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Role of Internet in the decision-making sequence for wildland fire management in Europe: the E-FIS service

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ABSTRACT: Recently a noticeable increase of Internet-based services has been observed. A good number of Web-sites have been devoted to forest fires in a list of subjects such as forest fire global monitoring, danger indexes, wildland-urban interface, fighting and safety and forest fire research among others. A review of contents and functions of the mentioned sites is presented. The project E-FIS, a market feasibility study, has been developed under the auspices of Ten-Telecom Programme of the Information Society DG of the European Commission. Seven entities of five European countries have participated in the project, all affected severely by forest fires. Within the project a survey on the needs and Internet-based existing products and services has been completed, which main conclusions are also presented in this paper.

1 INTRODUCTION

In the last two years a noticeable increase of Internet-based services implemented at operational scale has been observed. A good number of Web-sites have been devoted to forest fires in a list of subjects such as forest fire global monitoring, danger indexes, wildland-urban interface, fire fighting and safety and fire research among others. This has been in part thanks to the appearance of dedicated development environments that allow the implementation of powerful functionalities without spending too much manpower in programming and publishing. In the other side, Internet connectivity has been improved largely, increasing information transfer bandwidth, developing new and faster communication devices and decreasing prices of ISP services. In this sense Internet has reached end-users all over the world, thus making any Web-based information or application instantly ubiquitous.

2 INTERNET SERVICES

In the forest fire services the information flow in the decision making process demands specific channels, availability and accuracy. Besides, and for large regions, it is required a hierarchical structure in the information chain in which local data is gathered and transferred to central servers from which it is distributed. Internet is offering the possibility of establishing an information distribution network just through a number of computers connected to the Net, incorporating data gathering, data processing or end users nodes. In this sense Internet-based information services give

two important characteristics to this scheme: a) they are ubiquitous, and b) they are cheap to implement and easy to use.

Although there exist a different scheme of forest fire management for every region, it is relatively easy to identify a set of common points. The scheme presented must be understood as a general one which could be assumed to be roughly the same for all fire services. It has been identified five different phases which embraces all possible situations in a typical sequence of the forest fire management chain, each one demanding a specific set of information:

1.- Preventive activities and training, long-term planning

- Works on forest fuel
- Works on forest fire defense infrastructure
- Citizen education and sensibilization
- Personnel training

2.- Previous to fire events, short term and daily planning

- Meteorological data capture, forecast and analysis of weather and wind
- Estimation of fuel moisture and ignition probability
- Identification of potential sources of fires
- Estimation of fire danger and fire risk
- Pre-alert deployment of fire forces according danger/risk level

3.- In case of fire event, initial attack

- Surveillance and detection
- Estimation of position of fire outbreaks and access routes
- Estimation of fire severity
- Analysis of immediate danger and values at risk
- Dispatching of fire fighting resources
- Transportation of forces
- Deployment of forces and initial attack
- Aerial support (water bombing and transportation)
- Mobilization and co-ordination of heavy machinery
- Tracking and management of fire fighting forces
- On-site assessment on fire attack

4.- In case of severe or/and large fires

- Planning of emergency, deployment of co-ordination points
- Continuous information service on evolution of meteorological conditions and fire
- Mobilization and organization of extended attack forces
- Mobilization of complementary forces
- Mobilization and co-ordination of Civil Protection forces
- Mass media communication service
- Logistics
- Health care and medical services

5.- After the fire

- Control of fire extinguished perimeter and mop-up
- Measurement of final perimeter area and shape
- Estimation of losses and costs
- Investigation of causes

Let us review some of the most visited and well-known Web-sites which provide valuable information to forest fire managers, citizens and planners in the presented decision making chain. They are classified attending to the subject treated and can be classified into two types: a) general services which are also of use for forest fire management b) specific, thematic services which provide particular information regarding aspects of forest fires.

2.1 *Weather*

Weather prediction and observation is one of the most demanded services in Internet as is part of a large number of human activities and natural phenomena. Visualization of air fronts and clouds movement, lightning strikes, precipitation, evolution of temperature and relative humidity and direction and intensity of winds are the main pieces of information used for the weekly and daily planning of forest fire defense. Prediction reports and models are also demanded for a minimum temporal horizon of three days up to seven days. Some of the most well-known sites, which include the mentioned services, are:

- AccuWeather (http://www.accuweather.com)
- European Centre for Medium-Range Weather Forecasts (http://www.ecmwf.int/)
- Fire Weather Education: Educational Aspects of Fire & Forest Meteorology (http://earthlab.meteor.wisc.edu/firewx/)
- National Meteorology Institute Spain (http://www.inm.es)
- NTUA Weather / Intellicast (http://www.ntua.gr/weather/)
- University of Athens. Atmospheric Modelling &Weather Forecasting Group (http://forecast.uoa.gr/)
- Weather Underground - weather observation around the world (http://english.wunderground.com/global/GR.html)
- Wetterzentrale (http://www.wetter-zentrale.de/)

It is a general trend to couple weather prediction and observation with the calculation of forest fire danger indexes within the same Web-site, which clearly simplifies consults and add consistency to the information.

2.2 *Fire indexes*

Among the most visited sites:

- Wildland Fire Assessment System (http://www.fs.fed.us/land/wfas/)
- The Fire-EMS Information Network (http://www.fire-ems.net/)

2.3 *Global, regional fire monitoring*

Giving information on the state of the situation in the world, focusing on specific regions in which forest fires are in development, or providing technology and methods aimed at local fire fronts, the following pages are of great use to monitor forest fires:

- Global forest watch (http://www.globalforestwatch.org/english/index.htm)
- NASA Earth Observatory (http://earthobservatory.nasa.gov/Library/GlobalFire/)
- NOAA fire monitoring (http://www.ngdc.noaa.gov/dmsp/fires/globalfires.html)
- FUEGO monitoring system (http://www.insa.es/fuego/homepage.htm)
- Fire Globe (http://www2.ruf.uni-freiburg.de/fireglobe/welcome.html)ç

2.4 *Fuel models and fire simulation*

- A Numerical Model of an Explosive Forest Fire (http://www.scd.ucar.edu/vets/vg/FIRE/ClarkFire.html)
- Applegate River Watershed Forest Fire Simulation (http://www.cof.orst.edu/research/safefor/)
- A Simulation of Forest Fire Propagation (http://www.npac.syr.edu/REU/reu94/mveach/burn.html)
- CSIRO (http://www.ffp.csiro.au/nfm/fbm/)
- CSIRO. Project VESTA (http://www.bbm.csiro.au/vesta/)
- Forest Fire Simulation. Washington University in St Louis (http://ascc.artsci.wustl.edu/~bblank/Assignment_2_Fall_1998.html)
- Fuel Models NE California (CDF) (http://frap.cdf.ca.gov/data/fire_data/fuels/fuelsfr.html)
- GEO-F/X. Forest Fire simulation (http://www.geofx.com/html/geo-f_x_master_border_forest_fire.html
- Movies of computational Mechanics Group and Mathematical Modelling of Engineering)
- Processes (http://www.gre.ac.uk/research/cms/fphy.html)
- Simulating Fire Patterns in Heterogeneous Landscapes. Ecological Model for Burning the Yellowstone Region (http://research.esd.ornl.gov/EMBYR/embyr.html)
- STORMS Fuel Models(http://storms.cnig.pt/fuelmodels.html)

2.5 *Smoke, health, effects*

- Fire-Related Trans-boundary Haze and Air Pollution in Southeast Asia (http://www.icsea.or.id/sea-span/SCIPOL2/STUDY423.htm)
- Fire Effects Information System (FEIS) (http://www.fs.fed.us/database/feis/)
- Forest Fires and Forests Health (NCSE) (http://cnie.org/NLE/CRSreports/Forests/for-5.cfm)
- PLUMP: A one-dimensional plume predictor (http://www.fs.fed.us/database/plump.htm)
- Prescribed Fire and Fire Ecology Research (USDA-FS/PSW-Riverside Fire Lab) (http://www.rfl.psw.fs.fed.us/prefire/index.html)
- Smoke Management (http://www.pfmt.org/standman/smokeman.htm)

2.6 *Wildland-Urban interface*

- FIREWISE (http://www.firewise.org/)
- FIRESTAR project
- ICFME Interface (NWT) (http://fire.feric.ca/36112001/36112001.asp)
- WARM project (http://www.euwarm.org)

2.7 *Research*

- CEIF Centre of Forest Fire Studies in Portugal (http://www.adai.pt/ceif/index.html)
- CEREN (http://www.ceren.org/)
- EFAISTOS (http://www.tno.nl/instit/fel/efaistos/eric-efa.htm)
- NRIFD. National Research Institute of Fire & Natural Disaster (http://www.fri.go.jp/indexe.html)

- Research and results in Europe. European Commission (http://europa.eu.int/comm/research/success/en/env/0272e.html)
- The National Research Institute of Fire and Natural Disaster (http://www.fri.go.jp/yorane/reduction.html)

2.8 *Other sites and applications*

- DELFI Knowledge base and vocabulary (http://www.cinar.gr/delfi/)
- ENVISYS (http://www.nr.no/envisys/emergency_management/forest_fires.htm)
- California Department of Forestry and Fire Protection (CDF) (http://www.fire.ca.gov/)
- Fire and Resource Assessment Program – CDF (http://frap.cdf.ca.gov/)
- National Fire Protection Association (NFPA) (http://www.nfpa.org/Home/index.asp)
- Wildland Fire-fighter magazine (http://www.wildlandfirefighter.com/)
- IAFSS. The International Association for Fire Safety Science (http://www.iafss.org/index.htm)
- GEOFOGO (http://geofogo.cnig.pt/soft_form.html)
- Media Port (http://www.mediaport.net/CyberScience/BDD/fich_034.en.html)
- Forest view cabins (http://www.cybermarker.com/forest/photos/firetower.htm)
- EUROSTAT (http://europa.eu.int/comm/eurostat/)
- NEDIES. Natural and Environmental Disaster Information Exchange System (http://nedies.jrc.it/)

3 THE E-FIS PROJECT

3.1 *Background*

Experience has shown that appropriate information flow is essential in the success of defense operations against Forest Fires (FF). But this information must be complete, thematically and geographically accurate, updated, easily and quickly accessible, comprehensive, portable and ubiquitous. These requirements make FF-dedicated information systems too expensive and too complex to be used effectively.

FOMFIS[1] is a set of integrated Geographical Information System (GIS) tools and models designed to help fire preventive planners of forest fire defense. It was developed under the 4th Framework Programme of R+TD of the European Commission (Caballero, 1998; Caballero et al. 1999). This system uses a set of validated and verified sophisticated models and technologies integrated in a GIS platform, providing powerful analysis tools for preventive planning. But on the other side, it requires expensive hardware and supporting software, such as database management systems holding a complex architecture which requires expert knowledge for maintenance and operation. These points made difficult the real implementation of FOMFIS system in current users' information system configurations for decision making, despite the fact that operational fire services showed noticeable interest about FOMFIS.

During the two years after the end of the FOMFIS project in 1998, a number of communication and information technologies have been consolidated in the marketplace such as Remote Sensing, remote data acquisition, Internet-based map servers, Global Positioning and navigation systems, networking technology, XML-based application development environments and GSM, GPRS and WAP mobile communication technology and protocols. This already available and accessible technological developments, together with the increasing interest of end-users of forest fire management in integrated information systems, impelled a new demand for the models developed under FOMFIS project.

[1] FOrest Fire Management and FIre Prevention System. ENV4-CT96-0335, Environment and Climate Programme, 4th Framework Programme of R+TD, EC, Area 2.3 Topic 4, Forest Fires

3.2 *The project*

The response to this demand has been consolidated in the E-FIS[2] project (contract C26789), which is currently developed under the Ten-Telecom Programme[3] from January 2001 to June 2002. Five countries, namely Portugal, Spain, France, Italy and Greece, which are the ones in Europe most affected by forest fires in the last decades, participate in this project.

According to the philosophy and goals of the Ten-Telecom Programme, the main objective of E-FIS project is to study the market feasibility for the implementation of a simplified (compared to FOMFIS) Web-based assessment service for FF management. Besides, E-FIS contributes to the concept of European-wide based management of FF.

On the other side, the main objectives at operational scale are to centralize data hosting and maintenance, information processing power and human specialists assessment and provide information through an easy-to-use, cheap, ubiquitous service. In this way, the users are freed from concerns about the system maintenance and can concentrate on the decision making process. In this sense, part of the effort scheduled in the E-FIS project workplan is to adapt some of the modules and achievements in the FOMFIS system into a simple, integrated Web-based platform to provide FF assessment services and tools.

Several algorithms and methods have been extracted from the FOMFIS system, namely risk map calculation, resources planning and fighting efficiency calculation, fire dimension and dispatching, fire spread simulation and costs and loses calculation. Furthermore, a number of complementary modules have been adapted to complete the basic set of assessment services such as meteorological prediction and observation, potential risks management and historical data storage.

E-FIS system provides a definite number of information services which match the generalized chain of decision making process in forest fire management found in many FF defense bodies in Europe. These are:

- Access to General Map sets
- Short-term planning (weekly)
- Daily situation and planning
- On-Event assessment
- Access to and maintenance of Historical Databases
- Training
- Side Services (map set generation, experts etc.)
- Links to other external services

According to this structure of services a Web page has been developed which holds basic information of the project, some useful information about FF management, access to a restricted area for E-FIS project management and, finally, the E-FIS application.

3.3 *Structure of the E-FIS web-page*

In the operational plane, E-FIS can be understood as an Internet-based platform for FF management assessment in the form of a Web-page. In this sense E-FIS can potentially hold many other third-party services, such as processed information, simulation models, meteorology prediction or ground and aerial forces tracking by GPS. Besides, the E-FIS Web-page has been set-up with the idea of having a focal point from which the required information for FF management in a region can be obtained. This particularity helps managers to avoid spending much time searching important information pieces on the Net by providing links to other well-known and generally used websites and holding a number of third-party services as explained above.

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[2] Although E-FIS stands for "Electronic Fire Information System", the complete project title is "Electronic On-line Decision Support System for Forest Fires"

[3] Trans-European Telecommunications Networks, Directorate General of Information Society, Commission for the European Communities

Following this philosophy, the E-FIS web-page is divided into the following parts:

- Public section, including general information about the project, public reports and other documents and links to other related Web-sites
- Restricted area used by the E-FIS consortium for project management and information purposes
- Side-services and links to third-party services
- The E-FIS application, which includes the basic information services as explained below

3.4 *E-FIS: the application*

To demonstrate the usability and practicality of E-FIS platform, a FF management application has been adapted and implemented in the Web-page with a number of basic services which have been judged as fundamental in the day-to-day operation of FF defense bodies in Europe.

The E-FIS application has been designed to operate in the same way as a stand-alone program with a high degree of usability. In order to achieve this, noticeable effort has been devoted in designing and developing an easy-to-use, friendly and highly interactive Graphical User Interface (GUI) for the application. As interactivity and information flow has to be agile, specific programming strategies have been applied, such as the use of a proprietary Web-based map server which converts graphical data into JPEG images instead of digital maps themselves. These compressed files travel very quickly through the Net and hold all the graphical information required from the maps.

The E-FIS application makes use of basic digital maps which are held in the central server for each of the regions participating in the E-FIS network. A previous set-up process is required before full operation of the system, and this entails the elaboration of a digital terrain model, a forest fuel map and a road network map among other basic maps. All the supporting software, such as the digital map server, the database management system and all the algorithms and models are hosted in the central server. The server is a high-availability, high-performance one as a pre-requisite for any emergency information system, and has reserved data storage and processing capacity for each region subscribed.

The E-FIS application is accessed through the Internet URL address:

http://www.rtd.softwareag.es/efis/as

in which an access-control dialog is presented. Control of the logged users and security is continuously applied and ensured due to the sensitive nature of the information being generated and transferred through the system operation.

The application window is divided into two main areas, the right one which belongs to the graphical presentation of the map server (graphical area) and in which geographical navigation and map generation takes place. In the left side a menu and a number of dialog screens are presented to allow user-system interaction (working area) and which is managed by a number of menu options in the upper part of the screen (menu bar area).

Geographical navigation in the E-FIS application has basic tools such as area selection, map selection, panning, zooming and point information retrieval as found in many of the well-known GIS platforms in the market. To allow this high-degree of interactivity, E-FIS is working with blocks of 20x20 km geographical areas each time which information is loaded into the client once after selection the area of interest.

Users can handle a number of maps which are representative of the selected region and which are useful in the decision making process of FF management. The maps directory is arranged into four sections:

1. Thematic raster maps, which include surface fuel maps, topography, slope and aspect, vegetation coverage and any other basic raster map used in the system. The system uses one of these maps as background in the graphical area.
2. Thematic vector maps, such as roads, railroads, urban areas, reservoirs, water points, lookout towers, meteo stations etc. The system allows the use of many of them simultaneously in the foreground of the graphical area
3. Meteorological observations and derived maps. They are the result of interpolation calculations of the meteorological data and of the calculations of indexes of fire risk for the observed data
4. Meteorology prediction and derived maps, which are result of the calculations of interpolation and indexes of fire risk for the predicted data

The number and type of maps available depends on the number and type of maps which the users want to be included. This is extensible to customized fire danger and risk indexes (other that those currently available in E-FIS) for a region which could be of current use at local scale.

E-FIS divides the application menu into two sections. On one side the “Administration” section deals with the required data which is handled by the system and that has to be updated weekly and daily. This menu section is managed by the central services of a region but is available to all territorial centers. On the other hand the “Services” section has options for each of the temporal scales of FF management, namely weekly planning, daily planning, on-line fire event management and access to historical data. This section will be used by central and territorial services of a region and many cases by technical staff of mobile information centers displaced to the fire and connected through GPRS to the Net.

In the Administration section users manage data and generate information of four general databases, which are handled in less often used menu entries:

Prediction data management

Prediction of meteorological data, such as air temperature, air relative humidity, precipitation, average wind direction and average wind speed are specified for every meteorological station in the region for a temporal horizon of up to seven days. At press time E-FIS allows manual entry of these data but application design is adapted to automatically read and insert data coming from prediction services. This data is updated according the frequency of predictions, but daily updating is recommended.

Once the data is entered for all the stations, the application launches a chain of calculations which produce a number of maps for every one of the seven days ahead. These include spatial interpolations for every meteorological variable (applying separate algorithms for each case), dead fine fuel moisture content, ignition probability, potential linear intensity, potential rate of spread in the fire front, flame length and probability of crowning. From these, a number of indexes are calculated, following FOMFIS algorithms, namely destruction rate, potential damage risk and integral risk which model the aggressivity of fire and consequences in terms of monetary losses.

Observation data management
E-FIS holds a real-observation database for meteorological data, following much of the philosophy presented in the previous point. Actual readings of the existing meteorological stations are entered anytime in the day or even updating is performed several times during a real fire. After data entry the same type of maps are generated as for the predictions and are made available in the map selection area. Date and time of generation is recorded so users in the network know to which time the update belongs.

Potential risks data management
Another useful database managed in the E-FIS application, is that of the known potential causes of fire in a region. In this case the position, type and municipality in which a potential source of fire risk is recorded together with the temporal range in which this risk is expected to be active. Types are pre-defined and include, among others, waste disposal sites, recreational areas, vicinity of urban areas, side of roads and railroads, celebrations with fireworks, agricultural and other burnings, area of high probability of lighting strikes etc.

The idea of this service is to incorporate the information at local scale from territorial services and compile it in the central service. By crossing such points of predicted risk with the generated maps of fire potential, managers are helped to decide where and when fire-fighting forces should be pre-positioned weekly and daily. In some regions of Europe, such as Galicia (Spain), the number of known sources of fire risk can be counted by hundreds daily (i.e. permissions for agriculture and forestry burnings). Their management is hard without the help of a tool like the one presented in E-FIS.

Resources data management
For the region being managed, this menu entry allows managers to introduce data for every fire fighting unit available for the fire campaign, including ground forces such as fire trucks, crews, tankers and bulldozers, and aerial means such as helicopters air tankers and scoopers. The rest of the infrastructure, such as bases of forces, helispots, water points, airports, lookout towers are entered in the region set-up process as basic maps.

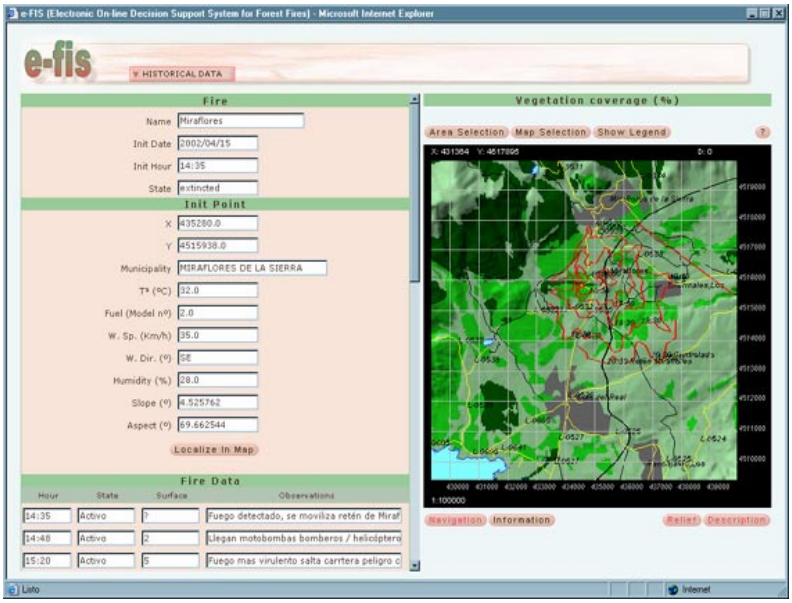
The resources have pre-defined fields of information, such as name, code, position, administrative dependence (municipality) type, state and assigned fire in case the fighting unit is currently working on an emergency. All this data can be modified according to the real situation and the fires in progress, and it is shared by all territorial centers in the region. Although position and state of fighting units is entered manually, the E-FIS application is prepare to receive automatically GPS readings and update the database on-line.

In the Services section a number of menu entries are found which are aimed to actually use E-FIS application at operational scales. These services are aimed at territorial centers mainly which make use of the available information for the immediate decision making process; nevertheless the central services compile all the generated information during real fires and take decisions at regional scale, for example when it is required to combine fighting forces from several territorial centers or even from outside the region or at national scale. These services are:

Weekly planning
Users access the maps which are generated based on the meteorological predictions as explained before. Besides they have access to the expected risks database in the time range corresponding to the week ahead. The purpose is to identify the general situation in terms of fire danger and expected risks and set-up a pre-alert, pre-suppression deployment of forces accordingly in the region and territorial units.

Daily planning
In daily planning users gain access to the generated risk and danger maps according to meteorological readings for the day, together to the list of expected potential causes of fire risks in the region and locally in every territorial unit. Besides users have access to the number, type, position and state of all fighting units deployed in the territory and, finally, have information about the active fires inherited from the day before.

The idea of this module is to give a briefing platform for managers entering the service each day and have a quick, accurate idea of what is in the fire scenario for today, so specific decisions on what, when, how and where to move resources can be taken easier.



On-line fire emergency management

E-FIS is holding a dossier for each new fire which is started and registered in the system. This module has a number of on-line tools to help managers to handle particular fires at territorial scale and also to deal with a number of simultaneously running fires for a region. In this module the fires and the driving factors, the fighting units and the expected risks are handled at a time.

E-FIS provides a platform for communication among the actors deployed in case of a fire. In fact this communication is two-way but the information generated is recorded and made available for anyone entering the system. In one side E-FIS provides an immediate tool for detection, identification and location of new fires. After that E-FIS launches and generates a first simulation of fire propagation, giving an idea of what is expected to happen in the few hours ahead according to the conditions existing at the fire location. All this information is typically generated in the central operational center of the region and is put in the system so territorial managers access an initial, valuable information to evaluate the situation and proceed to the dispatching of resources.

Once the initial fire fighting forces and fire managers reach the fire they gain much accurate an real information about the type of fire, the meteorological conditions and the availability of nearby resources such as water points. All this information can be recorded on-line in the E-FIS fire dossier and can be made available to any other involved actor in the region, including other territorial centers and the central coordination center of the region. The two-way information system is, on one side, gathering real information from the very fire location and, on the other side, providing decision support information at regional scale. In this sense, mobility of the E-FIS system is the strongest point.

On-line service allows first to set-up a new fire for which a number of basic data is entered, such as name, code, location and local conditions of meteorology and wind. Location can be entered directly by writing co-ordinates, by digitizing in the map presented or by calculating position according to the observation angles under which the fire is seen from three nearby lookout towers.

The system runs a simulation of six hours of surface fire and presents results both in numerical and graphical form. A table is presented of the predicted evolution of the fire front separating four intensity classes and the meters of fire perimeter expected for each class. Class one represents small flame lengths (up to 1.5 m) which can be attacked directly with hand-tools; class two with average flame lengths (up to 2.4 m) belong to fire fronts in which mechanized tools, fire trucks and perhaps aerial coverage is needed; class three with high flame lengths (up to 3.2 m) belongs to fire fronts in which direct attack is likely to be useless and dangerous and indirect attack and counterfires are suggested; for class four, with extreme flame lengths (more than 3.5 m) no effective attack is likely to stop the fire. By looking at this table managers can interpret the evolution of the fire hour by hour.

Additionally, E-FIS presents the fire evolution in the form of maps, namely the access time of fire to each point (the fire spread progression), flame length and fire linear intensity among others.

Other simulations can be done easily anytime, to predict short projections of current fire fronts according to the real data observed in the fire.

One of the most useful characteristics of the “on-line” module of E-FIS is that it allows the recording of annotations on fire progression, fire extinction operations and position of real fire fronts. All this real data is grabbed on the spot and gives managers real border conditions for further simulations and actual information for new decisions about fire forces deployment and operations. Particular attention has been paid to allow users to know the position and status of fighting forces in each fire in a region, thus facilitating effective and safe management of resources.

In the pre-operational validation activities in the test areas of the E-FIS project, it has been observed that simulations done with initial fire conditions for long projection time periods (i.e. 6 hours) do not match closely the actual fire front progression, giving instead an approximation of what can be the direction and speed of fire propagation. After entering real fire fronts and projecting them again with the new conditions, fire progression is more likely to match reality for the next two or three hours.

Management of resources deployed and assigned to the fire is done by controlling operations and registering them in the fire dossier, moving and tracking resources and controlling working shifts and status.

The E-FIS system allows to attach any type of file to a fire dossier, being particularly useful when digital images from the fire area are available. These files are uploaded into the server and thus become available to any actor connected to the system, including the central operational center, which can gain valuable information about the actual progression of every fire.

Access to historical data

Once a fire is declared extinguished all the recorded information is stored in a historical database which can be retrieved anytime. This is particularly useful when recurrent fires happen to be in a certain area in a short period of time as information registered about fire evolution, fighting operations and governing conditions that took place is quickly available.

E-FIS counts with a powerful database search and query tool which allows users to retrieve any piece of information incorporated to the system, whether it is simulated, real or historical, and generate reports with them. This query tool is applied to predictions of meteorology, real observations of meteorology, expected sources of risks, fire fighting resources and fires. It is connected to a geographical locator which looks for the position and centers it in the map screen displaying the existing information attached.

3.5 *Case studies*

E-FIS system is currently being tested in five areas in Europe which are prone to forest fires and hence have a real need for such an information system. These are:

1. Coimbra, in central Portugal, in which a dense forested area is often disturbed by large and dangerous fires in stands of pines and eucalyptus mainly.
2. Madrid, in central Spain, a province dominated by a large metropolitan area having a forested mountainous range close by. The latter receives a high pressure of citizens visiting the area and also includes a dense wildland-urban interface.
3. Torino province, at the bottom of the Alps suffering of a dry winter due to Fohen effect; it is also dominated by a nearby metropolitan area and a dense wildland-urban interface, and has many forest fire episodes due to agricultural burnings.
4. Aquitaine in France, is a large private exploitation pine stand with an understory of highly flammable grass and slash, is a good case in which local factors, such as water in the soil, directly affect the operations of fire fighting resources.
5. Pyrgos-Olympia area in Greece, a good example of intermix of forest and agricultural mosaic with a high value as an archaeological landscape and as a tourism attraction pole, is of great interest for the management of forest fire risks under severe meteorological and wind conditions.

As E-FIS is a European network, more users are joining this initiative at validation and demonstration phase, particularly those for which FF information systems are not fully operational or which always thought that the implementation is too expensive.

3.6 *Needs for E-FIS implementation and operation*

E-FIS has been designed under the premises of requesting very little from the side of the users. Thus, operation of E-FIS system demands a minimum in terms of hardware and software, namely:

- Internet Explorer 5.5 or higher
- Virtual Java Machine
- A screen horizontal resolution of 1024 pixels
- A fairly good Internet connection
- A personal computer, not necessarily powerful

Most of current systems offer these requirements by default so it is possible to set-up a complete fire assessment center by connecting some computers to Internet by a minimum amount of money.

Nevertheless, in case a region is interested in participating in this network, it is required to set-up the basic information in the E-FIS server, and this includes the following information.

Maps

- Digital terrain model
- Surface forest fuels
- Road network
- Historical FF pressure (nº of fires per 100 sq km per municipality)

Any other map that is useful for the manager as information source can be implemented, but the maps listed above are the minimum prerequisite to run the algorithms of the system. These maps should be given in raster format of 50 meters of resolution.

Databases

- Ground forces bases
- Aerial means bases
- Helicopters
- Airplanes (tankers, scoopers)
- Water points
- Lookout towers
- Meteo stations

The databases must include the position in the co-ordinate system used in the region, given that they are expressed in meters to allow calculation of distances in a consistent way.

3.7 *Conclusions*

At press time, the E-FIS project is in the validation and demonstration phase. During the activities carried out in this phase some observations and conclusions can be drawn:

E-FIS represents a step forward in the implementation of information services through Internet. Initially presented as an application containing basic services, E-FIS is an Internet-based platform, which can hold many other third-party services, including the results of other research projects.

E-FIS is assuming a hierarchical territorial organization in which a central station is collimating information from local stations, processing it, and providing back new synthesized information for regional management of forest fires. In this sense, E-FIS acts as a two-way intranet of FF information system.

E-FIS is an example that a pre-competitive prototype of a certain complexity can be transferred as a commercial service by an adaptation to user reality

Given that it is presented as a global network, E-FIS contributes to the consolidation of the idea of having a common platform for FF management in Europe

Although initially designed to provide assessment at the operational scale, E-FIS could be used for training and academic purposes as well, with a minimum number of requirements and investment.

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