Protection of the Mediterranean forests against fire

Local adaptation of a Fire Risk Index to the Mediterranean context

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The risk of forest fires is a major feature of Mediterranean woodlands. In the Med project Protect, several partners have come together to adapt a daily Fire Risk Index to Mediterranean conditions. During the fire season, every day, fire managers must make decisions on how many resources they will need and where those resources should be positioned. By providing detailed indications for fire prevention and fight against fires, this index can provide useful assistance to fire managers.

Background

Forests are crucial for a balanced social and economic development of the European continent, as they do not provide only trees, but they allow the development of invaluable ecosystem by-products like: oxygen production, carbon storage, soil preservation, landscape protection, maintenance of soil fertility, purification of surface water, climate balance. Furthermore they represent a key factor in controlling the hydrological cycle, they are the "house of biodiversity", all essential elements in the quality of life of European citizens and the rest of the world.

In addition to playing a significant role in the social and economic development of rural areas, forests are crucial in supporting the survival of the species, they are the recipients of heritage and local knowledge, as well as a source of energy and a natural reserve for medicaments and food.

Wildfires represent a major danger for Mediterranean forests, influencing patterns of vegetation and fauna, forest management activities, resource values, property and, even, human life (Lavorel *et al.* 2007). Only in 2003, in Southern Europe an area of 740,000 hectares was burnt, and several millions of euros are spent every year on fire management activities (Pelizzari *et al.* 2008). During 2007, Greece experienced the warmest summer of its instrumental history and prolonged rainless condition, with very destructive fires (Founda & Giannakopoulos 2007). Furthermore Mediterranean Europe, has been identified as likely to suffer warmer, drier summers towards the end of the century (Sanchez *et al,* 2004), and hence potentially will suffer an increased forest fire risk (Pinol *et al*, 1998). This general scenario could be worse as consequence of global climate change. Considering also that fire managers are facing

increasing demand and diminishing budgets, consequently, the reliability of predictive models for forest fire hazard assessment is a topic of major importance in the Mediterranean area (BONAZOUNTAS *et al*, 2005).

General description of the project

The PROTECT project (www.protect-med.eu) finds its reason in the necessity of creating and sharing an integrated model for the prevention of forest fires, through a common approach at transnational level.

Within the Community policies of prevention and mitigation of occurring natural hazards, the objective of the project was to develop an integrated common model for forest fire prevention, and in particular:

– Develop shared methods and techniques to map, evaluate and monitor hazards,

– Develop an efficient and eco-compatible model for forest maintenance and valorization of the biomasses coming from such forests,

– Carry out training and communication activities in order to develop a responsible behavior of citizens and tourists in the areas under risk.

The activities were developped through two main phases. Starting from the analysis of the existing situation in partner's countries, and from the spotting of best practices, the experts involved in the partnership contributed, through training sessions, info-days and simulations, to achieve the following goals:

– Develop an integrated model for the prevention of forest fire, making use of the work of three transnational working groups,

– Apply the model to the involved territories through a concrete planning and the elaboration of "action plans",

– Experiment the model through the implementation of pilot projects and simulations on the spot.

The Province of Macerata (Italy) was the lead partner of the project which include 8 other partners: 5 territorial partners from Spain (Province of Malaga), Greece (Region of Peloponnese), Croatia (Region of Istria), Portugal (Natural Forest Authority), Cyprus (Department of forests) and 3 universities from Italy (University of Camerino), Portugal (University of Algarve) and France (Aix-Marseille University). The involvement of such authorities coming from different geographic areas, where forest fire is a common and frequent phenomenon, and concerned with diversified scientific fields, was due to the need of specific knowledge and expertise in fields related to the project PROTECT.

The partners worked according to three working packages (WP), consisting of three thematic areas under analysis, as follows:

– WP1: methods and techniques for mapping, evaluation and monitoring of risks;

– WP2: sustainable maintenance of forests valorising biomass for the production of renewable energy;

– WP3: information, training and awareness raising strategies for responsible environmental behavior in areas at risk and in risk situation.

A new tool for daily forest fire forecast: one of the most important result

One of the most important result of the PROTECT project, was the elaboration of a common model aimed to forecast daily forest fire hazard.

During the last decades, several indexes were realized all around the world in order to face with forest fires; those indexes can be used to identify periods most susceptible to the danger of forest fires and can be divided into three different categories:

– Indices of long term hazard or structural indices: are calculated on the basis of the characteristics of the area that do not vary rapidly, such as morphology, orientation (north, south...), type of vegetation; these indexes indicate the vulnerability of a given territory;

– Indices of short term hazard or dynamic indices: are calculated on the basis of the characteristics of the territory that may change very rapidly, such as relative humidity, temperature, wind speed, quality, distribution and status of fuel in the forest; these indices are generally valid daily and they try to assess the probability of a fire in a given territory;

– Hybrids indices of hazard or integrated indices: are a fusion of the previous two types, they try to jointly consider both the inherent vulnerability of a given territory and meteorological variables. The integrated approach is based on the assumption that the start and progression of a forest fire is affected by different factors, therefore requiring an integrated analysis.

During recent years many researches have published papers, both at national and European level, concerning the comparison between different methods to predict the hazard of forest fire.

The published available information have identified a dynamic index, the FWI (Fire Weather Index), also known as the Canadian method, as one of the more effective methods to predict the hazard of forest fire in an operational way.

The FWI System consists of a series of numerical sub-indexes that are relative indicators of potential fire behaviour in common boreal fuel types (STOCKS *et al.* 1989). VAN WAGNER (1987) describes extensively the structure of the FWI System and its components (see Fig. 1). This system accounts for the effects of fuel moisture on fire behaviour, but the FWI equations were processed and tested in Canadian boreal forests, which have different characteristics compared to Mediterranean vegetation as well as climate: in particular the Canadian FWI was designed to track moisture in a standard Pine forest of Jack Pine (*Pinus banksiana*) and Lodge Pole Pine (*Pinus contorta*).

It appears that the Canadian FWI are well suited to moist climates, in any case it has been demonstrated that the models has the potential for assessing fire danger also in Southern Europe but, at the same time, it was recommended to conduct further tests of the system in more dry Mediterranean environments (DIMITRAKOPOULOS *et al.* 2011). In addition to the different climatic conditions, the Canadian FWI models were developed from data beneath dense canopy forests, while the Mediterranean ones are often less dense, with fuels directly exposed to the sun. For these reason, a calibration of the model to take into account these differences is a key-factor to obtain an effective method to determine forest fire hazard in the Mediterranean landscape and climate.

During the PROTECT project, the University of Camerino and the Province of Macerata suggested to adapt the FWI to local conditions by measuring the forest fuel moisture content on the field.

A standard strict procedure was elaborated in order to collect the different types of forest fuel included in the FWI to evaluate the moisture during the main fire season. During the project, four partners did the field data collection: Province of Macerata, Region of Algarve, Province of Malaga and Region of Peloponnese.

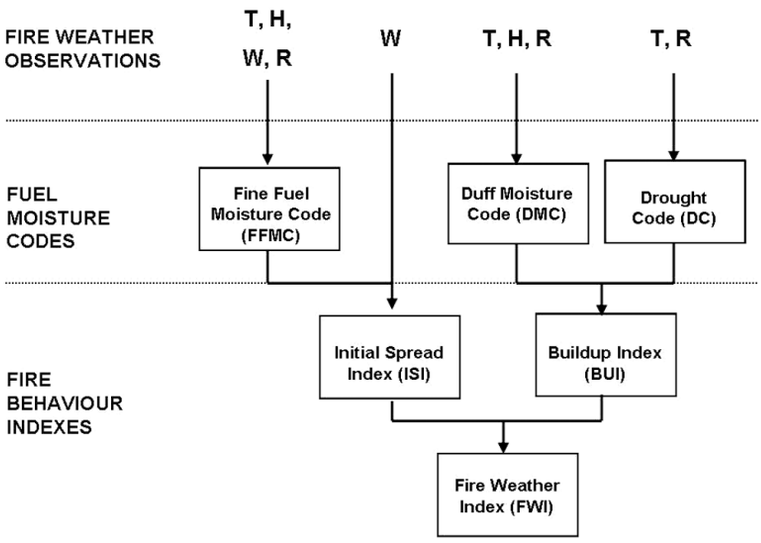

Figure 1:
Basic structure of the Canadian Forest Fire Weather Index (FWI) system (De Groot *et al*, 2007).
In the scheme,
T: air temperature;
H: air relative humidity;
W: wind speed;
R: precipitation

The data were useful to calibrate the FWI according to the different territories, through a specific mathematic procedure. These adaptations are one of the project outputs, but in order to increase the effectiveness and the utilization of the forecast, a dedicated software was realized.

The software

The prototype of a software is able to produce daily forest fire hazard forecasts using the adapted Fire Weather Index for each territory. The information, with a daily hazard map, can be sent automatically by e-mail to the local authority.

Every day, the software downloads meteorological forecasts from the GFS (Global Forecast System of the NOAA) for the 4 variables useful to elaborate the FWI (air humidity, air temperature at noun, cumulated daily precipitation, wind speed). Through these information and using the adapted FWI, the software produces daily maps, sending them to local persons in charge of fire risk monitoring.

The day after, in order to produce the next forecast, the software needs the real past measured data from local weather stations; these data are automatically taken from websites of local meteorological authorities. This last step is fundamental in order to do not accumulate error day by day and to be more precise. The density of meteorological stations in the territory, determines the spatial scale of the forecast. Here below there is a scheme of the software functioning (see fig. 2)

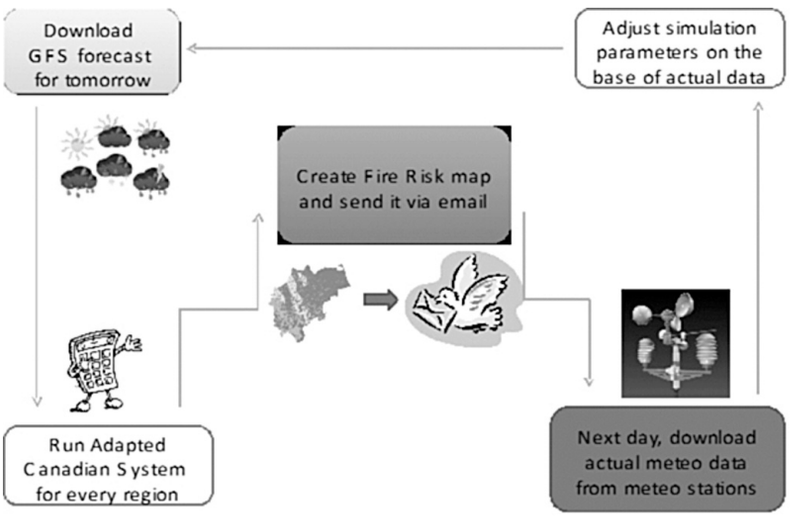

Figure 2:
Software functioning
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Conclusions and future perspectives

During the fire season fire managers must make decisions each day on how many resources they will need and where those resources should be positioned. The local adaptation of FWI can provide a useful tool with detailed indications for fire prevention and fight. Considering the heterogeneity of the Mediterranean vegetation, the FWI adaptation must take into account the different types of fuel.

The approach carried out during the PROTECT project demonstrates that the method applied produces effective and promising results, in different vegetations and meteorological conditions of the Mediterranean environment.

The European Commission, aware of the problem that forest fires pose on people and the environment, started towards the end of the '90 to develop methods and applications for supporting forest fire protection through coherent information at the European extent. As a result of this effort the Joint Research Center (JRC) set up the European Forest Fires Information System (EFFIS), which started operating in the year 2000 (CAMIA, 2011), using the standard Canadian FWI since 2007. EFFIS provides, among other services, daily large scale assessment and forecast of fire danger level in Europe.

A promising perspective could be the integration in the EFFIS system of the tools elaborated during the PROTECT project, in order to produce very detailed hazard maps with specific adaptation for each local climatic and environmental conditions.

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Summary

Wildfires represent a major danger in Mediterranean area, influencing patterns of vegetation and fauna, forest management activities, resource values, property and, even, human life. The PROTECT project, led by the Province of Macerata, had the aim of creating and sharing a common and integrated model for the prevention of forest fires in the Mediterranean. One of the most important project output was the realization of a software for the daily forecast of forest fire hazard, through a field and site-specific adaptation of the Canadian "Fire Weather Index" (FWI).
During the fire season fire managers must make decisions each day on how many resources they will need and where those resources should be positioned. The local adaptation of FWI can provide a useful tool with detailed indications for fire prevention and fight.

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