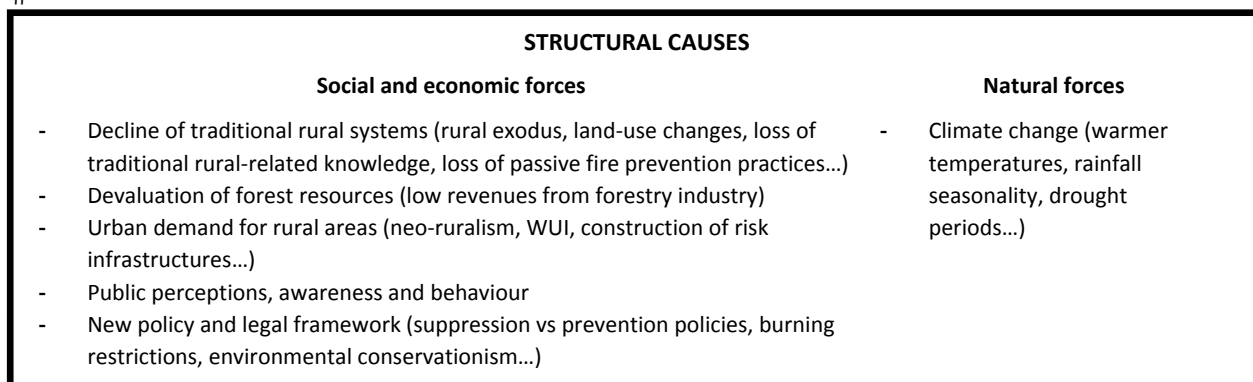
Both climate and fire regimes have been proven to play a determinant part in the formation of vegetation. Since climate and fire regimes are connected through vegetation, changes in climate such as warmer temperatures and more frequent and severe drought periods may lead to changes in fire regimes promoting fire to be the main agent of vegetation change in many natural ecosystems. Moreover, climate and fire regimes are likewise associated through the climate drivers of ignition and fire weather. At one extreme, wet seasons may promote fuels to build up; at the other extreme, drought seasons may induce the burning of great accumulation of fuels. Assuming that larger fires are more likely to occur under climate change conditions, particularly in a scenario of dry and warm seasons where fuel is abundant, the synergistic effect of fuel and weather should be underscored when preventing vast and catastrophic fires (AFE, 2006; CARROLL et al., 2007; PAUSAS and KEELEY, 2009; PECHONY and SHINDELL, 2010; RAFTOYANNIS et al., 2013).

Furthermore, shifts in climate are most likely to limit the ability to manage wildfire. Impending severe drought periods and high temperatures scenarios may bring suitable conditions for extreme fire behaviour to occur in areas historically affected by low intensity fires (e.g. temperate and boreal regions, this has significant relevance in terms of culture of fire). While effectiveness under extreme fire weather and conditions are expected to decrease, fire suppression costs are expected to increase. On the other side, regions exposed to unusual severe droughts, large areas may burn and forest managers will find difficulties to prevent destroyed forests from being taken in advantage by farmers to establish new farms (AFE, 2006).

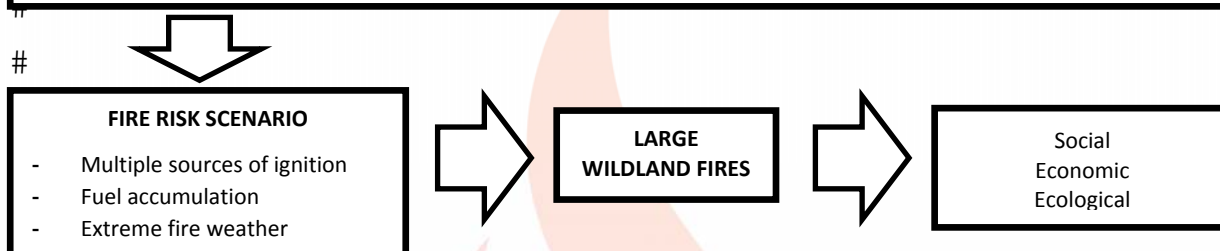
### **2.1.8. The need of an integrated assessment of wildfire risk causal frame**

All along this chapter several socio-environmental factors related between them have been described. All they are acting as driving structural causes that lead to larger wildfire events and the resulting conspicuous damages (figure 3). Wildfire risk management will need an holistic approach to identify them in a concrete way in a concrete territory, and balance their presence and influence. In all case, the efforts done in one component of risk chain will affect the others, and how to optimize the risk mitigation is one of the main challenges for the decisions making. It seems clear that the land planning plays a crucial role in terms of social and territory values vulnerability to wildfire.

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**Figure 3. Conjunction of structural causes leading to large fire events and associated conspicuous damages.**  
Source: the author.

## 2.2. Wildfire risk management at multi-scale, multi-stakeholder and cross-sectoral planning scope

### 2.2.1. The need of a landscape level scope

So far, we have placed an emphasis on the structural causes of forest fires as the main responsible for the increase of annual fire frequency and the occurrence of large forest fires –where extreme natural conditions act as triggers within an environmental risk scenario, as well as the subsequent need for acting with regard to fuel loads in order to decrease the potential fire risk. This primary assessment suggests that forest fire should not solely be seen as an accident, but also as a crucial element to be properly embedded into forest management and land planning. Forestry and spatial planning policies should therefore provide a coherent framework for integrating wildfire risk management from the perspective of the structural causes.

First of all, it is important to make clear the boundaries between forest management and forest planning when it comes to link wildfire risk with these two concepts. When it concerns practical applications of business methods and technical forestry precepts to the operation of a forest resource, we are talking about *forest management*. However, when it refers to risk analysis and its relevant planning provisions, assuring the connection from the territorial strategic higher level, tactical intermedium level, to the operational level, we are talking about *forest planning*. In short, tactical level modelling helps to bridge solutions reached at a strategic level using operational planning information.

Both strategic and tactical level are included into territorial-scale planning, whereas operational level refers to forest planning at stand level (PLANA, 2011a).

Current conjunction of socio-environmental circumstances highlights the territorial dimension of the problem and the need to incorporate it transversely at different levels of planning (multi-scale planning scope) with a high institutional coordination and a diversity of stakeholders. As PLANA (2007) asserted, from an institutional perspective, social and economic factors affecting the fire-related forest vulnerability go beyond the forest sector in so far as concern aspects related to agricultural land uses (landscape mosaic) or infrastructure planning and settlements (fire safety). In response to that, land managers should model how to think beyond property boundaries for territorial-level planning in wildfire preparedness while moving towards a scenario of proactive prevention in order to achieve stable landscapes to fire disturbance and less vulnerable elements to fire inside them.

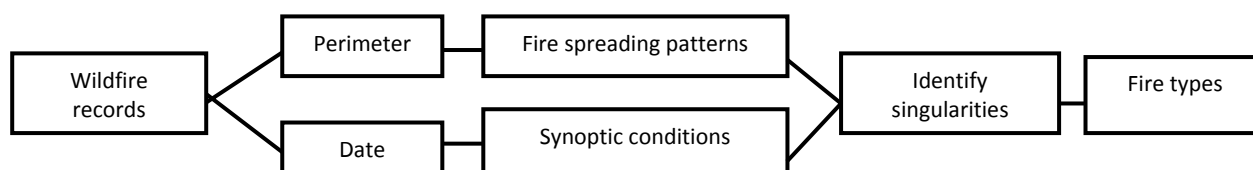
On the one hand, forest and landscape management must overcome widespread social topics such as rejection of logging and allocate resources and efforts to maintain diverse landscape with agroforestry-livestock combination. Hence, more initiatives should be aimed to integrate agricultural policies and livestock grazing practices into fire prevention. On the other hand, it should be pointed out that, from an economic point of view, urban planning may be the same or more important than forest planning itself, due to the greater potential losses in terms of material goods and people. As a consequence, it is important for land managers to reveal some insights into public's perceptions of risk from wildfire, attitudes toward fire management practices and multi actor and citizens' participation in planning efforts to reduce fire hazard in fire-prone areas.

### **2.2.2. The contribution of prior wildfire behaviour knowledge in land planning**

Predicting fire behaviour provides essential insights that must be connected to preventive management of large wildfires. By getting a better knowledge of the type of fires and fire regimes affecting a given territory, a better approach to implement in a real way the risk of fire in forest management and planning may be achieved. In this way, CASTELLNOU et al. (2010) stated that while moving towards fire management policies, leaving fire exclusion policies behind, a greater investment should be focused on "knowledge" instead of "more –suppression– resources".

While getting accurate predictions of potential wildfire behaviour seems to be an impossible task, by collecting factual information about a specific territory, such as weather, the behaviour of former fires or considering topographic features, one can approximately expect what type of fire may occur in the site under specific environmental conditions. The Forest Actions Support Group of the Catalan Government (GRAF) has developed the methodology for the fires patterns (recognition of singular and repeated spreading patterns and synoptic conditions (CASTELLNOU et al., 2009)) identification at regional level (figure 4). This is fully developed in deliverable 16 "Methodology for incorporating large fire risk into landscape management decision making" of FIREfficient project.





**Figure 4. Scheme followed by GRAF to identify wildfire propagation types.** Source: Adapted from CASTELLNOU et al. (2009).

Not all fires are possible at anytime and anywhere. The specification of a given region through the fire types concept with adjustments to specific landscape features results in the concept of model fires (CASTELLNOU et al., 2009). The difference between model fires and fire types lies in territoriality; that is, model fires go beyond to the extent that associate fire types concept with two additional variables: particular geographical area and local synoptic situation. Model fires provide some insight about when and where fire is likely to occur and enables to anticipate and reduce the potential fire spread. More specifically, it gives an opportunity to prepare the territory through promoting forest structures that are resistant to fire spread (prevention) and identifying strategic management areas where the modification of fuel and creation of infrastructures (firebreaks, fuelbreaks, tracks...) would let the suppression services conduct safe operations to attack and limit the range of a large wildfire (pre-suppression) (GALÁN and LLEONART, 2004; OLIVERES, 2011).

Thus, valuable knowledge of model fires is of great significance in terms of safety and efficiency during the emergence, civil protection (WUI areas), and finally has key connotations regarding prevention of large wildfires and forest management in general. As usual, the execution of preventive and pre-suppression infrastructures requires a boost by all the agencies and individuals who share ownership and responsibility for forest management, enabling synergies between all interests and coordinating efforts. The capacity of prediction of the upcoming fire events according the specific characteristics of the territory, as mentioned by PLANA (2011a), may be considered as a meeting point between suppression services, land planners, land use and forestry, as well as prevention linked to sustainability of forest landscapes and its diversity. The same author highlighted the new opportunities that this knowledge is offering for the effective integration of wildfire risk into spatial planning although some gaps in regards vulnerability assessment still exist. All in all, the necessity to integrate wildfire prediction in territorial-scale planning emerges as it helps to face a more efficient wildfire risk management and share responsibilities among relevant stakeholders (CASTELLNOU et al., 2007; PLANA, 2011a).

### 2.2.3. Towards a firewise land planning

The wildfire problem is not limited to nature. Simple cabins, mobile homes or large expansive developments in the WUI, many of them are nowadays constructed in the ways of past fires and in the path of future fires. When wildfire occurs, homes at the landscape interact with natural forces, and results are likely to be devastating (NFPA<sup>9</sup>, 2015).

<sup>9</sup> National Fire Protection Association. Firewise communities program ---- <http://firewise.org/>



Responding to fire in the WUI gets even more complicated. Fuel comes in all forms: from natural fuels such as grass, pine needles and trees to fuels introduced by humans such as furniture, fences and vehicles, all of which require a new understanding of fire behaviour. Firefighters who are called to fight WUI fires must deal with little multiple ignitions into the neighbourhood and they are forced to choose between attacking the fire or defending the home (XANTHOPOULOS, 2004; GILL and STEPHENS, 2009; NFPA, 2015).

People living in or near wildland areas should assume some responsibility for protecting their property, but many of them remain unaware of how wildfire behaves or of the preventive actions they may take to defend themselves and their homes (KRUGER et al, 2003; NELSON et al., 2003; AGRAWAL and MONROE, 2006; BLANCHARD and RYAN, 2007; GILL and STEPHENS, 2009). Likewise, land management agencies face increased planning requirements and the need to gain both institutional and public support in order to put it into practice (WINTER and FRIED, 1998; COSTANZA and MOODY, 2011; STEELMAN and MCCAFFREY, 2013). Thus, prevention of large forest fires should strive to move forward towards a better social understanding of the role of fire in the ecosystems that favours strategies based upon fuel management and a better social understanding of risk exposure that promotes attitudes of self-protection and shared responsibility (PLANA, 2011a).

For wildfire professionals working in fire-prone areas, firewise planning is a valuable service that landscape architects and designers can offer to homeowners. The WUI data and maps must be used in fire planning and management when it comes to know where housing and wildland vegetation coincide. Firewise designs incorporate the needs of two areas: the structure and the area around. On the one hand, homes' chances of survival resides in stopping thinking about these structures as homes and starting thinking as fuels. On the other hand, well design and maintained areas around the structure can offer a defensible space. In that regard, interrupting a potential fire path is a primary concern of maintaining the property and the landscape, and it is here that landscaping can achieve fire safety without sacrificing visual harmony (KRUGER et al, 2003; XANTHOPOULOS, 2004; NFPA, 2015).

Planning for wildfire protection in WUI should also expect suitable accesses for suppression services –public roads, property access roads and fire trails– in order to enable safe access, egress and defensible space. Efficient accesses to and from habitable buildings and water supplies would facilitate safer intervention, relocation activities during fire events and would provide firefighters with enough space to set equipment and forces. Moreover, it is worth pointing that additional accesses are required so as to avoid the potential for disadvantages of a single road such as vehicle congestion, condition of terrain or climatic contingencies among others (NFPA, 2015).

In USA there are quite a few recognition programs addressed to neighbourhood leaders who effectively foster local wildfire preparedness. Neighbourhood leaders are challenged to increase local awareness of fire preparedness actions, provide positive feedback to participants, and contribute to establish fire

preparedness as a social norm. One good example is the Firewise Communities USA/Recognition Program<sup>10</sup> in which neighbourhoods can elect to participate and, on the condition that they meet the criteria to prepare and protect their houses against wildfire risk, they aspire to get certified as Firewise communities and receive award and media recognition for their efforts (SHIRALIPOUR et al. 2006; NFPA, 2015).

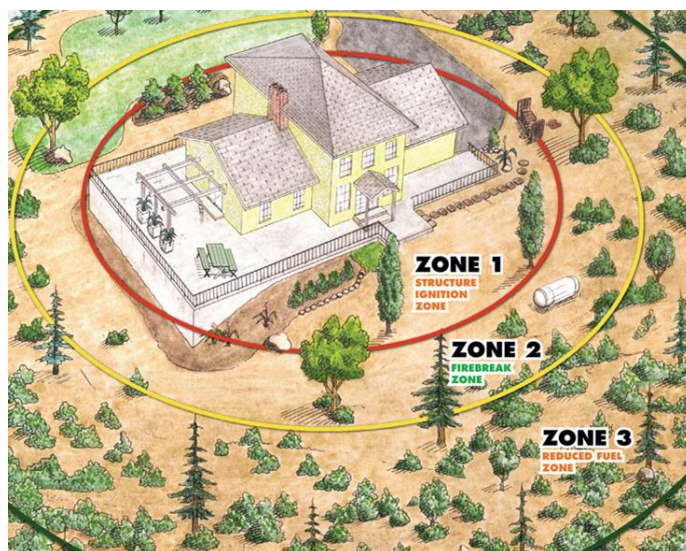


Figure 5. Firewise planning: model of defensible space around the house. Source: <http://napafirewise.org/>

#### 2.2.4. Wildfire risk as a complex issue; the need of a cross-sectoral and multi-stakeholders approach

Incipient destructive wildfires have evidenced the need for adapting planning procedures and practices to be addressed across a comprehensive number of variables which result from the complexity of the wildfire risk management. The previous mentioned variables ranged from human, socio-political, administrative-juridical and economic to technological or global change-related ones. All the same, by undertaking an actual scenario-based approach, some crucial weaknesses appear all across those variables putting difficulties and obstacles to not responding effectively on the prevention and suppression of fire-related disasters.

So far, we have achieved remarkable technical solutions to face wildfire risk problem, but its implementation land planning sometimes meets with environmental, social and economic impacts with little acceptance in the present socio-political contexts. In light of this unbalanced status between available knowledge and its integration into land planning, operational solutions are demanded for attaining successful (probably innovative) communication and transfer process of knowledge through end-users and policy makers involved in the decision-making processes.

<sup>10</sup> Further information about Firewise Communities USA -- Recognition Program can be found on the following website: <http://firewise.org/usa-recognition-program.aspx?sso=0>

Furthermore, land planning integrating wildfire risk needs to be approached as a “multi-scalar problem” by bringing it across broad spatial scales in order to make the best possible utilization of available knowledge and lessons-learned. Accordingly, fire risk management needs all three planning scales with salient implications: territorial, forest and urban levels.

Forest and rural policy needs to bring structural causes of wildfire into focus to provide a more coherent framework for land planning. In a context where large homogenous landscapes with a great accumulation of biomass have been the principal cause of fire proliferation, technological limits become evident and, moreover, effective fire suppression has contributed to heightened fire severity as it has led to fuel up and less fire resistance landscapes (fire suppression paradox) landscape planning scale appears to be the most suitable scope to take over the problem. Notwithstanding, landscape planning needs to provide an appropriate frame in regards to operational planning at forest (stand) but also land uses levels.

Last but not least, integration of wildfire risk into land planning needs to take account of urban planning, as when speaking about fire we are referring to energy that, in the event, may impact on vulnerable people and houses interacting with forest land. A serious deficit of urban planning is detected in a context where WUI is increasingly widespread all across the territory. In light of that, the necessity to involve new profile actors such as architects, urbanists or sociologists emerges in the realm of wildfire risk management and one can recognize wildfire risk more than ever as a “multi-stakeholder problem” (all those public and private actors with a direct or indirect participation in the causal chain related with the preparedness – response and recovery stages, figure 6), with a need of a “cross-sectoral approach” (where policies regarding forests, agricultural uses, urban and spatial planning or sectoral as tourism and energy ones meet all together) (PLANA, 2007).



Figure 6: Risk cycle. Author: National platform for natural hazards. Source: PLANAT, 2011

### **3. Social factors influencing individual attitudes and public support towards wildfire risk mitigation strategies**

#### **3.1. The value of the social research in the wildfire risk management**

The scientific literature debates on wildfire perceptions illustrates the complexity of the human dimension in fire management and suggests how important it is to understand human perceptions, attitudes and practices when planning feasible fire management strategies. Getting a better understanding of community perceptions and how they are formed may be a valuable first step when searching mechanisms to impel residents from fire-prone areas to take responsibility for future prevention and mitigation planning and implementation.

There has been a remarkable and prolific scientific progress in many areas of knowledge regarding the ecological factors of wildfires (plants' resistance to fire, forest fuels flammability, thermal fluctuations, water supply and demand...), but there is a fundamental subject that, until recently, had often been taken for granted: the human factors. As FOLCH (1996) stated, they have been dissociated from the traditional analysis since, differently from the ecological factors, they are not studied by applying natural sciences methods. Hence, bearing in mind that the human beings constitute a biological agent within the natural global system is an imperative since they are, probably, the most critical one due to their great ability to modify it.

The environmental reality is at the same time both natural and social. The present characterization of wildfires constitute, in essence, the corollary of a perpetual metabolism in which both natural and social processes have been combined in historical-geographic specific ways for finally producing a wildfire risk scenario made up of biophysical components in interaction with social, economic, cultural, etc. components (FOLCH, 1996; BOADA and SAURÍ 2002).

Over the last years the fire management community has begun to recognize the need for research findings from the social sciences in order to help solve many of the today's more relevant wildfire issues (JAKES 2003; HOOVER and LANGNER, 2003; KNEESHAW et al., 2004, VOGT et al., 2005). Although assessments of a community's vulnerability to wildfire are yet more strongly focused on ecological factors and landscape conditions, their growing interest in social subjects is reflected in a substantial increase of research incorporating disciplines based on the study of human behaviour, the role of fire risk mitigation-related institutions or culture.

With the purpose of stressing the consolidation of this line of research, among the many authors who put the matter of social challenges in wildfire risk up for discussion it is worthwhile to mention as mere examples some of them and briefly describe their supporting thesis:



- CUTTER et al. (2003), as speaking about natural risks, assumed that the social and environmental vulnerability interact to produce the overall place vulnerability.
- According to KRUGUER et al. (2003) the way how people manage natural risks and hazards hinge upon a large group of factors within biophysical and social spheres.
- JAKES et al. (2003) stated that preparedness for wildfire, that contributes to minimize losses and recover more quickly, must be based on the ecological characteristics of the landscape and the social characteristics of the specific community.
- CARROLL et al. (2007) stated that regarding the perceived risk of catastrophic wildfire there are two interconnected current states of affairs: the biophysical, which is connected with the condition of the forests, and the socio-political, which involves the debate concerning wildfire risk, interface lands and communities, and forest management.
- MACGREGOR et al. (2008) supported that risk-related behaviour is “adaptive, dynamic and sensitive” to social contexts; the author specifies that the keystone might be the idiosyncratic human nature: their society and their culture. for that reason, when encouraging the community exposed to wildfire risk to implement self-protective actions, more efforts has to be focused on getting a good understanding of socio-cultural context in which those measures are taken.
- Other authors supported that preparing a community for wildfire must be supported by a strong social foundation (GARDNER et al, 1985; JAKES et al, 2003; KRUGER et al, 2003; ABSHER and VASKE, 2007).

Thorough this chapter results of existing social science literature particularly focused on wildfire hazard is discussed for findings specific to identify which major factors may actually influence risk perceptions while considering the complex, diverse and variable of social concerns and the relation between humans and their environment.

### **3.2. Developing empathy with the social context and individual perception and expectations as a point of departure**

Wildfire management policy has to face with controversial forest fuel management and suppression tactics. Individuals prioritize human health and safety (MCCAFFREY and OLSEN, 2012); however, they might be highly exposed to health and safety risk because they lack an appropriate decision-making model for their situation (MACGREGOR et al., 2008). According to PLANA (2011b), the global changing context, the ignorance of danger and the lack of forest culture favour risk exposure. As COHN et al. (2008) pointed out, it is human nature to deflect responsibility for negative events and, assuming this fact, it makes easier to attribute the disaster culprit on a public deficiency management of the forest and belittle the inherent risk which entails the fact of owning a home in the WUI (COHN et al., 2008).

Fire suppression policies and fire prevention campaigns promoted by land management agencies are just a reflection of public support (CORTNER et al., 1990; KNEESHAW et al., 2004). In turn, support for



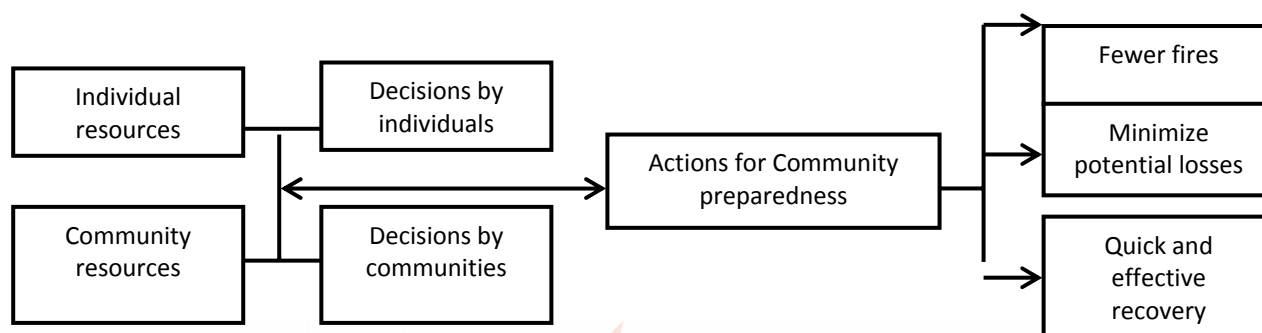
fire suppression or mitigation policies depends on public perception and an evaluation of a diverse series of trade-offs among endangered conflicting values (GARDNER et al., 1985; DANIEL et al., 2003).

Wildfire suppression has been the dominant policy for many years, so traditionally strict policies which projected a total suppression of fire were strongly endorsed by the public; however, public attitude toward fire can significantly change over time as people's understanding and acceptance of fuels treatment is rising (TOMAN and SHINDLER, 2006) and they can relate to both the beneficial and adverse effects of fire (CORTNER et al., 1990). That is exactly why discovering and understanding what public expect should be integral part of any process which is seeking solutions as, despite the politicians' legal authority in the decision-making processes, the formulation and implementation of fire policies ultimately are subjected to public acceptance (CORTNER et al., 1990; SHINDLER et al., 2009; PEREIRA et al., 2014).

Residents living in WUI do not always abide by the recommendation and guidelines suggested by fire managers. Agencies seeking to foster self-protective behaviour change regarding wildfire risk should strive for identifying the major influence of socio-cultural factors that affect in the decision making process (MACGREGOR et al., 2008). By learning and understanding how public perceive wildfire risk and land management strategies, recognizing what people expect as well as estimating existing levels of knowledge, land managers are more likely to design risk mitigation strategies that meet with public approval (CORTNER et al., 1990; MERRICK and VINING, 2006; MACGREGOR et al., 2008).

Furthermore, actions taken to increase wildfire preparedness consist of a number of steps they can take at both the individual and the community levels (JAKES et al., 2003; AGRAWAL and MONROE, 2006). While individuals are likely to be helpful when implementing measures associated with the placing of mitigation structures, building material or landscaping (individual resources), communities might be helpful in measures such as zoning, planning or educational programs (community resources). The combination of implementing measures at both levels results in the overall community preparedness, whose effectiveness will depend on the less likelihood to experience fewer fires, minimize potential losses and have a quick and effective recovery after fire (JAKES et al., 2003; MCCAFFREY, 2004).

While mostly of authors agree describing and characterizing types of factors that influence on public acceptance, slightly differences arise when assigning a specific weight to each one. What is certain is that effective strategies to preventive and management fire are multifaceted and must target specific of complex fire causes considering particular regions and localities since practices acceptable in one context may not necessary be acceptable in another (WITTMAN et al., 1998, ZINN et al., 1998; TOMICH and LEWIS, 2002; CUTTER et al., 2003; BLANCHARD and RYAN, 2007; COHN et al., 2008; MACGREGOR et al., 2008).



**Figure 7. Conceptual model for understanding community preparedness to wildland fire.** Source: JAKES et al. (2003).

### 3.3. Factors affecting of perceptions, beliefs and attitudes towards wildfire risk management

#### 3.3.1. Societal and individual relationship with risk

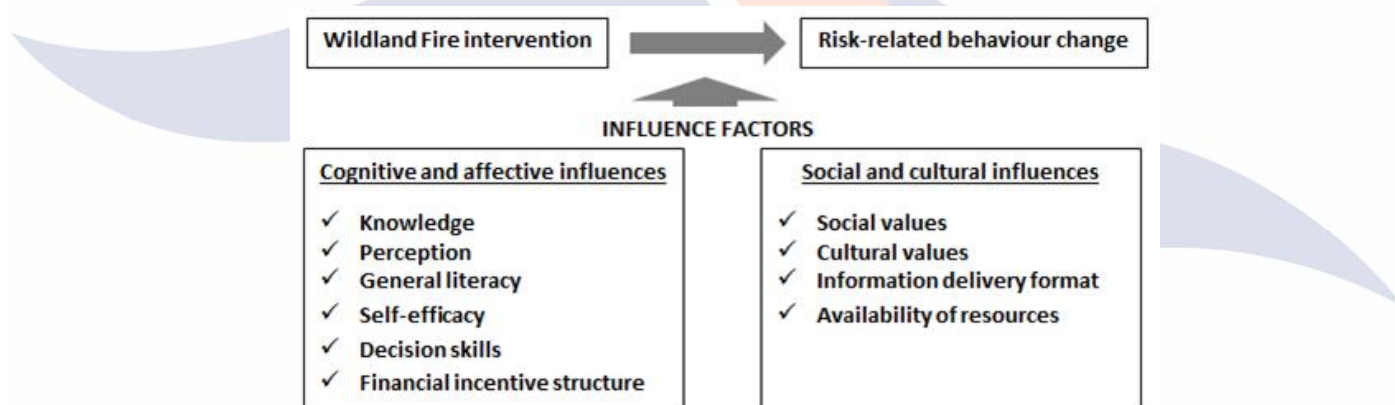
An anthropologist, DOUGLAS (1996), asserted that each society selects those problems that will not bring their social structures into question. She provided some insights of cultural and historical factors related to perceptions and ways of adapting to risks. For DOUGLAS, natural hazards would not be measured as natural problems but as social problems, and decisions adapt to current contexts, which is why in many cases they have no place due to current social patterns. Consequently, risks are differentially constructed by each society based on their educational and cultural level in such a way that the existence of risks and their acceptance depend on the unique characteristics of each society.

ABSHER and VASKE (2007) reported underlying factors for supporting wildfire management in three categories of variables: sociodemographic variables, situational variables and psychological variables. Psychological variables, related to public beliefs and attitudes, appear to be the best predictor of public policy support as they keep strong and pervasive linkages to different kinds of wildfire policies. On the other hand, sociodemographic variables, that include age, sex education and income, and situational variables, such as year-round resident or home ownership, would be less significant factors when explaining support for agency mitigation strategies.

Assuming the major utility of knowing the psychological variables, KNEESHAW et al. (2004) identified five situational factors influencing on people's normative beliefs about wildfire management strategies: fire origin (natural or human-caused), impact on air quality, private property, forest recovery and outdoor recreation. Their findings suggest correlations between different levels of these factors and acceptance of fire management: forest users showed stronger willingness for "put the fire out" strategies when the origin of fire is human, there is poor air quality, prominent risk of private property damage, difficulties with natural vegetation recovery and outdoor recreation areas closures due to a fire; whereas forest users' willingness is just the opposite for "contain the fire" and "let it burn" strategies.

In another formulation, MCCAFFREY (2004) considers two remarkable viewpoints that influence the perception of any kind of risk (“dread risk” and “unknown risk”) and, applied to the field of wildfire risk, would explain why it is not surprising that people are moving to wildfire-prone locations without enough risk concern. On one hand, fire suppression efficiency, resulting in considerably limited fires in most cases, contributes to a feeling of control and minimizes the perception of fire as a “dread risk”. On the other hand, perception of wildfire as an “unknown risk” is quite low considering that wildfire is an ancient and (in many regions) common danger and its effects and easily seen. The perspective of this second risk factor linked to the predominance of reasonably limited fires, as exposed in first risk factor, would help to better grasp why individuals are not enough concerned of fire as a dangerous hazard.

MACGREGOR et al. (2008) made an important contribution arguing that wildfire management interventions are determined by several influence factors that can be classified into cognitive and affective influences, as well as social and cultural influences. Cognitive and affective influences bring together knowledge, attitudes and perceptions hold by individuals, whereas social and cultural processes are relevant factors since the concept of risk itself differs depending on people holding different cultural values, and it brings significant implications for risk acceptance and management (figure 8).



**Figure 8. Factors that affect the impact of wildfire preventive interventions on stakeholders’ risk-related behaviour.** Source: MACGREGOR et al., 2008.

### 3.3.2. Past experiences with wildfire

The consequence that past experiences with wildfire galvanize people’s reactions leading to undertake fire management practices is not that systematic. As CABALLERO’s explained based on his own experience (see his professional profile in “Methodology”) (personal communication), immediate risk awareness and the desire to act increase after natural disasters when there are victims or remarkably property losses, but the memory tends to rapidly decrease with time. The extent of people’s reactions hinges upon specific crucial factors like the incidence of media coverage, which is directly bound to political interests. Moreover, people may show resistance to changes in the environment that they are

accustomed to. Hence, it is quite certain that the consubstantial human factor plays an important role when it comes to determine people's reactions. Generally, people react after traumatic experiences or due to social induction (natural disaster impacted in nearby communities or widespread media phenomena had influence over people's perceptions), but the reality is more complex since within a community there are many kinds of people and each one may perceive the risk differently.

If we look over the literature based on fire-related social issues, most of authors found tendencies pointing that those who have experienced wildfire in the past have an increased awareness of risk than those who have not experienced fire before and this fact influences participants' levels of concern about the impacts of management options (WINTER and FRIED, 1998; CUTTER et al., 2003; BLANCHARD and RYAN, 2007; COHN et al., 2008). In contrast, surveys conducted by VOGT et al. (2005) show that past experiences with wildfire are not as significant as other factors as beliefs and personal values. Concurring with those findings, COHN et al. (2008) specified that even in communities that have been struck by wildfire homeowners are reluctant to adopt risk mitigating measures for aesthetic and lifestyle reasons.

More surprising still, GARDNER and CORTNER (1987) found that southern California residents who had experienced an intense wildfire perceive fire as less of a risk after major fire, and this may be related to very intense wildfire in California that consume all the vegetation and the perception of a very low probability to the occurrence of wildfire in the distant future.

A social mobilisation that begins reactively may become proactive in the future. WINTER and FRIED (1998) stated that in many instances a fresh event of fire disaster brings opportunities to engage people in the discussion about risks, deficiencies, and construability or management alternatives. In the words of SIMS and BAUMAN (1983), the influence of experiencing a wildfire increases the level of awareness and risk perception for a relatively short period after the disaster occurs, and this is the reason why mitigation measures and legal change should be established immediately following the event. In addition, the tension resulting from the consummation of environmental risks can be seen as a socially positive scenario as it reveals new forms of participation and intervention. Such tension gives rise to new forms of bottom-up participation and innovative processes by tearing down barriers between different fire management professional sectors ---which is why interdisciplinarity appears to be an indispensable tool (RODRÍGUEZ, personal communication).

### **3.3.3. The acceptability of prescribed burning as a fuel reduction method**

Prescribed burning is a management tool which finds several impediments to effective implementation. While benefits of using fire as a management tool has been largely recognized among the scientific community, there might be hesitations about that in the social and institutional sphere (DALE, 2006). Land managers using prescribed fire must be aware that their actions will have some effect on members of the public considered stakeholders in such a way that it is essential to work with them during all phases of the process (MCCAFFREY, 2006).



Stakeholders' knowledge is fundamental to achieve satisfactory tolerance levels toward prescribed fire. However, it should be taken into account that there is a markedly variation among stakeholders not only in knowledge but also in attitudes or values (GARDNER et al., 1985; DALE, 2006; MCCAFFREY, 2006; KNOTEK et al., 2008; PEREIRA et al., 2012). On top of that, acceptance is not automatic and also highly depends on their inclination to trust in the implementing agency (further on we will discuss more deeply the value of trust) (MCCAFFREY and OLSEN, 2012).

### **3.3.4. Cost-benefit and implementation feasibility**

MCCAFFREY (2004) considered two sorts of evaluations that might make individuals reluctant to take actions: cost-benefit and implementation feasibility. Regarding cost-benefit, there comes a time when people need to balance both the perceived risk and the benefit of where they live (SLOVIC et al., 1987; MCCAFFREY and OLSEN, 2012). It is important to bear in mind that fire-related self-protection measures involve the predisposition on behalf of homeowners to expend time and monetary resources on that (MACGREGOR et al., 2008). Policy design dealing with wildland urban interface should consider people expectations like individual incentives and distribution of costs (see chapter 3.3.5) as well as avoiding unanticipated policy impacts (CORTNER et al., 1990). Factors such as people's preferences for location and style of the house, added to the financial cost of adjustments for prevention and to the fact that even preventive actions could not guarantee that the house will survive after fire event, might make people lean toward dismiss the option of protecting their houses with defensible space.

At the same time, implementation feasibility is influenced by environmental and technical viability. Environmental viability affects how the execution of preventive actions fit with the site and present land uses. There should be also bear in mind that people move into the woodland looking for getting in touch with nature and there might be a cultural rejection to actions such as cutting down trees or removing vegetation. Technical viability concerns people's resources (skills, tools and materials) to implement the aforementioned actions (SLOVIC et al., 1987; MCCAFFREY, 2004).

### **3.3.5. The acceptability of government intervention: public versus private risk exposure, the non-excludable principle to be protected and the role of insurances**

Hazard reduction actions by means of government intervention are tightly related to the perceptions of property rights to the hazard. According to MCCAFFREY and OLSEN (2012), people think that landowners share the responsibility to carry out risk mitigation strategies since actions taken on adjacent properties may affect one's risk; nonetheless, the government has responsibility to provide them information on how carry out effective fire reduction practices. On the other hand, since causes and consequences of wildfire risk are affected by permanent residents as well as seasonal residents, visitors or land managers, both public and private components interact when planning risk reduction strategies (CORTNER et al., 1990; WINTER and FRIED, 1998). In this way, WINTER and FRIED, (1998) pointed out that, considering that distribution of rights and obligations as well as changes in the assignment of costs and benefits depend on whether the responsibility for taking prevention measures is public or private, in



those cases that fire risk would be considered as a public issue, people exposed to the risk will probably regard with favour government intervention. Furthermore, building on previous discussions we can develop a more practical approach of responsibilities, but since fire risk can be hardly associated with property limits, it still leads us to further reflect on “who is the actual risk owner?” After all, the same (a lease, perceived) public authorities got the corresponding taxes and gave the corresponding administrative permits to build up a house into the forest (this can change with updating the legal frames, but the “pre-existences” are resulting from the old one).

Another factor that induces residents to demand government intervention is linked to the principle according to which wildfire management is a non-excludable good, so every single resident has the right to be provided with the same service. In view of that, residents would see fewer incentives to voluntarily take charge of protective actions and would expect government intervention keeping in mind that this service might be provided by markets (GARDNER and CORTNER, 1988; WINTER and FRIED, 1998).

Likewise, insurances industry incentives to attempt to reduce fire should be brought to the fore too. As some authors stated, the overall effect of insurers is not always providing with convincing solutions to ameliorate the fire problem and sometimes could even disincentive individuals and companies to assume more responsibility (GARDNER and EL-ABD, 1984; HEMENWAY, 1987; CORTNER et al., 1990; WINTER and FRIED, 1998). Homeowners<sup>11</sup> are more likely to invest in constructing a house in fire-prone areas when the government will provide them coherent compensation after wildfire destroys it, and they tend to believe that they are exempt from any public liability to construct defensible space by just maintaining insurance coverage (WINTER and FRIED, 1998). In addition, good compensations lead them to rather get the insurance and rebuild their homes elsewhere if it burns than alter their landscape by constructing a defensible space (NELSON et al., 2003). WINTER and FRIED (1998) proposed that, ultimately, the solution is to reduce insurance company pay-outs and taxpayer disaster assistance disbursements.

### **3.3.6. Gaps of knowledge and perceptions among stakeholders**

The divergence in the manner of conceptualizing self-protection between the ones responsible for fielding the intervention (agencies) and the ones targeted by the intervention (land and homeowners) could hamper the performance of an intervention itself (MCGREGOR et al., 2008). As MCGREGOR et al. (2008) stated this gap becomes more controversial when time and monetary resources gain significance in the context of long-term fire risk strategies.

On the other hand, COHN et al. (2008) focused on the existing gap between experts and laypersons, since it emerges as a major factor regarding successful communication. While experts mainly focus on quantitative aspects, like numbers of injuries that might be expected or probability of an event

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<sup>11</sup> Here is important to point the influence of difference housing contexts from predominant wood constructed houses with high citizens mobility around the country versus stone constructed and permanent house for all life (more common in Europe)

happening, laypersons not only consider quantitative aspects of risk but also focus on qualitative ones such as ability to control the hazard, knowledge of the hazard, experience and intuition.

### **3.3.7. Stages and issues in the decision making process of individuals**

Notwithstanding the foregoing, sources of public support and opposition should not just concern the research of attitudes and perceptions (MCCAFFREY, 2004;; MACGREGOR et al, 2008; PAVEGLIO et al, 2009; STEELMAN and MCCAFFREY, 2006) since they are just part of a decision making process where other factors also come into play (TOMAN and SHINDLER, 2006). In words of STEELMAN and MCCAFFREY (2013), even though public's risk perception should be considered as a premise for supporting risk reduction activities, it does not always leads directly to action or support; other key factors such as risk tolerance, trade-offs with benefits, and the ability and resources to implement those activities play a decisive role prior to move into action.

At this point, it is relevant to mention the contribution made by TOMAN and SHINDLER (2006), who described how people go through three different stages along the decision process. This ratifies the theory of various authors when they asserted that risk perception is not enough for people to move into action and sort the existence of other influence factors before going ahead with mitigation activities. Thus, in the first place people raise awareness about risk and the need to take mitigation actions like construction of suppression infrastructure or fuels treatment; next, they consider the suitability of the action weighting pros and cons of implementing it; and eventually, they decide whether to act (constructing their own defensible space) or to support agency fuels programs. On that sense, MARTIN et al. (2007) summarize as follow the main factors affecting the ability of the individual action: The perceived effectiveness of actions to reduce the risk; Confidence in the capacity to correctly carry out actions; The perceived responsibility for fire risk management and, Trust and credibility to the institution promoting actions.

## **4. Guidelines for cross-sectoral wildfire risk planning and societal involvement**

### **4.1. Expanding the approach of wildfire risk management**

Efficient spatial wildfire risk planning needs to be achieved by focusing more efforts on improving strategies of communication and transfer of knowledge to end-users. Holistic approaches (figure 9) provide the opportunity to address the complexity and dynamic behaviour of a particular system, and thus building alliances with professionals from other fields is essential to succeed in the fire risk planning strategies.

Nonetheless, the transfer of knowledge related to wildfire risk integration into land planning has to consider several challenges. For example, the contribution of new knowledge and techniques need to be transferred in a practical, concise and easily understandable format; the all-important culture of

multidisciplinary teamwork needs to be incorporated in the curriculum of professional training and education; and the legal, institutional and operational framework needs to be revised to integrate the cross-sectoral dimension of wildfire risk management (PLANA conference in the Seminar “Wildfires in the urban interface; towards a wildfire risk integration into land planning”, see Methodology).

As CERDAN (2002) stated, planning should be the procedure through which appropriate measure will be adopted so that the balance at all stages leads to the solution of the problem. Over this chapter we will make a review on social, technical, organizational and legal obstacles that might interfere with the effective integration of innovative knowledge, tools and mechanisms in the land planning process. A number of guidelines, available potential tools and recommendations will be discussed to guarantee a successful communication and transfer process among stakeholders involved in the land planning and management of emergencies and fire risk.

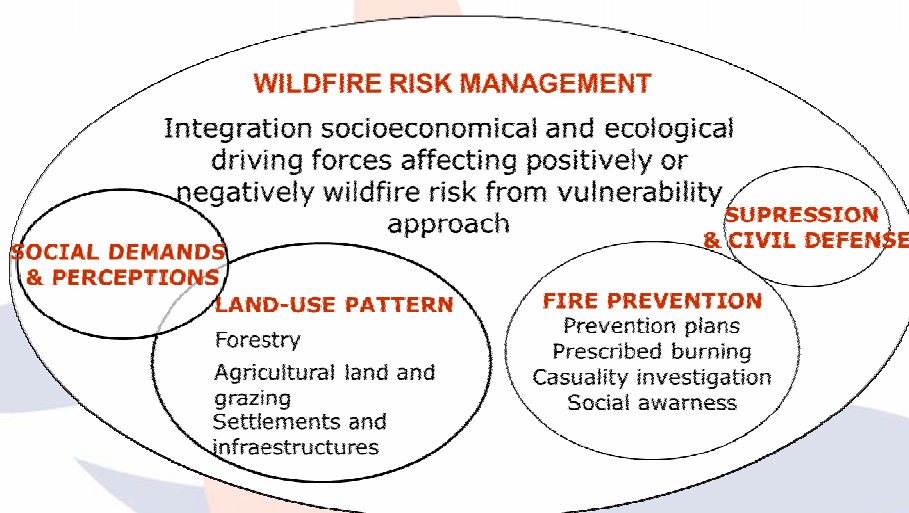


Figure 9. Components of an integrated approach of Wildfire Risk Management. Source: the authors

## 4.2. Promoting partnership working

### 4.2.1. Operational cooperation among public and private stakeholders

In the future wildfires will continue to threaten more social structures and affect political and financial resources on a broader scale. Fire protection means more than just firefighting, as it also includes prevention and pre-suppression. As firefighters' resources to face large wildfires become increasingly scarce it is more even important to strengthen cooperative relationships. Groups from a multi-disciplinary background are needed to contribute their different understandings to address complex fire management issues in a more effective and efficient approach (PLANA, 2007). In this sense, more cooperation and planning and the resulting formal agreements between both public and private actors involved become necessary.

Fire protection should be a shared responsibility amongst those who live and work in fire-prone areas. Accordingly, it is important to bear in mind that cooperation takes place between people and organizations, so it should be concerned with both public and private interests. Even though it is clear that cooperation can benefit all fire protection agencies and affected people, working to an agreement is a hard issue and requires careful planning.

When going through a process of partnership working, the very first step comes with identifying many potential partners and bringing them to the table in order to reach a commitment. Normally, these early-stage working structures are not created by decree but from the own accord of different social actors who meet the need for network to more effectively tackle common issues (CANYAMERES, personal communication). Above all else, cooperative relationships are governed by a human factor, so the first approach provides a common meeting ground in which each one should become very familiar with their neighbour departments and neighbour agencies (CANYAMERES; PÉREZ; RODRÍGUEZ, personal communication). In the long run, it is fundamental that they continue joining together on a routine basis to exercise cooperative system and develop trust level amongst one another (PÉREZ, personal communication).

The main challenge that concerns inter-agency cooperation implies a political consideration since wildfires do not respect administrative boundaries of communities or land management. A wide array of fire and risk management agencies are in charge of specific regional responsibilities that in many cases overlay, which is why wildfire risk management policies can be more efficient carrying out management schemes using a partnership working approach. Reaching a political arrangement constitutes a primary framework where coordination between fire prevention, civilian protection and emergency management agencies as well as rural development (including energy or tourism), urban and spatial planning ones is crucial. Hence, the diversity of stakeholders who are part of the fire community and could have been separated so far (fire departments, local government's jurisdictions, emergency management agencies, forest management departments, planners, homeowners' associations, volunteers...) must come together to deal with the wildfire problem. Providers and beneficiaries of environmental services (with or without direct or indirect economic trade-off) can be an useful criteria for the stakeholders map identification and start discussion their level of responsibility on risk mitigation and risk "property".

Multi-disciplinary roundtables ideally provide an appropriate framework to address an integrated forest management. Fire reduction strategies should be embedded in a cross-functional management that likewise amalgamates conservation, forestry, hunting or renewal energies objectives among others, as well as rural development, by dint of cross-sector assessment. These approaches require comprehensive mechanisms under the premise to better integrate human systems as a part of land management by means of social involvement and building alliances (FRIGOLA, personal communication). For instance, networks of active collaboration and cooperation management practices aimed to conserve ecological productivity and biodiversity should move towards diversity and landscape heterogeneity, which in turn



can have implications for the maintenance and enhancement of social and ecological resilience to wildfire (PAUNÉ, personal communication).

Roles and responsibilities must be properly defined for each partner. Missions and practices are important to be distinguished between fire protection agencies, private and public organizations, businesses and, of course, the residents themselves. It is not a matter of training professional specialists beyond their fields of expertise, but of learning to work alongside and promote cooperation (CANYAMERES, personal communication). Likewise, strengths and weaknesses of current programs have to be highlighted and areas where cooperative effort can be beneficial have to be focused (PAUNÉ, personal communication).

Nonetheless, the diversity of social actors involved in the fire risk management hinders the harmonization of the legal basis, instruments and related administrative processes. Despite emerging consensus among social actors on coordinating measures to prevent future fire disasters, partnership working does not always succeed because of hurdles such as time commitments, individual personalities or agency policies (CABALLERO, personal communication). Where appropriate, policy makers and governmental organizations commitments should be intended to minimize or remove legislative, bureaucratic market obstacles (FRIGOLA, personal communication). Likewise, fruitful cooperative agreements will require a formal documenting to clearly define agencies' tasks, provide guidance for implementation strategies and establish a legal basis for financial exchange.

In USA, fire protection organizations working together are signatory to a written cooperative fire prevention agreement which facilitates interagency work across jurisdictional boundaries. By means of that, agencies have specific guidelines and processes when developing cooperation assignments, in many cases including a formal legal review. Moreover, cooperative agreements require the development of operational plans which provide procedural details to implement the agreement whenever necessary. By documenting the commitment of each partner, standard operational procedures are given to all the organizations within a specific territory so that they can develop an unified command consisting of the set of plans to work, working to the same objective - not to duplicate efforts in the territory - and taking most profit of available resources. Operational plans are complied with an annual review that helps to ensure that they will meet the needs in the next fire season. After the fire season ends, all the agencies gather to talk about things that did not work so well and introducing things that may improve the agreement (NWCG, 1999).

#### **4.2.2. Synergy and knowledge exchange and transfer**

When conducting cross-sector wildfire risk assessments, it is importance to establish synergies that facilitate two-way exchange information and expertise on risk analysis between related agencies as equal partners. Positive synergies are easier to emerge by adapting of a common terminology on the risk elements which, in fact, will serve as a communication tool for teamwork. Accordingly, MC MORROW et al. (2010) argued that having consistent wildfire evidence must meet the principles of

being comprehensive, accurate, spatially robust and accessible. It is worth pointing that the information concerning the analysis of fire risk is usually displayed by means of vulnerability and hazard mapping, which is a key tool for aiding to effectively integrate risk management into urban, forest and territorial planning (see “Wildland fire risk mapping”) (CABALLERO, personal communication). Hence, the application of mapping tools is an issue of major concern for enabling the flow of information between stakeholders.

When analysing the causative agents of wildfire risk there are many aspects that transcend the forestry sector. By way of example, considering that power lines are a potential source of ignition and a serious hazard in the course of firefighting, power line construction and maintenance should be reasonably embedded into wildfire prevention planning processes. Planning documents should contain a minimum standards (e.g. areas of high fire risk in the plan of concretely assigned inspections and actions) based on the studies and experiences shared by fire agencies and electric utilities operations personnel. Likewise, basic communication and cooperation need to be permanently ensured between both partners: while the utilities need to report to the fire agencies in which cases their equipment or hardware can be the source of fires, the fire agencies need to immediately inform to the electric utilities when fires involve their property and equipment.

Links and synergies must also be pursued among professionals from the same field. For instance, when discussing land management and planning in the field of forestry, arrays of diverse interpretations might emerge. The clash between different discourses generated by experts from the same field hinders the decision-making process as it impedes to reach consensus concerning a forestry policy that may result in the creation of planning figures. That is why it is fundamental a discussion in depth which brings about a consensus regarding what model of forest should be promoted and what kind of management should be carried out to that end. If powerful discourses are generated after coming to a common understanding, they will be more likely to gain acceptability among the population (RODRÍGUEZ, personal communication). This takes special relevance in predominant private ownership woodlands.

According the prior chapter, fire management agencies and organizations are expected to establish cooperative partnership working with their counterparts with the purpose of facilitating two-way exchange knowledge and experience (e.g. interactions between emergency management agencies or between urban planners) (NEBOT, personal communication). The said interactions permit to gather available research and information as well as come together to define current fire management situation and resources in specific targeted areas. Considering that knowledge is largely founded on research, improving communication channels between research partnerships and fire managers can ensure useful information transfer into the state of knowledge and practice within the forest sector. RAFTOYANIS (2013) reported that stronger links between managers and researchers are all-important for an improved large-scale application of a comprehensive approach to fire management. Thus, capitalized and new research can contribute to keep identifying the knowledge gaps (MC MORROW et al., 2010) and face increased planning requirements.

#### 4.2.3. Example of partnership working: Wildfire Groups in the UK

Wildfires do not tend to cause large fatalities in UK as they are not at the scale as those that occur in the Mediterranean countries, Australia or North America. Even so, within a climate change scenario, suitable conditions for larger wildfires with larger social, economic and ecological impacts is also affecting countries from higher latitudes. Accordingly, research on estimation of economic costs is emergently demanded; concern about firefighter and people safety is growing; calls are increasing for specialized training and equipment; and people education is beginning to be considered as a key value to prevent future fire disasters (MCMORROW, 2011). In UK, these practical concerns are in part being addressed thanks to cooperative work among partnerships in local fire groups<sup>12</sup>.

Wildfire groups (also called Fire Operations Groups – FOG) were born in 1996, after a serious moorland<sup>13</sup> fire happened in UK. Initiative of fire groups was pioneered by the Peak District National Park, and as a consequence, social organizations converged to reinforce commitment for tackling the problem of wildfire in the moorlands. They are not widespread all across UK, but they have only been created where there is a need to focus on landscapes at risk from wildfire. Even though there are strategic groups that operate at a regional level, there are also other groups that work on more operational issues based on logical landscape areas to better cope with wildfire risk. Nowadays, fire groups are aimed to contribute to the sustainable management of natural areas, by protecting its economic, ecological, and environmental values and giving support to the development of rural communities. The membership can slightly vary depending upon local circumstances, but it is generally composed by Fire and Rescue Services (FRS), major Private and Public Landowners, Countryside Associations, Water Companies and the Ranger Services (GAZZARD, 2015; Peak District National Park<sup>14</sup>, 2015).

The importance of this cooperative group is that they bring different agencies together to tackle those part of the fire issues that individual agencies themselves or actors could not do. Therefore, by promoting joint working and collaboration, they improve and provide joint ownership of the causal chain “preparedness-response-recovery” actions. Likewise, wildfire groups fill a gap in current legislation that otherwise would limit Fire and Rescue Services competences on being responsible for making land management more resilient to wildfire (MCMORROW, 2011; GAZZARD, 2015).

Hence, fire groups are responsible for build wildfire mitigation and adaptation into land management and emergency planning. Since forest rescue services in UK are mainly trained and equipped to deal with fire in urban settings, partnership working between land managers from rural systems and agencies within a wildfire group have contributed to overcome pre-existing limitations such as the limited access

<sup>12</sup> Easily inspired in the experience of the flood action groups (see for instance: <http://www.nationalfloodforum.org.uk/>)

<sup>13</sup> Mountain moorlands are the most widespread area of wild natural habitat in UK. They are dominated by shrubs such as *Erica cinerea*, *Calluna vulgaris* and *Ulex sp.* or various rough grasses and sedges. About 10-15% of the world's moorland habitats are located in UK

<sup>14</sup> Peak District National Park. Fire Operations Group: <http://www.peakdistrict.gov.uk/looking-after/projects-and-partnerships/local-nature-partnership>

to all-terrain vehicles or wildland fighting equipment. For example, the local fire groups formed by agencies and rural landowners work alongside to share equipment and training, and even develop joint working management practices and prescribed burning plans (MCMORROW, 2011; Peak District National Park, 2015).

Fire plans and maps for specifically designated rural areas, which will provide valuable information about several aspects regarding fire management, are compelled by wildfire groups in association with other partners that assist their completion, such as the Rural Development Initiatives in the case of South East of England Regional Wildfire Group (SEEWG) and Home Counties Operational Wildfire Group. Land managers should ensure that fire plans are up to date and check that firefighting equipment is operative at the required moment. Such fire plans may include contact details of key people able to assist during the emergency; location of equipment (all-terrain vehicles, fire beaters...); prioritisation of key infrastructure and landscapes to protect; location and seasonality of nearby water resources; information of tracks which are suitable or not for dispatching in a given fire event. Thus, Fire Rescue services can plan in advance by positioning equipment where it is expected to be required and sharing assets across regional borders. The ranger service plays a key role in the wildfire groups since, a part of orchestrating organizational procedures like the secretariat or the meetings, they also act in support of the fire forces by accompanying firefighters during the fire emergency to provide them with special equipment they can use in supply or help them with suit technics which firefighters at the basic college never used overland (MCMORROW, 2011).

Furthermore, fire groups are also intended to build a strong network that encourages and allows local communities (rural and urban) to actively participate in protecting their environment and economy from the effects of wildfires. Education programs and initiatives are developed to provide advice and support on wildfire issues to help people understand the importance of fire prevention and thus contribute to raise awareness of wildfires. They include the production of fire awareness promotional material for locals and visitors to make them know about the impacts of wildfire and landscape management, including managed burning on the natural environment and landscape (GAZZARD, 2015).

### **4.3. Enhancing transferability of wildfire risk assessment to land planning**

#### **4.3.1. Reducing uncertainty and wildfire risk planning**

At the workshop on “Wildfire risk integration into land planning” (see Methodology), CASTELLNOU asserted that the existence of high levels of uncertainty leads to a delay in decision-making and a lack of leadership, which interferes with our ability to properly carry out management to minimize fire damage since we are not assuming the disturbance regime. As much as we reduce uncertainty our decision-making process is more consistent and the chances for an efficient wildfire risk planning increase. Getting a better understanding of inherent uncertainties associated with wildfire as well as developing decision support tools contribute to move towards a more disaster resilient system, since facilitate risk



assessment and improve decision-making resulting in the design of adaptive strategies (THOMPSON and CALKIN, 2011).

Main source of uncertainties affecting wildfire are intrinsic to the phenomena, as far as ignition and spread risk is highly human induced. Therefore, the effects of global change; that means the combined effects of changes in land use of the pre-fire landscape (vegetative succession and disturbance, soil sealing in dense housing developments...) and climate change (rise in temperatures, changes in magnitude and seasonal distribution of rainfalls, severity and recurrence of droughts...) are expected to create new hazard scenarios.

Thus, building local risk knowledge among land planners can improve fire planning options and minimize fire suppression costs and ecological disasters since inaccurate or missing analysis data and incomplete scientific understanding pose more uncertainty. At this stage, the new knowledge coming from the fire behaviour patterns and fire types mainly develop from the pre-suppression perspective is offering new challenges to transition in parallel from emergency management to fire prevention management and land planning. Moreover, as commented in the previous chapter (see “Synergies and knowledge exchange and transfer chapter” 4.2.2), methodologies must be homogeneously adapted to a multidisciplinary team environment and enable robust risk-based analyses to inform and be integrated into land planning and their variety of scales.

Uncertainty also comes with limitations in resource value measures that would hamper the establishment of prioritizations across fire events and resources at risk (THOMPSON and CALKIN, 2011). It is hardly possible to mitigate the problem of wildfires if we do not adopt a global perspective: fires are not just burning forest and houses but they are affecting all the intrinsic externalities with economic impacts at the local, regional and national. Fires can block or greatly damage to certain socioeconomic activities with a significant weight in the Gross Domestic Product (GDP) of a territory (GONZÁLEZ-CABÁN et al., 2014); consequently, relevant economic arguments may have a great influence on supporting fire mitigation measures as they help to understand fire risk management as an opportunity for economic development instead of as a cost (PLANA, 2007).

Wildfires are costly to suppress, and have long-term cost implications for forest resources, which include both tangible resources (those with market prices: properties, wood products, hunting revenues...), and intangible resources (those without market prices: recreational and tourist resources, carbon stocks, wildlife habitat, cultural heritage, intrinsic landscape values...) (THOMPSON and CALKIN, 2011; THOMPSON et al., 2012). Evaluating fuel treatments effectiveness, community preparedness or fire suppression costs is subject to knowledge uncertainty. Hence, the more accurate the knowledge about fire risk is, the more possible it is to expect the costs all across the stages of the causal chain “preparedness-response-recovery” and understand how investments on one of these stages may affect the rest. Considering forest resources as property assets would allow the costs of prevention and suppression wildfires to be set against the costs avoided damages to forest resources (MC MORROW et

al., 2010), thereby providing to decision-makers objective criteria as a basis for establishing priorities when implementing self-protection and risk reduction measures as well as optimizing public expenditures. Nevertheless, unlike other natural hazards, difficulties in defining the scope of spatiotemporal dynamics of wildfire (the equivalent return periods of flood risk and the predicted extent of affected area in function to a given level of river flooding) hinder cost-effective analysis and risk-based wildfire planning efforts as PLANA stated in the Seminar “Wildfires in the urban interface; towards a wildfire risk integration into land planning” (see Methodology) and is fully argued in Deliverable 14 “Wildfire risk mitigation: Protocol for a cost effective assessment on fuel treatments at landscape level”

Recent economic analysis conducted by the Association for Fire Ecology (AFE, 2015), which included all the direct, indirect and long-term post-fire costs of wildfires in the US, revealed that communities, businesses and governments may eventually come to pay between 2 and 30 times the amount of the official estimate of large wildfire costs. This example shows that estimating the true socioeconomic resource costs to wildfire along the stages of the above-mentioned causal chain is a difficult issue for quantitative economic risk assessment. THOMPSON and CALKIN (2011) underscored that challenges in quantifying risk of socioeconomic resources and assets exist specially for non-market values, which result in uncertainty due to a gap in the scientific understanding of the overall costs associated with wildfire.

Nonetheless, non-market valuation studies are in many cases beyond measure and their quantification methods are rarely objective and homogeneous. In this sense, the contribution of social actors established in the territory could aid to estimate the intangible values at risk, so it is crucial that fire managers understand how individuals and social groups value, appreciate and take care of their environment. In this sense, high levels of local actors’ involvement in more representative and holistic decision-making processes (see “Social involvement and democratization of participatory processes”) could be relevant to better account for the effects on non-market resources and, therefore, further assist prioritization efforts and articulation of fire management trade-offs under a multicriteria approach.

#### **4.3.2. Giving robustness to the wildfire risk mapping**

Wildfire risk maps are a data visualization tool very useful to present the results during the risk assessment process and therefore to establish planning and management guidelines. More specifically fire risk maps offer a format of lighting a more efficient allocation of existing fire-prone areas within a territory in which management practices are required to reduce the likelihood and potential negative impacts of wildfire. Planning function would delineate those areas on a map enabling planners to develop a serial of requirements that all planning strategies within the fire-hazard area must follow.

Risk mapping could be supported by standards and technical regulations in the form of guidelines or technically based prescriptions. Official mapping and regulations will be able to give legal coverage to

fire risk planning, which in turn will provide the tools for implementing operative and management indications. Risk mapping and technical regulations are supposed to complement one another; for example, by establishing limitations such as laws restricting open burning practices (to restrict open burning during high fire risk period) or zoning and land-use ordinances (landscape modification by creating fuel breaks and planting of less fire-prone species in public lands) on risk areas that have been previously identified and mapped.

Maps based on fire risk analysis should integrate the intrinsic vulnerability and hazard levels (see “Assessment of vulnerability to wildfire” chapter 2.1.2) of specific areas and infrastructures as well as their temporal dynamics and landscape values. The degree of detail which is necessary to work within each planning level is associated with different spatial scales: smaller scales in the urban and forest planning (1:2000 or 1:5000) and larger scales for regional planning (from 1:25000 on). Risk planning at different scales allows include an analysis of individual priorities in different fuel management scenarios in function to the vulnerability of the affected land. As a result, risk maps should ideally represent the thresholds of damage tolerance relative to the estimation of after-disaster social, environmental and economic missing targets.

Maps must be a visual and holistic view to share while making strategic decisions. Stakeholders should gather together to take advantage of the insights of each partner, agree terms used to establish probability estimates and get consensus on risk tolerance levels of potential losses. As a result, through the fire risk mapping should be able to identify the vulnerability of the values at risk and help to balance the public inter-agency and private resources and capacities needed to protect those values, thereby improving the governance of the management of risks processes.

Furthermore, fire risk maps, in addition to other WUI data, can be useful in urban planning to know where housing and wildland vegetation coincide. In this case, an operational mapping for emergencies there must be considered: if firefighters know how to recognize potentially vulnerable houses and how to protect them, they can reduce or eliminate much of that risk. According to CULLOTTA et al. (2014), land management policies should be at first developed for the higher levels of hierarchy and then scale down to the local levels. Keeping this hierarchy, when it comes to creating fire risk mapping suited to urban-territorial needs it is desirable to develop planning at different spatial scales which differ depending upon the target audience in each case.

Dealing with fire risk in WUI areas, on the basis of the 3 different mapping scales proposed by CABALLERO (personal communication) (territorial, local and micro-scale), a few insights about the way of conducting a cross-scale wildfire risk planning are going to be briefly exposed in the next lines:

1.- TERRITORIAL (SUPRA-MUNICIPAL<sup>15</sup>): By mapping fire risk at supra-municipal scale, knowledge of future fire paths and spreading patterns must be ideally recognized and mapped (see “The contribution of knowledge of future wildfires”). Supra-municipal scale is expected to embrace homogeneous landscape units assuming that fire spreading patterns do not understand administrative borders of municipalities but landscape features. This would support practical means to prevent future disasters from getting rural areas, developments and any sort of urban settlement in general.

2.- LOCAL (MUNICIPALITY): This level refers to the administrative borders of municipalities and forests owned by municipalities themselves within these borders. Municipal entities usually are the recipients of local risk maps and may act as a dynamic agent due to their proximity with residents and stakeholders. Risk maps at a municipal-scale level must be embedded into municipal emergency plans (evacuation and confinement protocols) and/or defence plans in the developments (self-protection, defensible space). High resolution remote sensing technology (LIDAR data) is already helpful to deal with the required level of detail at this scale. In many cases, fire impacts appear in the form of smoke and embers; however, when a WUI area has not adopted fire protection measures, fire might pass through the urban area. In whichever case, emergency action protocols should be founded on previously collected data of the municipality and local fire risk maps for purposes of efficient and safety strategies.

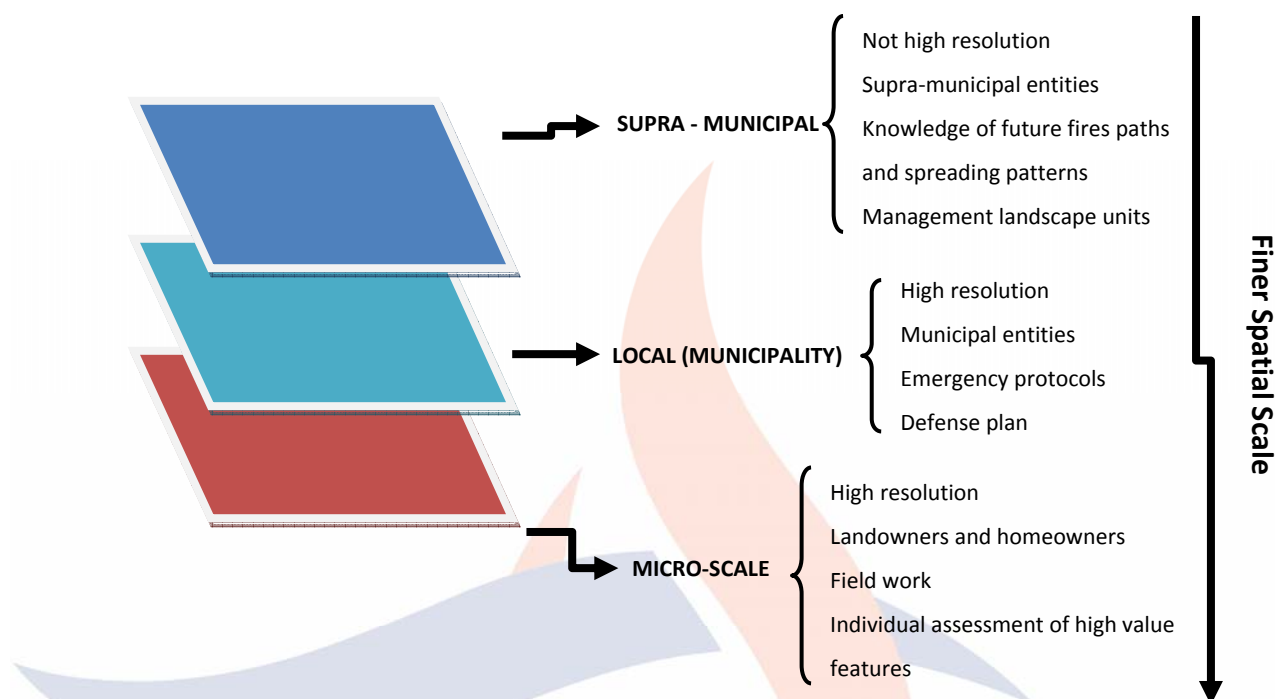
3.- MICRO-SCALE (INDIVIDUAL SENSIBLE FEATURES): Fire risk mapping developed at the finest spatial scale deals with highly localized issues at the farmer-estate level. The combinations of remote sensing technology (LIDAR data), high resolution orthophotograph and fieldwork are utterly necessary to reach the finest wealth detail possible. Every home belonging to WUI areas as well as isolated cabins, farmers or homes must be individually characterized and mapped based upon their fire-risk exposure. Consistent with the required level of detail, fire risk assessments are addressed to land and homeowners, who should become well aware about the situation of their properties. Likewise, the thorough identification of homes at risk gives way to assess the extent to which each home is feasible to be defensible (or self-defensible).

Regarding the risk mapping for forest land PLANA (2011a) fully develop a concerted model among forestry and land planning, seeking for the efficient integration of wildfire risk assessment in spatial and urban planning. The basic idea is to provide normative range to forest planning so that the provisions on risk assessment are transferable to the territorial and urban planning as binding regulation. This legal status is totally necessary to guarantee the activities and uses regulation as usually these are affecting the property rights. The same author shows how the common forest scaled planning model from national-regional-local levels (national/region – sub forest unit – property and forest stand level) offers a coherent frame where to asset fire risk in a top-down approach, which helps to overlap the administrative boundaries limitations as wildfire risk need to be analyzed under physical (massif) criteria. Another issue is, once the assessment has been done, how to organize the preparedness and

<sup>15</sup> In this case the supra-municipal-scale level could be reasonably compared with the territorial-scale level we have been mentioning so far.



response actions, and, as we will see in the next chapter, local administrations can develop an important role on the risk governance (rights and duties of multi-actors shared responsibilities, urban planning and homeowners' involvement) from the perspective of proximity and local actors' dialogue.



**Figure 10. Breakdown of mapping scales taken into consideration for wildfire risk planning in wildland urban areas.** Source: the authors.

## 4.4. Promoting local governance and management of risk

### 4.4.1. Reinforcing local administration as a key agent in the wildfire risk planning

Municipalities and other local administrations can play a key role within the tiered system of wildfire risk planning in so far as they are called to establish the link between the homeowners (fire risk planning at farmer-state level) and the upper territorial level. The absence or weakness of the connection between the municipality and the local population (lack of residents' commitment in local issues) is a major consideration in hindering social acceptability or approval of policies aimed to reduce wildfire risk. To materialize the set of preventive actions hypothetically defined within the territorial planning, a legal standard which considers the general interest over the private and municipal interests is needed (NAVALON, personal communication). The municipality should therefore introduce legislation that requires homeowners to conduct a series of fire risk protection actions.

In WUI areas, residents are normally required by law to maintain defensible space around their houses. Urban planning is regulated by state laws that are developed by the municipalities, which through municipal management plans should establish land use planning that will prevent placing people and structures in fire-prone locations. Hence, the set of actions arranged in the context of urban management plans, and specifically about wildfire prevention, must be driven by the municipalities when it comes to build agreements with the owners. In all case, considering the process of planning as a tool for promoting stake holders awareness and risk culture as well as, for defining the boundaries of the responsibilities among them, is a key issue to keep in mind.

Obviously, municipalities should be provided with the necessary information, capacities and resources to deal with the risk assessment and mitigation actions implementations. Deficiencies could come out when the law imposes preventive measures but does not specify the procedures for their implementation. In this case, there is a risk that it might become a “law of wills” instead of a “law of capacities” (CANYAMERES, personal communication) since municipalities may have neither human nor technical means to implement the region’s defensible space laws. Moreover, the municipality runs into a second problem when it comes to bear the costs of the defensible space and its maintenance. Under these circumstances, municipalities might put pressure on higher-level institutions to call for the necessary economic and technical assistance.

As a result, technical team responsible for designing and dimension defensible spaces must work side by side with the municipalities from WUI settings by providing them with technical assistance and helping residents to understand what the law says. Accordingly, they should prepare a technical document which defines the project proposal and establishes reasonable costs. These costs can be charged to the same municipalities, government or regional administration funding, or go by the owners. Governments, regional administrations or even municipalities can cover part of the initial costs to promote the implementation of the project; but the reality is that those public entities cannot set up permanent funds for the long-term maintenance of wildfire protection infrastructures (NAVALON, personal communication). That is why people living in the WUI should ideally pay the maintaining fees to keep their homes protected from wildfire.

Nevertheless, people who are exposed to the risks of wildfire do not always abide by the recommendations and legal requirements, so the application of a fee for the maintenance of fire protection infrastructures is very likely to be unwelcomed by the residents. It is worth noting that there are many developments that may already have deficiencies in the implementation of their basic services (water, sewage...), so an additional factor regarding fire risk can easily lead to refractory positions. A great deal of communication work is crucial and must be directed to fostering firewise actions by homeowners on their properties. Likewise, communication tasks - following the procedure described in “Societal involvement and democratization of participatory processes” chapter 4.8.2 - are as much essential as the role of communicator itself, who must be able to explain what to do and how to do at

the same time as raising awareness about the need to adopt peremptory safety and self-protection measures.

In this case, the local administration should take the first step forward and incentive the engagement of the homeowners. As CERDAN (2002) reported, the municipalities should attempt to give stability to the instruments of public participation as they should be guaranteeing the persistence of social controls beyond the local political situation. Municipalities have to create a space for dialogue attempting to influence homeowner's perception and adaptation taking into account that both aspects play a major role in determining awareness and response to risk. Likewise, the credibility throughout the process is essential. In this regard, it should be pointed out the major role of certain independent platforms, such as community associations, who are closely concerned about the reality of the owners, have direct contact with them and thus can build trust and establish credibility.

As mentioned earlier, fire prevention is difficult to promote (the fire is not perceived unless it has recently occurred in the territory), a fact that adds barriers to communication tasks. Uncertainty around wildfires causes flight of capitals (THOMPSON and CALKIN, 2011) (insurances see wildfire risk as a volatile product – CABALLERO, personal communication). Moreover, in the absence of adequate wildfire protection measures, homeowners know that they will not be charged for wildfire suppression-related expenses.

CABALLERO (personal communication) highlighted the importance of personal advising according to the disparity of homeowners (different cultural and economic status, with or without past fire experience, etc.) and type of housing. He advocated the realization of social communication work on site with the purpose of advising house-to-house about what investments need to be done to improve fire protection. To that end, WUI should not be considered as a single category, but different categories should be all described and legislation containing all the casuistry is needed: isolated homes, farmers or cabins are not the same as dense housing developments just as dwellings occupied by permanent residents are not the same as homes owned as secondary residences or tourist settlements. If this disparity is not contemplated as part of a legal requirement, communication tasks will hardly raise awareness through the local residents.

#### **4.4.2. Achieving WUI planning requirements for an improved emergency response**

The potential extent of wildfires largely depends upon the availability and effectiveness of firefighting resources. However, when speaking about WUI areas, effectiveness is primarily influenced by the level of vulnerability of people and infrastructures, which are pressing civil protection issues during the emergencies and thus polarize the attention of fire-suppression resources. In any case, the criteria for vulnerability analysis developed from the perspective of civil protection and fire-suppression forces may be useful to establish planning precepts. This includes the re-suppression planning which is intended to identify and acquire the resources needed for the suppression of potential wildfires (improving access for vehicles and fire apparatus, availability of water sources on site, adjusting target placements,

providing buffer and safety zones or creating strategic management zones of fuel loads reduction for wildfire control), for which firefighters, as end-users, must be certainly concerned about their design, dimension and prioritization (NEBOT, personal communication).

For firefighters, entering a burning structure may not be a safety WUI tactic; however, not saving a home opposes what most of firefighters naturally feel to be their duty, so they may want to save every home often costing them to take a high risk. To tackle this dysfunction, the contribution of knowledge of future fires has also led to build bridges between the first stages of the causal chain: mitigation and preparedness (prevention) with response (suppression), allowing the incorporation of pre-suppression precepts in the urban, forest and territorial planning. Pre-suppression planning is intended to identify and acquire the resources needed to suppress anticipated fires once they start (improving access for vehicles and fire apparatus, availability of water sources on site, adjusting target placements or providing buffer and safety zones), for which firefighters, as end-users, must be certainly concerned about their design, dimension and prioritization (NEBOT, personal communication).

Therefore, firefightings is negatively affected by the absence or weakness of the connection between forestry and pre-suppression planning since there is a lack of work that must be done before fire passes through aiming to ensure timely and effective suppression (PAGÉS, personal communication).

When the wildfire risk is not adequately embedded into the urban-territorial planning, dwelling houses can be recklessly settled in fire-prone environments. While firefighters are expected to protect houses within fire-prone areas, they cannot keep them stop from being constructed. According to the axiom of elements to be protected during an emergency, as a matter of priority human health and safety are the primary issue for firefighters followed by sensitive features and, ultimately, the environment. Thereby, if there is no urban and building regulation that integrates the risk of wildfires, firefighters are forced to prioritize defensive strategies towards dwelling houses and residents rather than offensive strategies against wildfire (PAGÉS, personal communication). Both urban and building regulations have to be focused on two aspects: to build safety and functional infrastructures to wildfires and to conduct fuel management efforts (both around structures and within the urban area) so that fire cannot cross the urban area. Once these requisites are met, firefighters will be able to change the priority of their strategies and work in a more efficient way.

Ideally, architects, developers and contractors working in fire vulnerable environments are expected to plan firewise home constructions to their clients that could provide improved conditions for a house to survive. Some knowledgeable decisions about the materials and the design has to be made while establishing the appropriate balance between fire resistance and another factors important to the client like costs and appearance.

Policy-level decisions, such as providing financial incentives to conduct urgent changes in existing developments (“pre-existences”) and creating building codes for future developed areas, may be



translated into fire-safe practices (MCCAFFREY, 2004). Thus, by making technical building codes, a set of prescriptions to choose appropriate materials in the minimization of fire hazard are provided. Such codes provide technical instructions for the estimation of the radiation flux received by a home during the fire event in such a way that a set of guidelines for fire-protection are collected in a technical regulation that requires homes be built with fire-resistant materials.

The creation of a technical forest wildfire code akin to the building code is also necessary. GALLARDO (2014) and GALLARDO et al. (2015) reported that the two variables that define the risk of buildings against wildfires are the distance between the vegetation and the structure, and the model of fuel close to, or in contact with, the structure. Additionally, during a major wildfire, structure materials and design should prevent penetration of any burned embers. Requirements for reassessing a technically based engineering on which underpinning the arguments to establish passive prevention measures must be developed. These codes should consider both; impact of radiant heat of an encroaching wildfire on the different types of structures, thereby prescribing an adequate safety distance between the vegetation and the building (NEBOT, personal communication); as well as, potential emission of spot fires into the WUI area and spread capacity among gardens and house. Eventually, government departments with authority to draw up planning documents will be willing to approve all these technical instructions and convert them into mandatory technical regulations.

Technical cooperation between the urban and wildfire risk management disciplines is essential in order to provide a solution to the WUI structures at risk of wildfire. Social and legal disconformities underpinned by economic standpoints could emerge since such measures involve the introduction of zoning regulations and restrictions used by municipalities to control and direct the development of properties. Local ordinances should outline operational procedures for its implementation (CANYAMERES, personal communication). Likewise, clearly defined administrative processes should allow municipalities to know specific policy legal instruments designed to sustain legal restrictions as well as applying property taxes to make residents pay for ongoing maintenance of defensible space perimeter.

## **4.5. Promoting more disaster resilient communities**

### **4.5.1. Considering cultural change and awareness of risk exposure as processes**

The diagnosis of the structural causes as precursors of large wildfires are widely recognized by fire managers and the scientific community at the same time that suggest a long-term commitment in the management of forest risk systems. All the same, as one starts to involve risk perceptions and attitudes, social and cultural aspects emerge to be crucial issues for enhanced fire risk management, and structural causes should be more precisely redefined as socio-structural.

Social capacity to cope with large wildfires risk need to overcome barriers to action (need to build people awareness regarding fire prevention); the capacity of institutional coordination is in many cases deficient to cope with socio-structural causes (urban and spatial planning did not consider the risk of large wildfire in the WUI); eventually, when fire occurs, people tend to focus on looking for culprits, and, as DOUGLAS (1996) pointed out (see “Social factors influencing individual attitudes and public support towards wildfire risk mitigation strategies”), neglect the structural causes that would cast doubt on our patterns of society.

Fire managers would like to find a mechanism that positively influenced stakeholders’ levels of concern about the impacts of management options as well as their support for fire hazard reduction strategies, but the fact is that there is a cultural issue involved which actually might be more specifically considered as a matter of cultural processes. Awareness of risk exposure, knowledge of fire’s role in the ecosystems, best attitudes towards fire management approaches as well as adaptive capacity by adopting self-protection measures are key aspects to take into account throughout these processes (PLANA, 2011b).

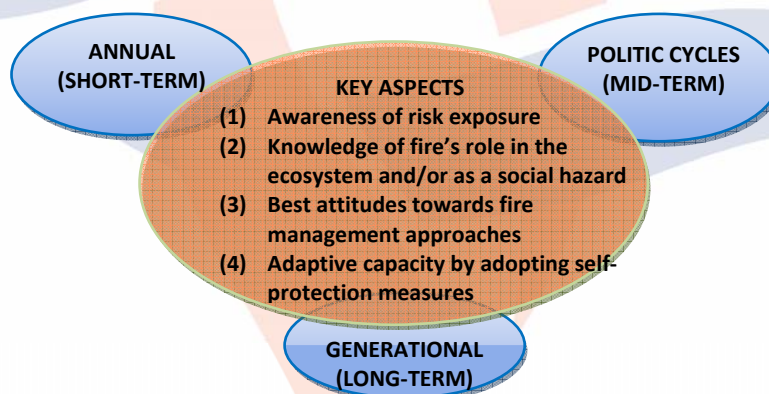
When speaking about cultural processes towards more resilient societies to wildfire, mechanisms seeking to catalyse positive changes should be considered at 3 different levels that are chained to each other: annual (short-term), politic cycles (mid-term) and generational (long-term).

1.- ANNUAL (SHORT-TERM): Some of the wildfire preventive actions are needed to be conducted in the short-term with the purpose of obtaining promptly outcomes. To promote public education, best attitudes as well as to improve the degree and state of preparedness implies actions that must be taken on a year-long basis. As an example, beyond the proper structural design of a house and its surrounding defensible space, a home’s chances of survival can be improved by preventing the annual accumulation of combustible material in the gardens in order to make them not-ignitable at the time that fire occurs. Homeowner’s responsibility to cure outer-areas of all dead vegetation and other materials that may burn in case that embers land inside the property is one the most imminent preventive measures. Moreover, every annual wildfire plan to prevent fire disaster will need some adjustments so that when fire season arrives efforts will be realized. Procedural problems and lessons-learned by the array of stakeholders involved in the different levels of the causal chain must be laid on the table so that wildfire risk management can be worked out more efficiently before the emergency. Thus, annual reviews and revisions will aid to more efficiently meet the protection needs as well as evaluate the levels of commitment in terms of resources and procedures that so far were agreed upon.

2.- POLITIC CYCLES (MID-TERM): Public anxiety to get immediate outcomes and political pressures are two situations that collide and hinder long-term effective planning in the management of forest risk systems. Politically, it is desirable to make visible progresses as long as the political cycle lasts, which in many circumstances it might result in passing costs off to future generations, reducing the burden on current stakeholders. Assuming that the feasibility of any approach is strongly determined by political

acceptability, political cycles must be coherently taken into account in the wildfire planning. The growing rate of forest fuel is governed by natural cycles that somehow can resemble political cycles. Without losing sight of long-term management strategies to deal with fire risk prevention, specific short and mid-term outcomes in the frame of those strategies may be visible over the political term's four (or five) year period. All in all, integrating the duration of political terms when planning wildfire strategies is crucial to reach political support and, therefore, facilitate their implementation.

3.- **GENERATIONAL (LONG-TERM):** Wildfire risk managers should firstly accept that socio-structural changes leading to more disaster resilient communities take long time and they need to prepare people for a long-term process. As CARROLL et al. (2007) reported, [sic] "it will take at least one human generation before we know if we have made enough significant landscape wide progress in addressing the fire problem". Among the current society it is generally unfounded negative perception of fire's role in the ecosystems and forest management practices to prevent the impact of large wildfires: fire's relevant ecological functions as a part of the ecosystem's dynamics as well as large-scale logging events such as clear-cuts and deforestation are not always understood and tend to be viewed with scepticism by the general public. In reality, the current generation is influenced by the former perceptions and beliefs about the wildfire risk and forest management practices. As we acquire an improved and more realistic approach about the wildfire problem over the time we must assume responsibility for educating new generations so that young people have a different view about fire impacts in the landscape and be aware about the need of self-protection in the WUI.



**Figure 11. Representation of all three social levels to promote a positive fire safety culture.** Source: the authors

#### 4.5.2. The need of communication to build support for a fire program

At local community level, a partial perception of the risk can influence the cooperation capacity in prevention and self-protection actions. For homeowners to actively improve their safety, they must first recognize their need for it; nonetheless, public's understanding and experience of risk are often based on the information environment that they are exposed to, which might lead to misperceptions about wildfire hazard and the efficacy of specific practices designed to counter it (MACGREGOR et al., 2008).

That's why greater support for implementing policies and management actions is gained by conducting communication strategies to enhance residents' knowledge and understanding, bring about a significant change in people's level of awareness, attitudes and behaviors (ABSHER and VASKE, 2007; SHINDLER et al., 2009; PLANA, 2011b; STEELMAN and MCCAFFREY, 2013). As a result of this, public support is translated into a more disaster resilient communities (STEELMAN and MCCAFFREY, 2013).

Fire education and outreach programs should be designed with the aim to change people's attitudes, behavior and level of knowledge (MCCAFFREY, 2004). Nevertheless, creating an effective risk information program is not a simple process; even assuring that the message has been properly conveyed and has not produced any feeling of confusion or fear, people tend to be influenced by their own biases and preconceptions and this can distort their final information (SLOVIC et al., 1987; MCCAFFREY, 2004). In light of those circumstances, education has been proven to be a significant variable when building awareness about the role of fire in the ecosystems and support related to wildfire prevention, suppression and management practices (GARDNER et al., 1985; MCCAFFREY, 2004; DENNIS et al., 2005; MCDANIEL, 2014; PEREIRA et al., 2014).

Moreover, STEELMAN and MCCAFFREY (2013) supported that wildfire communication is not just necessary before the fire occurs, but also during the event, because part of the success of the communication efforts is attributed to how the communication in one period influences another. Considering that, they described the dichotomy between risk and crisis communication: while risk communication warns homeowners about a potential future damage so that they can take preventive actions to fireproof their homes, crisis communication focusses on communication during an event. Thus, effective communication both before and during the event opens the door to more flexible strategies to be implemented by wildfire risk managers and accepted by the local people.

#### **4.5.3. Societal involvement and democratization of participatory processes**

Implementation of participatory processes involving communities living in wildfire vulnerable environments should lead to facilitate the policy choices among fuel treatment management prevention alternatives and overall self-protection practices. Beyond the fundamental right that public have to take part of the decisions that affect them, the social involvement in wildfire prevention planning may be justified from a technical view through the relationship between the human factor and the number of fires as well as the intensity of the fires that are occurring in recent times. Thus, it is essential to create a debate about which level of vulnerability we can assumed (strongly related with which can of forests/landscape we want in terms of fuel load) and what is the most suitable management model in which the public should have a room for interaction with fire agencies in the management decisions. Simultaneously, there should be a political commitment to establish adequate channels to ensure the social legitimacy of participatory processes.

PEREIRA et al. (2014) asserted that by means of community participation in decision-making processes, a better democratic development and implementation of management actions are achieved. When the



administration brings to the territory a set of already deliberated ideas, public may see them as a solution being imposed. Nonetheless, when part of the solutions comes from the local population, social acceptability is most likely to be higher while the level of social commitment and activism increases.

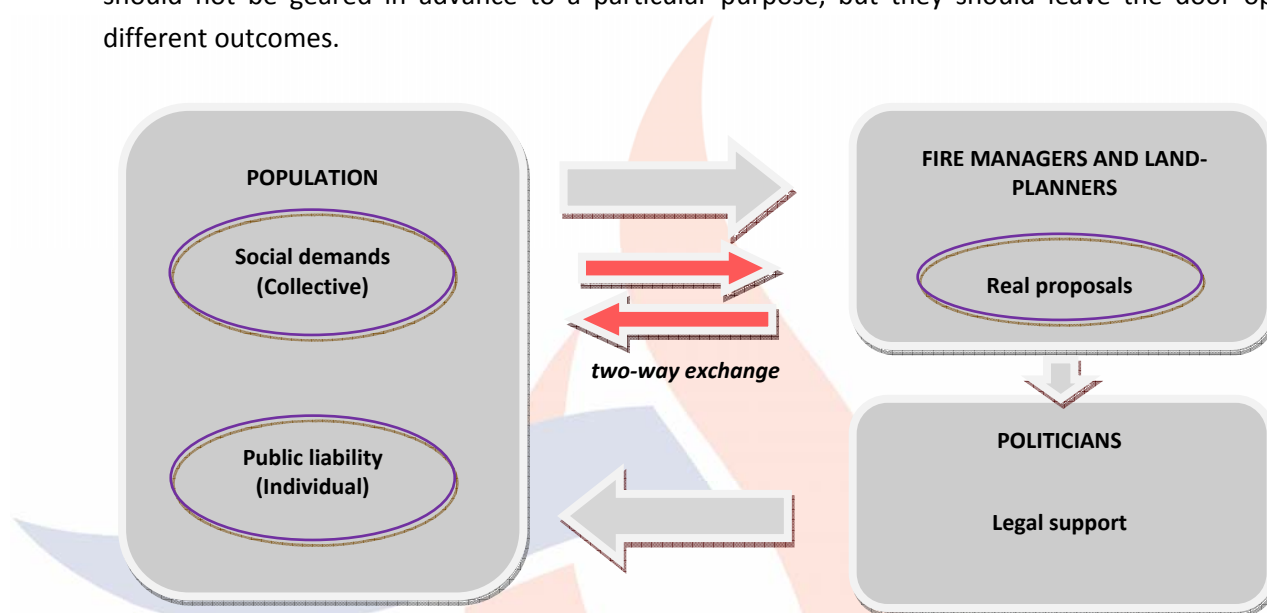
On this matter, HERAS (2006) discussed about the benefits that participation programs may bring within a community. First, Social involvement enriches the quality of decisions. The conjunction between local and scientific knowledge contributes to provide a broader understanding of natural systems and processes by giving rise to an interactive and two-way learning between participants. Residents' knowledge about local ecosystems and culture is crucial in the daily adaptability of communities since they can contribute with different type of knowledge and perspectives to local problem solving (REED, 2008; PAVEGLIO et al., 2009). Secondly, if the discussions raised in participatory processes are transferred to the public sphere, the result is a wider social debate which may reach a broader amount public than the one initially involved or interested in it. As is obvious, not everyone will agree with the deliberated solutions that are commonly convened, but everyone will understand why it is necessary to obtain consensus in a democratic process, thereby improving the governance of the respective areas and projects. Finally, participatory processes are increasingly appreciated as opportunities for environmental education of participants, since they promote or enhance social learning contributing to recover the link between society and the forest.

Furthermore, MCDANIEL (2004) explained that those participation programs constitute a great chance to foster neighbour contact which in turn helps to form a sense of community. People have to understand that fire hazard is a problem that affects everyone, and cooperative working is required to effectively tackle a common challenge. Moreover, getting people to work together the social advantage of adopting fire defensible strategies increases as this work becomes "the norm rather than the exception" (MCCAFFREY, 2006).

Participatory processes are long, so they should be stable over time. Many of the traditional methods and approaches of communication are limited to provide information in order to contribute occasionally to arouse public interest (media campaigns, town meetings, brochures, workshops...); but all the same, they lack real participation processes carried out on a regular basis. As a matter of course, the technics analyse the situation, conduct a fire hazard risk assessment, define objectives, establish proposals, and eventually inform about them to public. In contraposition to that, WINTER and FRIED (1998) defended that engagement with stakeholders should be considered from the outset of any decision-making process, prior to going ahead with implementing management strategies which might not be welcomed among local residents.

REED (2008) supported that, beyond incentivizing people to take part of decision-making processes, participation should be institutionalized by means of organisational cultures taking part of processes on behalf of local population. If participation processes are intended to be a binding democratic right, they have to be institutionalized to enable people to influence the questions that are argued and the outputs

that are produced. The same author argued that goals which are negotiated between organisational cultures and fire agencies must necessarily have uncertain outcomes since non-negotiable positions may be the consequence of preassigned decisions decided at higher levels within the organisation without taking into account public participation in the process. In this light, RODRÍGUEZ (personal communication) defended that, to reach fair and effective participation processes, cooperative and deliberated discussions are always necessary and remarked that in social sciences there are always unexpected factors that come into play in favour of certain tendencies. For that very reason, discussions should not be geared in advance to a particular purpose, but they should leave the door open for different outcomes.



**Figure 12. Expected closed—cycle during participatory processes.** Source: the authors

#### 4.5.4. Enhancing forest landowners' associations

As we have seen up to now, the challenges of wildfire policies are complex and land management agencies must face increased planning requirements as well as develop both institutional and public support. Nonetheless, vulnerability of forests in the presence of large wildfires increases since forest management is increasingly limited with scarce economic productivity direct for the landowner. When analysing forests as an economic asset, the contradiction between price and value emerges: while landowners do not receive substantial revenues from timber sales in low productive woodlands, the intrinsic social value of forests is high (CANYAMERES, personal communication). Large tracts of land are in the hands of individuals who currently do not get enough financial incentives, not even to get back into harvesting of timber and biomass or controlling fuel loads. As a result, there are a large number of small-scale landowners who absolutely are not concerned about forest management and fragmented land-tenure.

The ownership structure of forests may be highly variable and this determines the ability to implement different fire management strategies. Under those circumstances, it is worth designing a comprehensive

forest policy that addresses the risk of wildfires in both conservation and utilization of forest resources. Fire safe municipalities should foster the commitment and cooperation of existing associations interested in the well-being of the community. Particularly, efforts should be directed to the revitalization of unmanaged forest areas through landowners associations (FARRIOL, personal communication). As reported before, risk perception is an aspect strongly associated with a generational dynamic (see “Considering cultural change and awareness of risk exposure as processes”: the risk of wildfires may exceed what the current owners expect. The creation of landowners’ associations is then a communication opportunity to convey the need for a change in the traditional model of forest management and explain the guidelines that should give greater attention to formulating and updating policies directed at the current context of change.

In front of the lack of economic productivity to manage forest lands, and the circumstances of ownership’s absenteeism, land-tenure fragmentation, and incapacity to manage their estates, landowners’ associations are called to come together with the local administration to comply with the development of a forest-scale planning tool with the purpose to conduct a joint labor management (FARRIOL; PAUNÉ, personal communication). This planning process should come out with strong incentives for landowners and biomass/timbers companies to carry out forest management initiatives. Thus, if there is a clearly defined forest management model and those companies cooperate at the same time with a representative of the homeowners association, the feasibility of carrying out a joint labor management increases.

During participation processes involving landowners’ associations a dysfunction in the hierarchical model between the owners and the administration should be generated; that is, bottom-up reconstructive methods which allow the categorizations and parameters in a landowner to be defined by the landowners themselves. If the reverse occurs (top-down), it could lead landowners to perceive risk measures as an imposition (CANYAMERES, personal communication). Moreover, to get effectively involved into participation processes, landowners associations should ideally concur with the election of a leading figure. It is a representative person, leader and dynamic, recognized as a person of trust among members of the association and as a leader-representative by the administration (FARRIOL, personal communication).

#### **4.5.5. Example of residents involvement in fire management: Firewise communities in US**

National Firewise Program is an initiative from the National Fire Protection Association in USA that provides homeowners with the knowledge and technics necessities to create an environment so that their homes can survive a wildfire. The program encourages homeowners to take the initiative in protecting themselves and their homes as they keep enjoying the beauty of nature notwithstanding the reasons why they chose to live in these areas. If homeowners get involved and meet the requirements set by the program, the government provides national recognition to them by rewarding the effort to protect their homes from wildfire.

Becoming a Firewise community in USA requires the commitment and inter-agency cooperation of civic leaders, fire staff and homeowners. Any neighbourhood, subdivision or homeowner association may participate by performing activities to reduce the threat of wildfire to their homes. Some of the local solutions that Firewise Program considers are homeowner education, fire department response, prescribed fire, structural retrofits or open space design (SHIRALIPOUR et al. 2006; NFPA, 2015).

To get the Firewise recognition, communities are required to go through a five step process, each of which must meet a number of requirements as exhibited in the next table. All in all, Firewise community efforts have provided, among other things, improved public services for emergency or disaster events, fuel management programs, emergency action plans, and continuing education for the citizens, volunteers and professionals. Recognized Firewise communities are awarded with the recognition kid including some item so they can prove the benefit for their efforts. In addition, they may receive preferential consideration for medication grants and funding for continuing their work, understanding that it must be a continuing process.

**Table 2. Recognition standards for becoming a Firewise community.**

| RECOGNITION STANDARDS  | ACTIONS   |
|--|---|
| <b>1.- Community Hazard Assessment (in cooperation with WUI specialists)</b>   | Create a plan in coordination with local fire officials which identifies locally achievable solutions that the community is able to implement. An inventory of the area will be necessary in order to determine the potential impact of the fire (what areas need to be treated?).  |
| <b>2.- Creation of a local Firewise task force, committee, commission or department and an action plan based on the assessment</b> | Be responsible for maintaining the Firewise community program, monitoring its progress and reporting its tasks. The recommendations are approved by the WUI specialists who may work with the community to identify project implementation funds. It should involve homeowners, fire professionals, planners, land managers, urban, foresters, who are all expected to take part in the development of the WUI plan.  |
| <b>3.- Organise a Firewise communities' USA day</b>  | The event should be designed to increase awareness among communities about fire ecology, firewise technics, landscaping demonstrations or provide opportunities for homeowners to share information and skills.   |
| <b>4.- Financial commitment</b>  | Participating communities invest a minimum of 2 dollars annually per capita for local Firewise community's efforts. These funds stay in the community and they are not necessary cash. Small neighbourhoods achieve their minimum investment through municipal employers or volunteers using municipal or other equipment.  |
| <b>5.- Annual report and renewal application</b>   | The local Firewise community need to submit an annual report documenting complains with the program. In addition, each year, every recognized community must renew its commitment to Firewise program by reapplying and documenting its continuing efforts to reduce wildfire hazard. Communities are granted after implementation plan has been presented to the local Firewise representatives and at least one Firewise eventual project has been completed. |

Source: the author, based on the information provided by the National Fire Protection Association (<http://www.firewise.org/>)<sup>16</sup> (NFPA, 2015).

<sup>16</sup> <Firewise Communities USA – Recognition Program> <http://firewise.org/usa-recognition-program.aspx?sso=0>



## **4.6. Promoting an effective wildfire risk communication**

### **4.6.1. Adapting the message to different groups and specific social contexts**

Any kind of outreach effort is designed to gain a reasonable level of social acceptance. The construction of the right message constitutes a mayor issue, and the deliverer of the message plays a key role in the course of a communication process in which the sources of public's support need to be carefully examined. For that reason, a number of key aspects to raise awareness in various interest groups should not be disregard while delivering the message with the purpose of promoting a better acceptance of fire management strategies. Adapting the message to different groups and specific social contexts is some tips that can help make communication processes with communities living in wildfire vulnerable areas more successful.

Several authors underscored that the diversity and variety of communities with different requirements and aptitudes for adaption to the risk of wildfire should be recognized (PAVEGLIO et al., 2009; PLANA, 2011b; MCCAFFREY and OLSEN, 2012; STEELMAN and MCCAFFREY, 2013; MCDANIEL, 2014). Since there is not a homogeneous public, challenges to attain effective communication may differ on different communities according to their social contexts (PAVEGLIO et al., 2009; MCCAFFREY and OLSEN, 2012). For instance, MCDANIEL (2014) asserted that small communities within a rural culture may be easier to reach than largely populated places, such as wildland urban interface developments with manifold populations. Similarly, MCCAFFREY and OLSEN (2012) underlined that differences of ethnicity and race may be crucial when accepting fire management strategies and assuming the responsibility for reducing risk. Keeping that in mind, integration of local perspectives in data collection and planning needs of an accurate evaluation of the particular social and biophysical contexts as the adoption of one-size-fits-all management programs seems reckless (ABSHER and VASKE, 2007; COHN, 2008; REED, 2008).

Likewise, people might respond differently to fire management alternatives since perceptions on fire management are tightly linked to the fundamental values that individuals hold (BRIGHT et al., 2003; KNEESHAW et al., 2004; FRIED et al., 2006; REED, 2008; STEELMAN and MCCAFFREY, 2013; MCDANIEL, 2014). For instance, homeowners living right near the forest might be more concerned about certain wildfire risk factors such as private property damages and effects on air quality (KNEESHAW et al., 2004). Therefore, when it comes to deliver the message, intergroup differences should be taken as a key issue to reach successful educational efforts. In accordance with this some authors proposed that educational programs should be targeted to specific groups such as property owners, year-round residents, chambers of commerce, local realtors or schools (GARDNER et al., 1985; MCCAFFREY, 2004; MACGREGOR et al., 2008; SHINDLER et al., 2009; MCDANIEL, 2014).

### **4.6.2. Constructing the right message**

A wildfire protection agencies should attempt to demonstrate the efficacy of specific strategies that will enable them to control most of wildfires (WINTER and FRIED, 1998) by addressing effective and persuasive messages that catch the audience's attention and interest (MCDANIEL, 2004). To that effect,

NAVALON (personal communication) stated that reasons why people might be motivated or adverse to support the agency and take certain actions should be figured out beforehand and it is essential to plainly articulate the objectives towards which the group will tend. Thus, when constructing the message, agencies can demonstrate how fire protection practices are not inherently incompatible with their interests and values (MCDANIEL, 2004).

Likewise, MACGREGOR et al. (2008) clarified that the goal of the message should not just intend that people become aware of risk, but also that this risk could pose significant and severe consequences to them; and, most important yet, that their efforts to reduce the risk would be effective. In concordance with that, WINTER and FRIED (1998) highlighted the need of constructing a message which provides enough evidence that those actions will guarantee a return on public's investment in fire defensible infrastructure.

Furthermore, the aim of the communication processes must transcend the purpose of enforcing awareness as it must also enable communities to meet the wildfire challenge by providing the appropriate capability and tools to effectively undertake fire prevention actions. Even when residents show an optimal level of awareness, and therefore motivation to take preventive actions, they encounter a series of obstacles that deprive them of carrying out the desired actions. Implementation feasibility is, as discussed before, determined by a combination of factors related to the individual's competences and resources as well as socioeconomic and environmental conform within the area where they are supposed to be performed (MCCAFFREY, 2004 - see "Cost-benefit and implementation feasibility" chapter 3.3.4).

Pedagogical strategies that have the mission to educate and motivate recipients about the effects of fire are also a fundamental ingredient in the communication processes. As a core premise, communication must be conducted without provoking alarmism, in a way that do not frighten or disconcert people. Communication should be designed with the aim of helping to understand, not to alarm. Likewise, while today's society may have acquired a high degree of commitment in regard to environmental problems, there is still a high degree of ignorance or misperception of reality in many ways. Forestry profession meet broad negative perceptions of logging practices such as clear-cutting. On one side people want forest to be prevented from large fire, but on the other side they might be reluctant to anaesthetic fuel treatments to prevent them. This example demonstrates how important it is to educate while communicating, attempting to make people acquire a better approach of actual fire hazard and risk prevention planning.

#### **4.6.3. Trust and credibility**

Scientific knowledge and public education certainly play a role and should not be excluded from any consideration, but they are not the only factors influencing residents' perception of wildfire risk, as the lack of trust and credibility constitutes the main barrier to effective risk communication (SLOVIC, 1999;

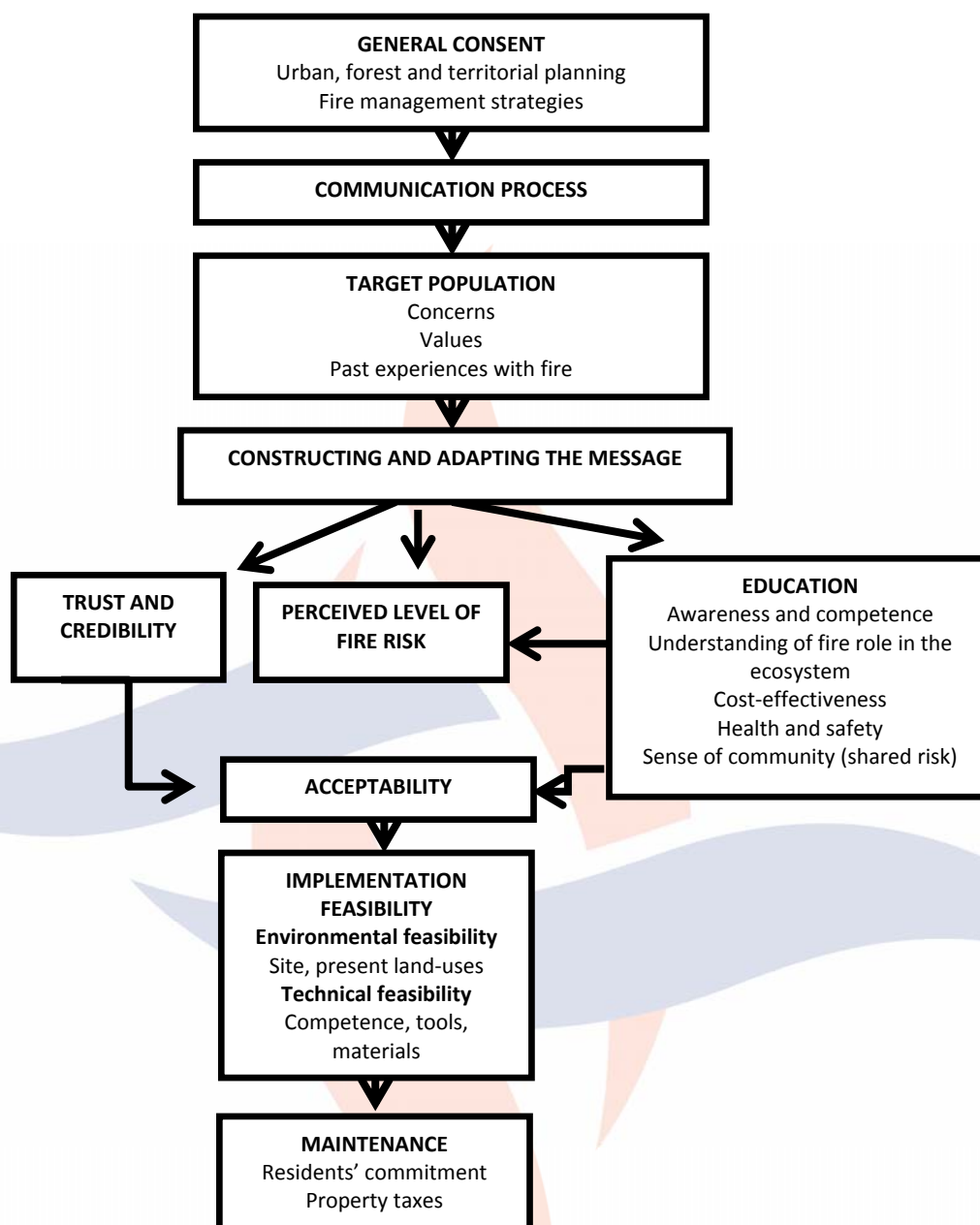
VOGT et al., 2005; MCCAFFREY, 2006; MACGREGOR et al., 2008; SHINDLER et al., 2009; STEELMAN and MCCAFFERY, 2013; MCDANIEL, 2014).

COHN et al., (2008) suggested that introducing more public involvement in both risk assessment and risk management should be seen as an essential mechanism for enhancing trust. Similarly, MCDANIEL (2014) pointed out that the core premise to build public trust lays on building good relationships with the neighbourhoods and communities. According to this author, personal contact, through interactive events such as workshops, field trips or demonstration sites, can be seen as a proof of openness and transparency as they are a chance for experts to justify and clarify their actions as well as for public to make their voice heard. Moreover, in addition to trust in the process, the credibility of information provider may be one of the most important issues determining the long-term viability of a fire management program as it is crucial in the information sharing and communication. The person who is called to carry out communication tasks must assume that both credibility of the information source and clarity of the message will influence the effectiveness of the information. As a result, acceptability of the message and increased likelihood to conduct fire mitigation practices would be associated with people who pay carefully attention to fire information (MCCAFFREY and OLSEN, 2012).

In groups like neighbours associations, landowners associations or other non-professional groups involved in participatory processes for the management of wildfire risk, it is important for all to recognize a representative; that is, a dynamic and trusty leader with a high degree of involvement who is recognized as a person of reference for both the group whom she/he represents as well as the administration and other participating organizations in the decision-making processes. A qualified person to become representative of such collectives is not enough since beyond a good capacity to argue delicate matters there must have been a previous collective consensus.

Finally, while we have insisted that residents from WUI areas have to place their trust in both private and public administrations responsible for fire protection management, it is remarkable pointing out that trust and credibility must indispensably be a two-way street in the course of any participation process. In so far as residents are the primary actors who have the duty to protect their own properties - and themselves - from fire, it would be very positive if wildfire risk management agencies also built a reasonable level of trust and credibility towards the residents.

The following figure illustrates a conceptual model of factors that influence public's acceptance of fuels treatment. In essence, it could be a good synthesis of the discussion addressed throughout this chapter since it condenses and relates risk perceptions, communication and outreach while suggesting the paths to strive for such interactions to result in socially accepted fire risk mitigation practices.



**Figure 14. Sequence of stages in the process of communication and factors that influence public acceptance of fire management.** Source: the authors



## 5. Conclusions

### *Socio-environmental dimension and cross-sectorality of wildfire risk management*

- Wildfire risk assessment and management analysis, especially in the current global change context, needs to ensure there is room for interpretations coming from social science disciplines aimed to tackle the new forms of interaction between fire and society.
- Social vulnerability to wildfire risk includes both exposure to risk and capacity to undertake self-protective measures. High vulnerabilities in wildfire-prone landscape is limiting the extinction efficiency as protection of individuals and houses is a major priority.
- Austere policies founded on rapid identification and suppression of fires are overtaken by extreme fire events which exceed the extinction capacity. However, the impact and lessons learnt of former wildfires has let be more effective and efficient in direct suppression of many later fires.
- Mitigating strategies for reducing wildfire risk need to establish an integrated assessment of wildfire risk causal frame by focusing attention on social, economic and natural structural drivers and their interaction as the major determinant of fire behaviour and spread.
- The territorial dimension associated to structural causes suggests the need to address the problem at a multi-scale planning scope by promoting a high institutional coordination with shared responsibilities amongst an array of stakeholders involved.
- By applying a specific methodology on the basis of fire types prediction (identification of the fire behaviour pattern affecting a given territory), critical areas to be managed and help potential fires suppression can be identified in an anticipatory way and designated resources for prevention measures can be better justified.
- Given the growing Wildland Urban Interface areas and the wildfire events severity, the need to implement wildfire risks mitigation measure at the urban level becomes a pressing issue at the same time as communication work to encouraging property owners to undertake self-protection actions.
- Wildfire risk planning is more likely to be appropriately addressed with planning tools through a cross-sectorial and integrated relational framework as well as ensuring that captures the complexity of multi-stakeholder decision-making fora

### *Social factors influencing individual attitudes and public support towards wildfire risk mitigation strategies*

- Growing interest in fire-related social research ----human behavior, the role of fire risk mitigation-related institutions or culture---- has emerged in recent decades and emphasis has been placed on how to better involve social sciences in the sphere of wildfire risk planning and management.
- The use of social science data to inform wildfire policy can clarify different considerations that are important in affecting support, opposition or behavioural compliance with wild fire policy.

- Social questions such as people's perceptions, beliefs and attitudes toward fire impacts appear to be key issues which require further research since they play a decisive part to the success or failure of fire management programs.
- Experiencing wildfire do not systematically engage communities in adopting fire preparedness actions, and immediate visceral reactions to the risk tend to fade away over time. However, public's reactive attitudes after fire disaster bring about positive circumstances that are conducive to fostering future proactive attitudes.
- People should understand that carrying out fire prevention practices may entail expending some time and monetary resources, but they are worth if they want to avoid greater post-fire costs. Likewise, despite of accepting those costs, people should perceive that implementation of those practices are technically feasible and will fit with the local environment.
- In addition to the deficit of the territorial culture, the deficit of public liability must be considered too. Moreover, at the heart of the problem of vulnerability lies the tension between individual action and collective consequence. Since the question of "who is the risk owner?" is not clear, designation of responsibilities may be a hard issue and people will likely favor government intervention to solve their problems.

#### *Guidelines for cross-sectoral wildfire risk planning and societal involvement*

- Cooperation should be invoked prescriptively. Working cooperatively can provide necessary tools to reduce the effects of wildfires by improving the effectiveness and efficiency of inter-agency fire protection. Identify many potential partners and seeking their ideas and suggestions would increase the level of cooperation.
- The synergistic effect of the partnership working might encourage learning and exchange of knowledge —which must be robust, homogeneous, harmonic and transferable---- in the group setting resulting in a systematically approach to fire risk planning.
- In a multidisciplinary team work, we cannot pretend that everybody becomes an expert in all fields. Professionals with specific trainings must join together to provide comprehensive tools leading on to further technical proposals.
- Efficient fire prevention results from the integration of farming, forestry and livestock practices as well as territorial labour economic and social policies. The forestry sector also offers prominent opportunities for economic development and social cohesion.
- Land planning must meet lower levels of wildfire uncertainty while developing and implementing renovated fire management models and considering that the resilience of our system to fire disasters involves long-term and collective solutions.
- Facing an uncertain fire-related scenario ----in which regardless of suppression resources large fires can be uncontrollable---- policies should promote a shift in investment from suppression resources to knowledge. While maintaining a reasonable set of suppression resources, long-term fire management calls for professional, knowledge-based programs of fire behaviour and operations as well as social science research, all of which provide the foundation for implementing wildfire management plans.

- The forest economy may fall in value as it generates uncertainty because of the fire hazard. Forestry, as any industry that generates uncertainty, will be conducive to flight of capital. A broader adoption of principles of decision-making under uncertainty may be reached within economic analysis: avoided costs of fire damage to forest and human values must be set against direct costs of wildfire prevention and suppression.
- Under a wildfire event, people are afraid of losing what they most value. The wildfire risk planning should not talk about hectares but about values: to what extent we have the ability to estimate the value of the landscape?
- Knowledge based on cultural traditions is not enough to meet adaptive demands for the type of predictive solutions that today's wildfire risk demands. The mind-set of end-users and decision-making groups cannot be based on continuity: working on a changing social, economic and environmental conjuncture requires implementation of a revised wildfire risk management policy and developing new technical skills of fire organization personnel to renew state-of-the-art knowledge about wildfire impacts, and wildfire behaviour.
- Wildfire risk mapping, supported by technical regulations, are the source and endorsement to establish planning guidelines. Cross-scale wildfire risk planning needs to be consistent, even legally, with different spatial scales and their respective end-users.
- Wildfires will happen, but homes can survive. Managing the WUI fire issue at home scale within the community is the key to creating safer homes at the same time as residents continue to enjoy the beauty of nature.
- Local administrations play a core role in the fire risk planning as they are called to be the nexus between the homeowners and higher level institutions.
- Higher level institutions should support local governments to design and carry out wildfire prevention strategies to be embedded into urban management plans.
- There are not simple solutions to fight wildfires. The simplest one is a ban, but it does not work in most of cases. Learning to live with fire appears to be the most effective strategy all across the world. Designers, developers or builders working with structures in WUI areas have the opportunity to offer residents a home designed and constructed with firewise features.
- Communication processes must be fuelled in the local level to actively engage homeowners in planning processes and increase their understanding about the public liability to create and maintain defensible spaces around their properties.
- If firefighters are responsible for protecting forest and homes from being burned, they should be also responsible for the design, dimension and prioritization of pre-suppression infrastructures. Efficient planning including pre-suppression precepts can enable firefighters to easily and efficiently meet fire-suppression strategies.
- Further research in the field of forest wildfire should result in the creation of a technical code with legal implications for establishing properly defensible space around sensible structures and prevent homes to be constructed in high fire risk areas.

- Since wildfire risk planning is influenced by an intrinsic matter of cultural processes, fire prevention strategies should be expected at different temporal scales that follow social and natural cycles: annually, political terms and human generations.
- Pathways of communication should be articulated throughout planning processes and must be intended to involve the public in a dialogue about risk, consider public as a legitimate partner and make an effort to understand and taking into consideration public concerns.
- The debate taking place in the technical field must be properly explained and adapted to non-expert public that is affected by wildfire risk attempting to transfer the knowledge from the technical field to social activism. Therefore, before creating partnerships and alliances with the public, fire experts must come out with a strong discourse over wildfire risk management at the same time as considering that technical solutions have to be worked according to bottom-up forms of participation being very receptive to public feedbacks.
- As part of comprehensive decision-making processes, from the perspective of knowledge it is necessary to allow other ways of understanding the reality, such as those derived from local knowledge.
- Landowners' associations can act as a driver for the revitalization of unmanaged forest areas. However, they require the momentum of fiscal incentives, and therefore run the risk of weakening after political periods, due to changes in the provision of resources and aids prefixed with the previous government, and is determined by the arrival of crisis periods.
- Public participation should be tailored to the specific social and environmental realities of each territory, so it does not seem appropriate to adopt of one-size-fits-all measures. The agencies responsible for organizing participatory processes should specifically plan the process by characterising the target public and, in view of that, selecting the most appropriate participation mechanisms.
- It is fundamental that the discourse is not solely focused on "explaining what to do", by raising awareness of the need for prevention and self-protection measures, but also on "explaining how to do" it by providing the means for it.
- Strategies that incentive homeowners for adopting risk mitigation measures do not have to be limited to communication, education or persuasion approaches. Efforts focus on enhancing the trust by promoting public participation and dialogue can shift residents' ideas of personal, household and institutional responsibility.
- Trust in the process and credibility in the information provider are crucial aspects in effective information sharing and communication. Interactive approaches encourage two-way exchange in such a way that they can promote better understanding between the parties and trust in those who implement a practice resulting in a greater acceptance of risk reduction measures.



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