EUFIRELAB:
Euro-Mediterranean Wildland Fire Laboratory, a “wall-less” Laboratory for Wildland Fire Sciences and Technologies in the Euro-Mediterranean Region

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Recommendations for up-dating the relevant European regulations
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The views expressed are purely those of the writers and may not, in any circumstances, be regarded as stating an official position of the European Commission
CONTENT LIST

1 Wildland Fire Data sets: enhancing both investigation on wildland fire causes (ignition) and the documentation of official wildland fire data sets ...........................................................................................................1
2 Wildland Fire Risk Assessments using the most advanced techniques ............................................................2
3 Wildland Fire Risk Assessments: the social issues ...........................................................................................4
4 Better Infrastructures for Wildland Fire Pre-attack ..........................................................................................5
5 Wildland fuel treatments across the landscape .............................................................................................6
6 Best wildland suppression actions .....................................................................................................................9
7 Fire Fighter Job hazard Abatement Actions .....................................................................................................11
8 Advance Education in Forest Fire Management ..............................................................................................15
9 Allocation of public money to easy consequences of wildland fires .................................................................16
10 References .......................................................................................................................................................17

Acknowledgements.....................................................................................................................................................17
1 WILDLAND FIRE DATA SETS: ENHANCING BOTH INVESTIGATION ON WILDLAND FIRE CAUSES (IGNITION) AND THE DOCUMENTATION OF OFFICIAL WILDLAND FIRE DATA SETS

More dedication is needed in European countries to National Forest Fire Databases. It is necessary to share and integrate more efficiently data from different agencies (i.e., Forest Service, Civil Protection Service).

Databases today have a high percentage of unknown causes of wildland fire.

No proper wildland fire planning could be done with this degree of uncertainty.

Understanding the reasons why fire starts is crucial when determining what to do to prevent or to reduce their incidence.

Since causes are more diverse than is often assumed and fire initiative is neither as random, nor, in some cases, as meaningless as some analyses have suggested, a rational approach is necessary to give an interpretation to this complex reality, which is site and culture-specific


The European Union is already aware of the necessity to improve the forest fire ignition causes identification.

So a French Forest Focus program called “Improvement of for developing a georeferenced database” has been founded by CEE (2005-2007).

Its first objective is to develop a method in order to obtain data on fire ignition to feed an existing database.

More precisely, the aim here is to provide some indications to develop the existing database with newer and more precise data.

If the test is conclusive, it would be of great interest, in a further step, to supply the European database, and to promote new conferences on the subject of fire database (FAO et CIHEAM, 1999).

It will be a way for obtaining better and cheaper information because data collection method will be reproducible for some information.

Its second objective is to develop an outstanding information system about fire ignition points:
- precise localization,
- description of natural environment (elevation, aspect, slope) and landuse at the ignition point,
- fire ignition cause definition and mechanism knowledge.

Cemagref of Aix en Provence has to coordinate this program, whose study area is located in South of France.

The main result will be:
- to adapt to French context of a method focused on “physical proofs method” for localizing fire ignition points with precision (method already used in Spain and Portugal) and
- to elaborate recommendations to end-users.

This regard, to complete this kind of initiative, our recommendation is that the European Union should mention in its official documents that:

1. More dedication is needed in European countries to National Forest Fire Databases

2. It is necessary to share and integrate more efficiently data from different agencies (i.e., Forest Service, Civil Protection Service)

3. All wildland fires larger that 50 ha require a detailed a GPS record of their perimeter as well as the starting point of the fire This will enable managers and researchers to learnt the specific fire propagation pattern.

An example of report on wildland fire propagation can be seen in http://www.etsea2.udl.es/~UFF/6_photos_videos/pages/lleida_group.htm

Figure 1: Investigating the ignition point and later the fire cause (Castellon, Comunidad Valenciana, Spain) an Francisco MONTESINOS’ photo
Socio-economic development experienced in most European countries during the last decades has caused a generalised reduction of traditional activities in forested rural areas. Abandonment of activities such as cattle grazing, firewood extraction and forest cleaning has notably increased the fuel load. In a situation like that, fire could find a favourable environment for ignition and propagation.

This problem could be especially important in privately owned forests with no prospect for economic profit.

The result is an increase of forest fuel accumulation.

Although enhancing investigation on wildland fire causes (ignition) is essential (as mentioned in previous chapter), we want to focus now on the need of a comprehensive understanding of the causality of fire spread, fires under conditions of heterogeneous terrain (i.e., elevation, slope, aspect), fuels, and weather.

This is critical to pursue a cost efficient forest fire control based on the most advanced techniques on Wildland Fire Risk Assessment.

To do so, simulators such as FARSITE are needed in planning both pre-attack actions and to ensure that the best suppression actions are taken to control a given forest fire following a recognized pattern of causality of fire spread.

FARSITE (Fire Area Simulator) is a two-dimensional deterministic model for spatially and temporally simulating the spread and behaviour of fires under conditions of heterogeneous terrain (i.e., elevation, slope, aspect), fuels, and weather.

To do this, FARSITE incorporates existing fire behaviour models of surface fire spread, crown fire spread, spotting, point-source fire acceleration, and fuel moisture with GIS data.

Simulation output is in tabular, vector, and raster formats (Finney 1998, Finney et al., 1997).

To properly assess Wildland Fire Risk we need to recognize that, in many European regions (and abroad), wildland fire regimes have recently changed due, in part, to the growing weight of large wildland fires -LWF-. Today, a much larger percentage of our area swept by fire belongs to the LWF fire class.

We have more suppression resources than before while LWFs are even bigger; therefore, our fire planning should change.

Many of our LWF are beyond the threshold of suppression forces.

To fight these LWF, we have to build suppression means (i.e., hydrants, pools, fuel break areas, dirt roads, firefighter safety zones) before suppression efforts.

Molina et al. (2006b) show how to assess cost-efficient pre-suppression actions after careful study (multiple Farsite and Flammap simulations) of the specific, most likely pattern of LWF behaviour for each forest massif.

In a like manner, Molina et al. (2006b) illustrate how to locate the required aggressive wildland fuel management actions in priority areas (i.e., where suppression efforts are useless with actual fuel conditions) using the above mentioned computer simulations.

They show several case studies in both in NE Spain and Insular SW Spain.

Fire-fighters needs are different in planning ahead (i.e., fuel management) and suppression actions (we will address suppression actions later).

A major need is to study and review historical fires and to simulate their behaviour (Finney 1998, Finney et al. 1997, Molina & Castellnou 2000) to learn to forecast fire behaviour in future events.

This should lead us to have a classification of LWF types to properly assess the potential of future fires and have a proportional response to their potential.

Therefore, computer simulation tools are very useful for fire-fighters in planning ahead, and should be used linked to Wildland Fire Risk Assessments based on daily weather forecast.

Another approach is to focus risk assessment in the wildland-urban-interfaces. Because of their high vulnerability and their high ignition probability and combustibility, it is important to insist on their characterization.

European programs have already founded researches such as WARM, FIREPARADOX (in progress).

Spatial analysis method that allows to define wildland urban interface types and to map them from SPOT 5 satellite imagery has been developed in France (Lampin & al, 2006).

The method uses remote sensing to produce up-to-date land cover map, and ecological indices associated with houses density calculations.

GIS is used to combine and to map quantitative data above cited.

The result is a map of wildland urban interfaces on wide areas and at a large scale (1:10 000).

In the European project FIRE PARADOX, several research and engineering teams are working together with a view to improve the methodology to characterize and to map WUI through spatial analysis of the territory according to regional and local approach.

And the objective at term is to be able to assess and to map vulnerability level or index according to each WUI types and also damages in case of fire.

These results will allow developing appropriated prevention actions, to help fire-fighters adapting their fighting strategy (concentration or dispersal of crews and facilities according to the stakes, positioning on the most vulnerable zones of interface).

A whole of recommendations will be also proposed and will complete the first recommendations below.
Figure 2: Wildland urban interfaces map (LAMPIN’s graph)
Socio-economic development experienced in most European countries during the last decades has caused a mostly urban communities and less rural inhabitants. Therefore, information to public is essential.

In this regard, our recommendation is that the European Union should mention in its official documents that

1. More dedication is needed to educate citizens in wildland fire hazards and taking themselves active part in providing for a fire safer housing environment.

2. Specific educational programs for children at schools and high schools are among the best investments to implement.

Figure 3: Forest Fire Fighter employees igniting a prescribed burn (Catalonia, Spain) for high school students within environmental awareness curricula (Moises GALÁN’s picture)
To fight these LWF (large wildland fires), we have to build suppression means (i.e., hydrants, pools, fuel break areas, dirt roads, fire-fighter safety zones) before suppression efforts.


One of the consequences of the decreasing profitability of forests in general in the last decades is the loss of interest of forest owners and administration for doing investments in the forest.

This is especially critical in Mediterranean areas, where forests happen to be less profitable and more hazardous regarding fire occurrence.

Not only forestry as economic activity is endangered by this situation, but even forest protection elements are difficult to create and maintain.

One possibility that opens here is to include the construction and maintenance of these infrastructures as part of general policies of forest fire suppression, subsidized by regional governments.

This would mean not the transfer of funds from forest suppression to forest prevention but the transfer of know how and human resources (specially in more urbanized regions).

In Catalonia (NE Spain) “passive suppression” (run by a strong, highly staffed, fire fighting service FFS) has been called as a substitute of “pre-suppression” (run by a weaker forestry service, FS) can also help in this matter.

This has implied that it is the FFS who assesses where forest fuel treatments are necessary for a safer and more efficient fire suppression to address society's general interest.

Therefore, after forest service approval, it is FFS who invests time, personnel, and resources to implement that forest fuel modification.

In this regard, our recommendation is that the European Union should mention in its official documents that

1. More dedication is needed to justify where to locate pre-suppression infrastructures in European countries specifically in the wildland urban interface.

2. Specific work is needed to establish fire-fighters’ safety zones in wider “full above vegetation” removal strips”.

3. Developing good digital (GIS based) maps of infrastructures (i.e., hydrants, pools, fuel break areas, dirt roads, fire-fighter safety zones) is a must.

![Figure 4 (left): Fire-fighters’ safety zones in the wider “full above vegetation” removal strips”](image1)

![Figure 5 (centre and right): Farsite simulations (Bergueda County) during 24h free fire spread (S or SW wind driven fires) in centre figure. 24 h Farsite simulations but limited by fuel-breaks South of every dirt road (in right figure).](image2)
Despite the negative impacts of severe fire control on fire dependant ecosystems and escalating fuel hazards, it is still the prevailing practice in much of the extensively managed forested/bush areas in Europe.

No substantial fuel management is carried out but along main roads without a reasonable criterion.

Aggressive fire suppression has become a defining character of agencies for wildland fire suppression around the world.

Over the years, it has produced astonishing results in the pursuit of fire control goals and objectives. While the criteria, for what constitutes a successful initial attack, varies somewhat amongst agencies the overall results have been exemplary.

Influenced extensively by land management practices and related fire regimes, initial attack success generally exceeds 90%, with some agencies operating in the high 90% ranges.

The results speak for themselves as few industries can show off such a success.

Clearly, if some aggressive initial attack was good, then more must be better and a lot must surely be better yet.

It was applied as a one-size-fits-all solution to what has proven to be a more complex ecosystem challenge.

On the other hand, there has been a substantial marginal agricultural land abandonment in the last decades that is a major operational factor in compromising both forest resilience to fire spread damage and forest fire suppression capabilities under extreme fire weather.

This change in socio-economic trends do imply the need of an additional effort of public forest services in particular to address this new complex fuel build up at a landscape scale (specially in Mediterranean regions in Europe).

Therefore, it is clear to us that more work should be conduct in on extensive wildland fuel treatments across the landscape.

It is important to note that cost efficient wildland fuel treatments are seldom found.

Most wildland fuel treatments are not thoroughly justified in relation to a given (most probable) pattern of fire.

However, MOLINA et al. (2006b) show (figures 6 and 7), among other cases, a study where treating (i.e., fuel management) only 59.6 ha (strategically located) we are able to dramatically reduce the potential of large wildland fire in 11309 ha of the study area in NE Spain.

They used extensive FARSITE simulations to assist in this assessment.

The strategically located fuel treatments will create a set of valuable opportunities to contain (by means of suppression fire or backfiring) a large wildland fire that respond to a LWF type that we have previously characterized.

Additionally, we must consider the social acceptability of forest conditions and management practices. SHINDLER et al. (G.H. 2002) have address these issues.

Prescribed burning could be a tool to accomplish these actions of management for mitigating fuel now needed at large scales than in previous decades.

It is worthy to mention here new legislation in this regard:

A specific regulation regarding a methodological use of fire (both prescribed burning and backfiring operations) in Catalonia (NE Spain) http://www.belt.es/legislacion/vigente/sp_pcivil/pcivil/estatal/norm_comp/incendios/pdf/2707006_decreto_incendios.pdf.

Similarly, there is a call to encourage the use of prescribed burning in forest management in the recent Canary Islands (Spain) forestry policy (Directrices de ordenación de los recursos forestales) (http://www.gobcan.es/boc/2005/159/017.html).

The consideration, in both Catalan legislation and Canary Islands forestry policy, of prescribed burning techniques as fuel management method can be a starting point for a new policy in fire prevention for other regions of Spain (and elsewhere in Europe).

The effectiveness of this policy in comparison those applied in other regions in the medium term will be definitive for their further application throughout Spain and Europe.

A recent (2002-2005) prescribed burning program in Gran Canaria (Spain) was assessed (MOLINA et al. 2006a).

That paper studies prescribed burning as a mean to create fire resistant stands to allow wildland fire control.

The program was aimed not only to establish fuel-breaks but to provide strategic locations for those (after FARSITE and FLAMMAP simulations).

MOLINA et al. (2006a) also show a case study for the Mesas (May 11th, 2002) wildland fire and the prescribed burn fuel breaks established around it in the last years in which this fire was successfully anchor (figure 16).

In this regard, our recommendation is that the European Union should mention in its official documents that

1. Member States or regions should not only rely on “aggressive fire suppression” but on extensive wildland fuel treatments across the landscape

2. Prescribed burning should be consider as a useful tool in vegetation management in order to help to the removal of some national legal restrictions or bans to these techniques (i.e., Greece, Italy)

3. Fuel treatments should be strategically located to effectively create a set of valuable opportunities to contain (by means of suppression fire or backfiring) a large wildland fire that respond to a LWF type that we have previously characterized.
Additionally, (and as we mention in chapter 9) we strongly believe that “money” from the European Union to help to easy consequences of natural disasters should be allocated to forest fire affected regions only after a detailed investigation which prove that in that region there have been substantial investments actions in fire management planning in the last five years.

Figure 6 (left). Most likely fire spread from potential large fires based on historical fires in Rialb area (Catalonia, NE Spain). It has a hot, Southern wind synoptic pattern.

Figure 7 (right). With only 59.6 ha (strategically located) treated we are able to dramatically reduce the potential of large wildland fire in 11309 ha of the study area in NE Spain. It has a hot, Southern wind synoptic pattern.

Figure 8. Forest Fire employees igniting a prescribed burn (Canary Islands, Spain).
Figure 9. Forest Fire Fighter employees igniting a prescribed burn (Catalonia, Spain).

Molina et al. (2006c) details fuel bed characteristics and management implications. This document may be seen in http://www.eufirelab.org/prive/directory/units_section_2/D-02-04/D-02-04.pdf

Figure 10. Fuel bed management in Valencia (Spain)
6 BEST WILDLAND SUPPRESSION ACTIONS

Today, best wildland fire suppression actions should be based on a full knowledge of the resources, personnel and infrastructures available and this cannot be done without GIS technologies and digital thematic maps.

However, in some European regions, fire suppression is run in the year 2006 with low skilled personnel, no specific maps, inefficient communication systems, and only visual identification of other crews.

The development in the last years of technologies (especially those related to GIS and remote sensing) opens a wide number of possibilities for improving forest fire suppression achievements.

The increasingly common use of digital geographic information, even when initially developed for other purposes, can definitely contribute in these subjects.

Moreover, international cooperation and coordination in research (joint initiatives, international projects), as well as the sharing of information and know how can be also useful tools.

Aggressive fire suppression has become a defining character of wildland fire suppression agencies around the world.

Over the years, it has produced astonishing results in the pursuit of fire control goals and objectives.

While the criteria for what constitutes a successful initial attack varies somewhat amongst agencies the overall results have been exemplary.

Influenced extensively by land management practices and related fire regimes, initial attack success generally exceeds 90%, with some agencies operating in the high 90% ranges.

The results speak for themselves as few industries can show off such a success.

Clearly, if some aggressive initial attack was good, then more must be better and a lot must surely be better yet. It was applied as a one-size-fits-all solution to what has proven to be a more complex ecosystem challenge.

In suppression actions, tools like Campbell Prediction System language (CPSL, Campbell 1995) are helpful to forecast the most likely fire behaviour as fire moves on the landscape and through time and helps to fire-fighters' safety.

Better fire suppression actions can be obtained from the “The Dead Man Zone” concept.

The Dead Man Zone is the area directly around a wildland fire that is unburnt, and therefore can burn if the wind were to change direction or a new fire were to ignite.

Members of the CSIRO research team in Australia who were investigating the spread of bushfires coined the term “Dead Man Zone” (Project VESTA).

Project VESTA, headed by CHENEY, found that when the wind changes direction, the line of fire will move out at its maximum rate of spread almost instantly, and that that speed was nearly three times what was previously thought.

Fire-fighters will try to stay out of the dead man zone at all times, working from safe points such as burnt ground or a large area of non-burnable ground.

This is achieved by attacking the fire from the flanks, or the rear, so that burnt ground is always nearby, and the fire head is always in front of the fire-fighters.

Were they to attack fires at the head of the fire, they risk having spot fires start behind them.

They would also risk changes in wind behaviour accelerating the spread of the fire.

The result of several inquiries into fire-fighters death in Australian Bushfires found that fire-fighters should stay out of the Dead Man Zone, and that they should always keep 250 litres of water in their truck for personal safety.

This is now a standard operating procedure in the Country Fire Service.

The skilled use of fire in suppression actions could be a tool to accomplish wildland fire control actions now needed for today’s complex at large scales than in previous decades.

It is worthy to mention here new legislation in this regard:

A specific regulation regarding a methodological use of fire (both prescribed burning and backfiring operations) in Catalonia (NE Spain) [link]

In this regard, our recommendation is that the European Union should mention in its official documents that

1. Member States or regions should not only rely on “aggressive fire suppression” but on extensive wildland fuel treatments across the landscape.

2. Best management tactics should be written suppression protocols (as well as best management actions) attending to wildland fire type from a previous, educated clarification. All fires are not similar; therefore, suppression efforts should vary accordingly.

3. It is generally the best to attack the fire from the flanks, or the rear, so that burnt ground is always nearby, and the fire head is always in front of the fire-fighters.
Figures 11 and 12: Suppressing (left) and controlling (right) a wildland fire with hand tools operation in Gran Canaria (Canary Islands, Spain).

Figure 13. Backfiring operation in Portugal (Eduardo MARTINEZ’s photo).

Figure 14. Backfiring operation (2003 Alcover fire) in Catalonia, Spain.
The belief that accidents are the result of a chain of events consisting of many causal factors has general recognition.

In the wildland fire industry, such factors often include:
- communications;
- fire behaviour;
- strategies and tactics;
- equipment; and
- a variety of infringements of the 10 Standard Fire Orders and 18 Watch Out Situations.

Where human behaviour factors have been recognized as causative to accidents to at least some extent, it is typically referenced as the much-maligned “Can Do Attitude”.

While an admirable quality by many accounts, “Can Do” can produce disastrous consequences if not tempered by a strong measure of reality (BEAVER, 2001).

Casualty investigations will frequently categorize underlying factors according to the manner in which they may have contributed to the event.

MANGUN (1995) suggests a classification layout that includes the way in which the causal factor may have contributed (directly or indirectly) plus the extent to which the factor may have contributed (influencing or contributing significantly).

Such a format is generally oriented to proximal origin identification for the purpose of developing new procedures, equipment or standards to eradicate or lessen the risk.

BRAUN (1995) argues that this is far too narrow-minded and it is the human factors that control the acceptance of hazardous and risky behaviour that need to be investigated.

This sentiment reflects HEINRICK’s “Law of Safety” who, like BRAUN, implicates high-risk behaviour as the source of most near-hits and accidents (HEINRICK et al 1980).

In this respect, causal factors relating to near-hits and/or fatalities from wildland fire entrapments can be generalized as either fire behaviour or human behaviour (BEAVER, 2001).

While there has been a great deal of research regarding fire behaviour in the past decades there has been modest research into the attitudes and behaviours of the wildland fire suppression culture.

Wildland fire behaviour mainly conforms to principles of chemistry and physics while human behaviour in contrast is far more complex and at times doesn’t appear to conform at all (BEAVER, 2001).

In appreciation that human behaviour is motivated by consequences either good or bad (GELLER 1996), the very successes and failures of the fire suppression business need to be examined with respect to the impact they may have on the wildland fire culture specifically.

PUTNAM (1995) and MANGUN (1999) report that entrapment fatalities, injuries, and near-hits are most likely to happen during initial attack phases or extended initial attack periods in transition to sustained attack operations.

A mixture of these observations reasons that the majority of entrapment related accidents and near-hits share two common elements:
- Extreme fire environment conditions
- Initial attack or initial attack transition to sustained attack phases.

This was most certainly true of some of North America’s most highly publicized wildland fires, the Mann Gulch Fire (MCLEAN 1992), Dude Fire (USDA 1999), South Canyon Fire (South Canyon Fire Investigation 1994), Thirtymile Fire (USDA 2001) plus many others.

If conditions of the fire environment are largely beyond the control of the fire manager, then it is the phases of initial attack, over which some degree of management control may be exercised, that must be examined.

What then makes the initial attack phase of fire suppression operations so susceptible to entrapment fatalities, injuries and near-hits?

MANGUN (1999) summarizes it as the period when fire-fighters may be taking independent action in an environment where communications might be confused and the fire environment conditions not well understood.

One might also argue that in any given year there would be far more initial attack fires than there would be extended attack fires.

Data on related person hours of exposure to each is not readily available.

Although the circumstance of extreme fire behaviour and initial attack are common to wildland fire entrapments it is not absolute and appropriate caution should be exercised on all wildland fires regardless of the fire behaviour or phase of operation.

GELLER (1996) recognizes risk taking as a learned behaviour that develops from a risk and reward/punishment relationship.

Risk taking or unsafe acts are in reality, seldom punished by an injury or even a near-hit.

In many respects this is likely a good thing as one can only imagine the pandemonium of traffic accidents if all unsafe driving habits translated directly to an accident.

On the other hand, if risky behaviour such as taking short-cuts produced rewards including increased productivity, leisure-time or control and extinguishments of wildfires, they can become entrenched as habit or even Standard Operating Procedures (SOP’s).

GELLER (1996) explains learned risk-taking by means of a learning activity that most people can relate to.
When first learning to drive a motor vehicle, we were reasonably nervous and very watchful.
Because this was a fresh experience it commanded our total attention.
Human nature in this occasion was on the safe side.
As our experience enlarged and many of the skills necessary to operate a motor vehicle became rather instinctive, our defensive behaviour likely began to diminish; we were more prone to drive with only one hand on the steering wheel, carry on a chat with passengers.
GELLER explains that these risky behaviours spread because we perceive them as being cool, convenient, or they save us time.
Therefore, these risky behaviours grant us with a reward, while only occasionally are they punished by an accident.
There are numerous instances in the wildland fire business where activities that might be considered as risky have produced fire control rewards with few punishments.
Such activities as hot-spotting unanchored fire-lines, deploying from a heli-spot upslope of the fire because the brush was less dense and it would require less clearing, or foregoing a detailed size-up in favour of quick engagement (BEAVER, 2001).
The need to fight wildland fires aggressively has been edited to include the statement “Fight fire aggressively but provide for safety first”.
From that time onwards, aggressive fire suppression has been linked with fire-fighter safety, the suitability of which has come under some debate.
Aggressive fire suppression has become a defining character of wildland fire suppression agencies around the world.
Over the years it has produced astonishing results in the pursuit of fire control objectives.
While the criteria for what constitutes a successful initial attack varies amongst agencies the overall results have been excellent.
Influenced extensively by land management practices and related fire regimes, initial attack success generally exceeds 90%, with some agencies operating in the high 90% ranges.
The results speak for themselves as few industries can show off such a success.
Clearly, if some aggressive initial attack was good, then more must be better and a lot must surely be better yet. It was applied as a one-size-fits-all solution to what has proven to be a more complex ecosystem challenge.
Still, no agency has been able to produce fire control results 100% of the time through strict fire suppression alone.
It is the fire environment conditions that occur a relatively small percentage of the time that will account for the majority of area burned.
It is also these exceptional conditions that contribute to the majority of entrapment related near-hits, injuries and fatalities.

The most important impact of risk and reward/punishment relationships is on the evolution of the fire fighting culture itself.
Rewards in the wildland fire business are many and may be intrinsic or extrinsic.
The scope of this discussion is specific to the various initial attack rewards and punishments and how they might influence the safe or unsafe aspects of the wildland fire culture (BEAVER, 2001).
The rewards of aggressive initial attack to fire control agendas, as previously described, are obvious, at least in the short-term.
On the other hand there are relatively few punishments when one considers the number of fire-fighters assignments that occur globally throughout a single year.
Most fires are controlled as per policy with relatively few accidents or near-hits.
Further influencing this is the prospect of near-hits going un-recognized or even providing a reward in itself.
BRAUN (1995) labels a near-hit from a behavioural perspective as an accident without the consequences.
To persons who thrive on the “adrenaline rush”, a near-hit may go un-recognized as a punishment and could actually be valued as an exhilaration reward.
What person in the wildland fire business has not observed the rise and fall of fire-fighter interest and enthusiasm as a direct function of fire danger?
As HART (1995) explains it, “getting away with it” reinforces the attitude that fire-fighters can do the job with an ever-diminishing margin for error.
In this respect, getting away with it effectively raises the bar on risky behaviour.
In combination with the adrenaline rush, getting away with it can become the subject of fire control folklore, effectively undermining the safety first objective (BEAVER, 2001).

Unlike other natural phenomena humankind has been able to (within limits) control wildland fire.
This ability to control wildland fires under ordinary fire environment conditions, produces the fire control rewards that agencies hold in such high regard.
This has not come without a price however.
The manner in which agencies define and reward, success and failure has a major influence on the attitudes and behaviours of its employees and hence its safe or unsafe business culture.
Traditional methods of aggressive fire suppression have produced astounding fire control rewards over the decades, and for the majority of fire environment conditions aggressive fire suppression and “can do” are both safe and effective.
But as the fire environment escalates to extreme fire behaviour conditions the risk to fire-fighter safety increases accordingly while fire control effectiveness (rewards) diminishes.
It is necessary to train fire-fighters in this “fire environment escalates to extreme fire behaviour conditions”; there is a lack of recognition of this critical issue.
Because of this relationship, aggressive fire suppression can oscillate between an activity of low risk and high reward and one of high risk and low reward according to conditions of the fire environment.

As fire managers have largely no control over the fire environment it is the human factors influencing the acceptance of hazardous and risky behaviour that will need to be managed.

There is a need to recognize when aggressive fire suppression and "can do" will save lives and control fires and when it will not.

While “can do” can be an admirable quality, if it is not tempered by a healthy dose of reality it can have disastrous consequences (BEAVER, 2001).

The wildland fire community, politicians, and the public will have to correct their perceptions and expectations regarding the realities of wildland fire versus fire suppression technology.

Aggressive fire suppression would not represent the unquestionable, solitary solution to the wildland fire problem.

Fire suppression tactics would be applied consistent with the prevailing conditions of the fire environment, probability of mission success, and the values at risk.

It could mean total aggressive fire suppression or complete non-engagement.

A total safety culture may well translate to fewer fires fought, reduced initial attack success rates, increased area burned, with fewer accidents.

We must ask ourselves if we have the determination, conviction and most of all, the courage to attempt such a cultural change (BEAVER, 2001).

We slightly disagree with BEAVER (2001) here.

Our suggestion here is that we should have new regulations across Europe that prioritise fewer accidents while recognizing that, if we have forest no proper management, this might imply both reduced initial attack success rates and increased area burned.

To reduce the mean area burned per year we have to address landscape fuel patterns with efficient fuel management and not by unsafe fire suppression actions.

Efficient fuel management has been addressed in chapter 4 “Wildland fuel treatments across the landscape”.

The highest and most serious losses produced by wildland fires evidently occur in terms of human lives.

Very serious fire-fighter accidents, most of them clearly avoidable, have occurred in Europe in the last decades, some of them still open as civil trials.

Among the measures to prevent for these accidents to occur, we suggest:

- an enhanced training (constant training and refreshment courses of fire-fighters focusing of real risks and consequences of aggressive attitudes in fire combating),
- a job hazard reduction attitude (aimed to collective protection) and lastly
- the improvement of personal protection equipment of every person participating in fire suppression.

It is as important to train units in technical issues as in psychological and awareness aspects (prevention policy applied to crew).

An accurate evaluation of the risk of a given situation can help to prevent accidents.

Lastly, when fire involved a Wildland Urban Interface, human behaviour changes and it is most likely that unsafe actions may occur.

In this regard, our recommendation is that

1. The European Union should lead and encourage Members States to correct perception on enforcement and punishment in fire suppression (castigation, retribution). If wildland fire agencies are going to progress to a total safety culture they will have to go beyond the traditional view. It will require in-depth investigation, by professionals in human behaviour, into the factors of reward and punishment that shape the very culture of the wildland fire industry.

2. Specifically, the European Union should encourage to remove any behavioural mood (i.e., “adrenaline rush”) that may lead to accident or fatality because of any near-hit might go un-recognized as a punishment and could actually be valued as an exhilaration reward.

3. The European Union should lead and encourage Members States to effectively train fire-fighters in the anticipation or forecast of “fire environment escalates to extreme fire behaviour conditions”; there is no justified lack of recognition of this critical issue. And different, specific protocols and best management actions (human behaviour) should be developed to match (to address) extreme fire behaviour.

4. The European Union should lead and encourage Members States to completely investigate all fatalities and serious accidents and their links to fire behavior changes. Additionally, these reports should be available to end users in all details but those that could be label as confidential.

5. The European Union should lead and encourage Members States to understand that, to reduce the mean area burned per year, we have to address landscape fuel patterns with efficient fuel management and not by unsafe fire suppression actions.
Figure 15. Gran Canaria Forest Fire employees in full protection gear and with excellent training to mitigate job hazards (Canary Islands, Spain)
It is common to find that many forest fire managers do not have a specific training in this issue. They may have extensive training in forestry, general fire-fighting or else. However, it is true that sometimes we can see well-trained forest fire managers.

Within FIRE PARADOX Integrated Project (http://www.fireparadox.org) is currently seeking to build a comprehensive forest fire academic and training program.

The picture below is an example of this training and more can be seen at http://www.etsea2.udl.es/~UFF/6_photos_videos/pages/lleida_group.htm

In this regard, our recommendation is that the European Union should mention in its official documents that

1. Member States must encourage advance education and training of both their forest managers and workers to ensure a better protection against forest fires with lower job hazards.

Figure 16. The wildland fire in the graph was effectively controlled on the prescribed burned stands and therefore, it required less suppression money (Canary Islands, Spain).
9 ALLOCATION OF PUBLIC MONEY TO EASY CONSEQUENCES OF WILDLAND FIRES

Public expenditure has to be watchfully distributed in order to prevent for fraud and deliberately originated fires.

Thus, it seems preferable to execute restoration techniques than direct compensations to affected citizens.

The goal of public aid must be focused on promoting good practices, such as fuel management activities, building and maintenance of infrastructures, etc.

The support of these good practices could be also promoted even in absence of fire, via increased subsidies for forest management or forest restoration activities in regions that prove to be efficiently protected against fires.

Another key public budget dependent instrument in forest fire prevention is also a fast and efficient solution to land property conflicts: a forested land that is demanded by different owners is more probable to be burned when the conflict is prolonged.

In this regard, our recommendation is that

1. “Money” from the European Union (aimed to easy consequences of natural disasters) should be allocated to forest fire affected regions only after a detailed investigation which prove that in that region there have been substantial investments actions in fire management planning in the last five years.

2. European Union should mention prescribed burning as a useful tool to help removal of national legal restrictions or bans to these techniques

3. European Union should mention backfiring techniques (i.e., suppression fires) as a useful tool to help removal of legal restrictions or bans to these techniques in some countries.

Figure 17. Unmanaged forest stand. Therefore, we may say that it does not deserve regeneration funds if a wildland fire occurs. (Domingo MOLINA’s photo).

Figure 18. Managed forest stand. Therefore, we may say that it does deserve regeneration funds if a wildland fire occurs. (Domingo MOLINA’s photo).
10 REFERENCES


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