TOWARDS A NEW APPROACH TO FOREST FIRE

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ABSTRACT

Statistics show that in the past twenty years, there has been an evolution of the burnt surface of the wildland fires in the french mediterranean area. The number of small and medium-sized fires have decreased while the number of larger fires has increased. The larger fires are responsible for the major part of the burnt area today. They represent 60% of the burnt area compared to 33% twenty years ago. Prevention and firefighting means are efficient for smaller fires but are more limited in the fighting of larger fires.

This suggests a change or modification in both fire management and in risk studies. Basically, it seems important to study crown fires and conflagrations risk, in order to propose a new methodology which takes into account these changes, to improve the prevention and fighting of fires.

The goal of such methodology is to determine where fire managers can expect danger. The authors try to define these areas and in addition, such a methodology needs to take into consideration other area characteristics such as the environment, social and human characteristics (of an area involved with forest fires), or more precisely prevention measures and emergency priorities.

To reach these goals, researchers, territory managers and fire managers are working in partnership. This collaboration is necessary to propose quality models and to develop applied research.

INTRODUCTION

All regions all over the world with major forest fire problems have their own methods for dealing with this problem.
For example in the United States they have fought fires agressively for almost eighty years. For the last twenty years they have faced a changing ecosystem and an accumulation of fuel, because their system was adapted to fires.

To face this new problem they used prescribed fire and a "prescribed natural burn" policy in designate cases. After the well known Yellowstone fires, this approach has been almost abandonned.
As we can see, there have been a lot of changes in a relatively short period of time with continuing changes in the society.

In France we face an identical problem with accumulating fuels, but more importantly through social changes. Where the small farmers/herdsmen leave the mountains and their grazing fields turn slowly into highly flammable fuels, the city people leave their towns to live in the so called wildland urban interface. They do not introduce more fuel but a higher ignition risk for property and increase the priority for the resources needed in fighting the fire.

But all parties: foresters, home owners, fire fighters, politicians, ecologists, wildlife biologists... have their own different points of view and approach for this complex problem.

The goal of this paper is to emphasize some ideas for a better forest fire management. From statistics, we found out the new problems induced by forest fires and we

propose both a new methodology and a new decision support system.

This paper proposes to help researchers to improve the knowledge on risk and danger, to catch the real problem for firefighters and managers and to improve the effectiveness and safety of wildland fire management.

FROM WILDLAND FIRE TO CATASTROPHE

Some Figures And Ideas

The statistical analysis of the situation indicates that frequency and damage of wildland fire represent one of the most important disturbances for the mediterranean ecosystems.
The protection of this patrimony is an important preoccupation with 2,2 millions ha of forest in the french mediterranean area (4.2 millions ha wildland of which is 2 millions of landes, garrigues and so on).

Some observations can be established from wildland fire statistics. They show that in the past twenty years an average of 40000 ha has been destroyed by fires which correspond to 4000 starting points.
We notice both a small decrease in the number of starting points and a stability of the total burnt area, in spite of the urbanisation, the surrender of the agricultural area, and the growing area of forested land.
These positive results (compared to the other mediterranean countries) can be explained by the efficiency of the communication and firefighting.

However, we have noticed an evolution in the characteristics of fires. The number of small and medium size fires (1 to 500 ha) are decreasing. On the contrary, large fires (more than 500 ha) represent a growing part of the burnt area: 57 per cent today against 32 per cent ten years ago.

Another change also appeared in the time period in which the fires burned. Now, most of the burnt areas were concentrated in four or five days as opposed to fifteen days, fifteen years ago.

The analysis of these figures permits several observations:

- in the lower cases (small fires), we notice few evolutions, both in burnt area and number of starting points

- in the intermediate situations, the progress is significant and the average burnt area is divided by two

- the worst cases show an opposite situation and the average burnt area is multiplied by two

- most of the fires are controlled sooner, but the few fires which occur in the period of high meteorologic risk involve a larger surface

So prevention and fire fighting have a positive effect on the intermediate situations but are deficient in the worst cases, where we notice an increase of surface burnt.

Different explanations can be found:

- fire fighting is more difficult today because the forest is a growing area and the wildland urban interface complicates fire fighting

- the efficiency of fire fighting in normal cases contributes to increase danger in exceptional conditions where the fires involve a high quantity of fuel

A paradox appears: prevention and fighting actions contribute to preserve biomass and accumulation of fuel. At the same time, the danger of large fires is increasing in the coming years, with the increase of the fuel load.

The Paradox

The progress only represents a delayed effect. The reduction of the normal danger leads to an increase of the exceptional danger. The success obtained in recent years contributes to increase the fire danger and the probability of larger burnt areas.

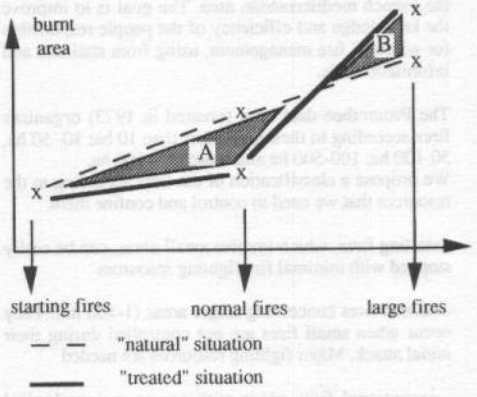

figure 1: Evolution of the different kinds of fires

To improve the fire prevention and fighting, It would be interesting to evaluate the values of A and B

If A situation, which represents a profit (compared to "natural" situation without intervention and preventive actions), is more important than B which is a deficit (opposite effect of the efficiency of the firefighting), it means an advancement and we have to go on fighting fires in the same way.
If A an B are more or less equal, we can wonder whether it is interesting to work towards this end.
If B is more important than A, it is necessary to change management. It means that we must try to live with fire and not require its elimination. Besides, the use of decision support system and danger analysis has to be considered.

Accordingly, we can consider fire as a natural event (as an element of the ecosystem), and we can choose not to fight the fire and let it go its natural way.
This does not seem logical with the close proximity of forest and urban areas. Moreover the limits of such policy are reached when the damage caused by the frequency and the intensity of the disaster is greater than the capacity for regrowth of the biomass and involves a change in vegetation.

This study indicates that one of the most important aspects of prevention and fighting of wildland fires is the size of the fires and our capacity to prevent and control them.

How To Classify Fires ?

A database, named Promethee, studies wildland fires in the French mediterranean area. The goal is to improve the knowledge and efficiency of the people responsible for wildland fire management, using from statistics and informatic tools.

The Promethee data base (created in 1973) organizes fires according to their areas: less than 10 ha; 10- 50 ha, 50-100 ha, 100-500 ha and more than 500 ha.
We propose a classification of the fires according to the resources that we need to control and confine them:

- starting fires, which involve small areas, can be easily stopped with minimal fire fighting resources

- normal fires concerning larger areas (1-100 ha). They occur when small fires are not controlled during their initial attack. Major fighting resources are needed

- exceptional fires occur with severe meteorological conditions, low fuel moisture content, low relative humidity, strong winds and high temperatures. In these cases, we can see an important number of ignition points in no time, both in wildland-urban interface and forested areas, which indicates an expansion a spreading of the firefighting resources because of the importance of protecting people and structures

It would be significantt to determine the areas where such a disaster may occur. The authors took into account the spatial variability of danger and also analysed the origin of the danger in order to find the relation between the prevention and the variables of the threat.

This analysis needs to be updated in accordance with the evolution of the "value" of the wildland areas, the use or social observances that people make in wildland areas.

THE FIRE DANGER

Fire danger is often defined as a general term expressing the result of both constant and variable factors which affect the chances of a fire starting, spreading, doing damage, and its difficulty to control.

The Danger Parameters

The identification of the danger parameters is a stage in the danger analysis and decision support. We can classify these parameters in two categories: human factors and environmental factors.

The human factors are linked with fire occurence

- land use (housing concentration and dispersion, road network)
- land managment
- activities (industry, tourism, rubbish dump)

In this case, the human factors are associated with the causes of fire and not as an effect of fire on man as we can see below.

The environmental factors, associated with spread of the fire, include three kinds of parameters which concern:

- fuel: nature, morphology, continuity, arrangement, flammability of vegetation

- weather: aspect, elevation, slope

- climatology: wind, precipitation, relative humidity, temperature

A Methodology For The Danger Analysis

A fire danger analysis requires taking into account the indicators of danger and the definition of the areas affected.

The Indicators

For a reliable analysis of a large fire, it is necessary to know the value of the parameters of danger and the relationship between them, in order to adapt the firefighting plans. The authors propose a particular methodology for this kind of disaster and to notice its indicators.

The number of severe fires is relatively independant of the number of days with a high danger. Only one day can produce significant result: severe meteorological risk is only one of the conditions in the occurence of a large fire.

This observation is important because large fire occurence depends on the land use, the fuel density and arrangement, the organization and the firefighting plans.

Many areas correspond to these situations, and we can try to identify them. We can establish a "potential" danger of fire in the frame of different risk parameters which could include:

- the location of an area in comparison with a forest clump. An area can be threatened, only threatened if ignition is in its territory, or in one or several bordering ones

- the accessibility of an area (in the sense of the intervention capacities) characterized by the topography, the location of the emergency centers, the road network density...govern the control of the phenomenon (knowing there is no danger when the burnt area at the moment of the intervention is less than 1 ha). A classification of these areas allows us to register the most dangerous conditions

- the high risk days when the meteorological conditions can provoke large fires in a particular area

- the pressure of ignitions (fire events, statistical history), which is an indicator of the part of human factors in the occurency of large fires

The Areas

We obtain for each area an indicator of having a large fire in relation to the history of this area (Promethee data base). We can constitute several kinds of threatened areas:

- the most sensitive and threatened forest belts. The danger of fires is at the top. The only thing we can do is to prepare to fight the fire

- the forest belts which are less sensitive but are threatened by large fires. The danger is significant and the prevention, the surveillance and a quick intervention can be important solutions

- the boundaries of the forest belts (which are very sensitive lands) with a high and constant pressure of starting points. Human life and structures are the most important focus of the rescuers. The danger is significant and the focus is to try to limit the effects of fires

- The urban areas where the danger is high because of demographic pressure. Here, prevention is the best solution

- the more dense areas, less sensitive. The danger is low

DISASTROUS FIRES AND CONFLAGRATIONS

There are two kinds of large fires according to social and scientific points of view.

According To The Impact On The Social Life

A fire which destroys agriculture crops, houses, natural lands, human life is a disaster by its consequencies on social and economic activities. Most of the time, these fires concern the wildland-urban interface.

This fire danger results from both demographic and technological factors and overlay natural lands and urban areas. The boundaries between them concentrate most of the starting points which can become a conflagration and/or a disaster.

The evaluation of the wealth, owned or shared by the different areas is another aspect of the wildland fire management. Figure 2 represents a synthesis of the components of the problem.

It would be interesting to associate the fires of the wildland-urban interface (also the threatened goods), which represent the highest ignition, with a large fire danger estimation. These two kinds of danger seem to be independant, but are acting on one other. This foreshadows what should be a decision support system integrating the different kinds of danger.

From A Scientific Point Of View

From a physic point of view, a conflagration is defined by the amount of released energy and spread. When crown fires become very large and intense and spread quickly, fire managers rename them conflagrations, which are large destructive fires with moving fronts and high rates of spread. Conflagrations often throw embers a long distance ahead of themselves. This phenomenon is called spotting.

Basically, we distinguish between large fire and conflagration. We can have only a large fire if the product energy*speed is not enough. On the contrary, there is the possibility that a conflagration occurs even if it is not a large fire in terms of the area burnt. A starting fire can quickly turn into a conflagration.

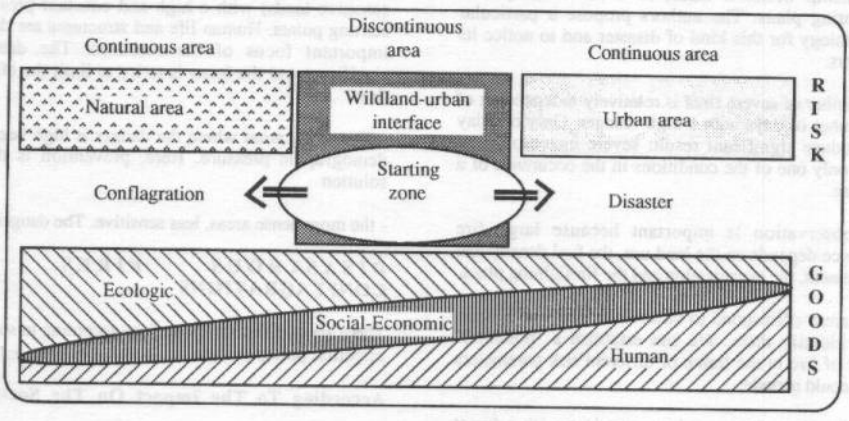

figure 2: Disaster and conflagration

We have two poins of view on the problem. One is considerating the operational aspect and the fire is defined by the area burned and the damage caused by the fires. The other approaches the fire by its energy aspect.

CONCLUSION

In the French mediterranean area, the characteristics of wildland fire require to have a revison of wildland fire management. Managers and firefighters, responsible for prevention and firefighting have to take into acount the changes which we have noticed above, i.e, both the decrease of small and medium size fires and the growth of the large fires.

In this paper, we indicate this evolution and show a new framework for evaluating a large fire, associating an other component: the fires of wildland-urban interface which represent most of the starting points and concentrate human life and structures. The integration of this framework within a large fire danger estimation, could be an interesting way for a better wildland fire management, both for managers and researchers, willing to approach the reality.

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