An information system for the management of forest fires

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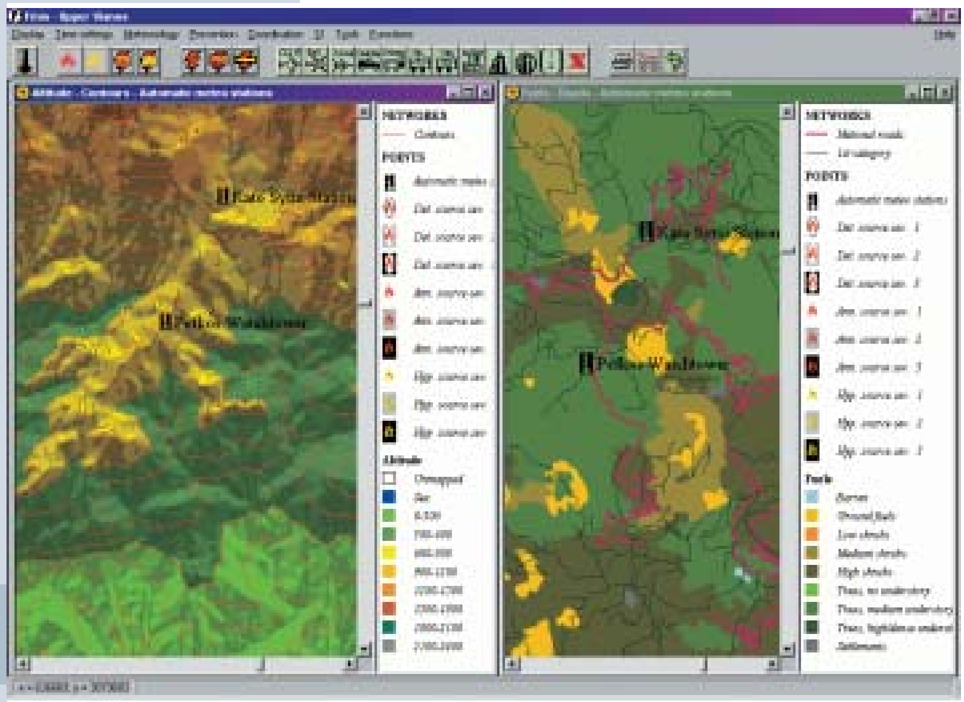

Figure 1. Various combinations of maps.

A short tour of FMIS (Fire Management Information System) is presented. Its prime functions, relating to fire prevention, behavior estimation and suppression coordination are described and screenshots of various stages in the use of the system accompany the text to aid understanding.

During the past 10 years, the Environmental Management Division of Algosystems SA, an information technology company based in Athens, Greece, has invested a considerable amount of time and effort in the production of an integrated decision support system for the management of forest fires. This system is called FMIS and its realization has been necessitated by the fact that forest fires are a prime environmental hazard in Greece. This article describes the fundamental operational structure of the system, as an aid to prevention and suppression of forest fires and aims to give an overview of its various functions.

The Fire Management Information System (FMIS) is an integrated software system that runs under Windows 98 or Windows NT. Its functions may be divided into three main groups, each one related to:

- the organization of fire prevention;
- the estimation of the behavior and the simulation of the propagation of one or more fires;
- the coordination of their suppression.

FMIS operates for a number of target geographical areas that the user wishes to protect. For each area, FMIS maintains a family of raster, vector and point maps. Various combinations of these maps may be displayed in distinct windows within the main frame of the application. Each of these windows is equipped with a legend (figure 1).

The user may zoom in to any particular sub-region of a map and zoom out to view larger portions.

Organization of fire prevention

FMIS may be connected, through a conventional or GSM telecommunications network, to a number of automatic meteorological stations that have been installed at points throughout the target area which represent microclimatic zones; for example, the area in figure 1 has two such stations indicated by a small thermometer icon. The user may download data for temperature, relative humidity, wind direction and wind speed from each of these stations and store them in a database.

Production of climatic maps

The data collected over a number of days preceding the current day may be fed into an interpolation procedure to produce an estimate of how each of the above weather parameters will behave at each station and throughout a predetermined period of the current day (Cartalis *et al.*, 1994). This period is defined as the prediction period.

An example of the estimated curves for a particular station is shown in figure 2. The user is at liberty to change the estimated values.

Having done this for each of the stations, it is possible to invoke a spatial interpolation procedure to produce temperature and relative humidity maps as well as the wind field for the whole area and for any hour within the prediction period. This particular hour is defined as the operational time. Both the prediction period and the operational time are determined by the user.

An example of a computed temperature map together with a superimposed wind field is shown in figure 3.

Another meteorological quantity that plays a part in the computations of FMIS is the rainfall. This is dealt with on a 24 hour basis. The rainfall of the last 24 hours may be fed in manually using a grid of 2 x 2km cells (figure 4). Rainfall input influences fire danger calculations (see below) as well as the determination of fine forest fuel moisture content, the latter being used in calculating the rate of spread of a fire front (see below).

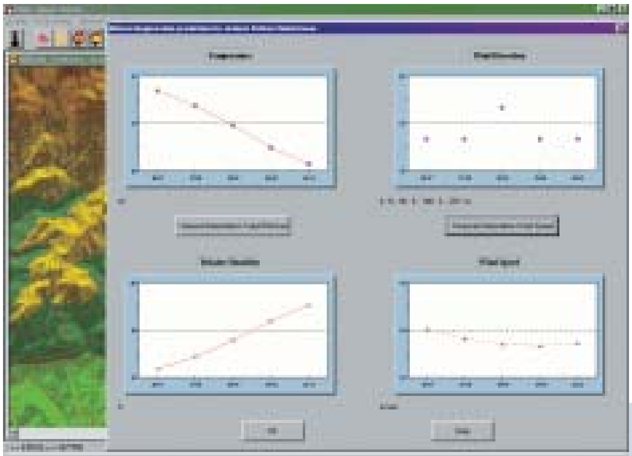

Figure 2. Estimation of the evolution of the four meteorological quantities at a station throughout the prediction period.

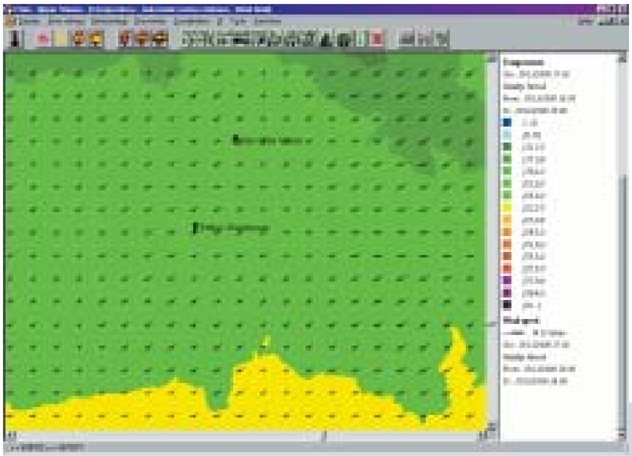

Figure 3. Temperature and wind map.

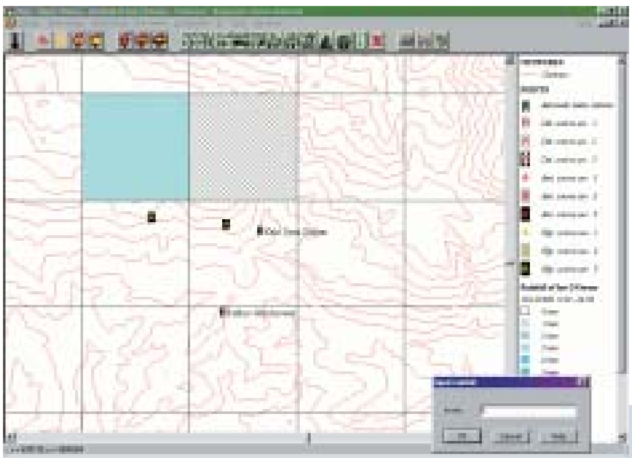

Figure 4. Rain input.

Maps depicting fire danger indices

Having produced maps for temperature, humidity, wind and rain, the user may go on to produce a pair of maps that depict two fire danger indices, known as the Portuguese and the Canadian index (Van Wagner, 1987; Van Wagner *et al.*, 1992). These maps enable the user to determine those regions of the target area that are most at risk of catching fire (by natural means). The user may then plan an appropriate prevention policy (recall the first group of functions cited earlier on).

An example of a map showing the Portuguese danger index together with the wind field is shown in figure 5.

Estimation of fire behavior

Concerning the second group of functions relating to the estimation of fire behavior and propagation simulation, the user may enter a variety of sources of fire: point sources that are announced, hypothetical point sources as well as fire lines and combinations of points and lines. It is also possible to connect the system to an infrared detection system, from which it may obtain the coordinates of a detected fire.

Given a set of fire sources, the user may choose the interval of time within which the simulation will take place. The system depicts the estimated spread of the fire as a family of contours (fire fronts), each of which corresponds to the progress of the fire at a particular instant in the interval of simulation. There is also the option of having the system calculate the area burned by each front as well as its perimeter. The results are displayed in a small dialogue box (figure 6). FMIS uses the BEHAVE system (Rothermel, 1983; Andrews, 1986) for the assessment of fire behavior, suitably adapted to Mediterranean forest fuel types.

Actual (as opposed to hypothetical) fire sources are stored in a database and may be retrieved later on.

Fire suppression coordination

Concerning the third group of functions relating to fire suppression coordination, the user may monitor a number of fire suppression units (vehicles or personnel detachments) that are distributed throughout the target area (figure 7). Any such unit may be equipped with a mobile version of FMIS, a GPS and a GSM mobile phone. In this way, it is possible for the unit to track and send its position and other data back to the FMIS system that is operating at the fire management coordination centre. The activities of the various units as well as other data coming from them are stored in databases.

The FMIS system provides a user-friendly environment in which to conduct the various tasks that relate to forest fire management. The system is under continual enhancement so as to comply with the needs of those concerned with this sensitive matter.

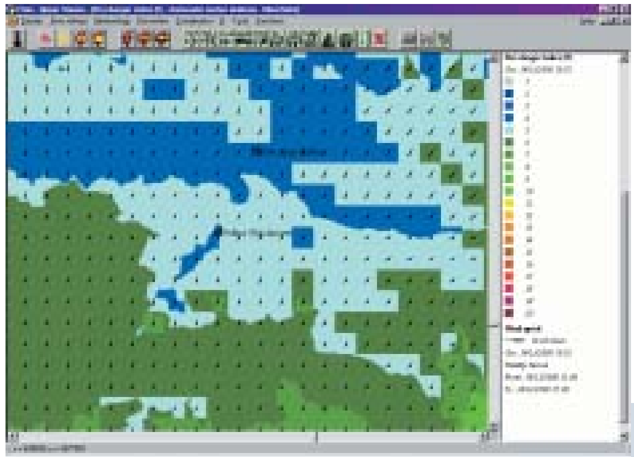

Figure 5. A map showing the Portuguese fire danger index and the wind field.

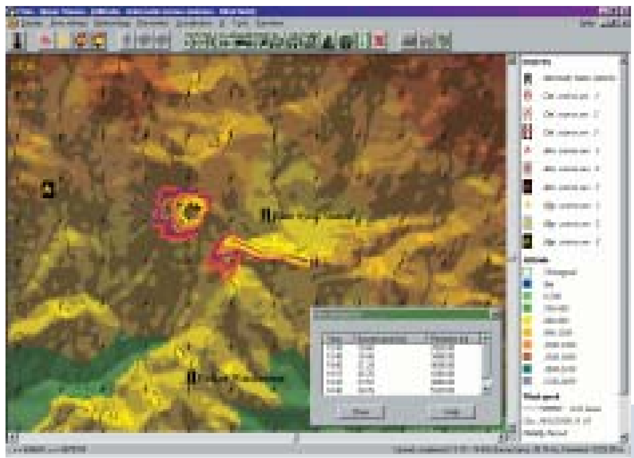

Figure 6. The simulation of the propagation of a fire.

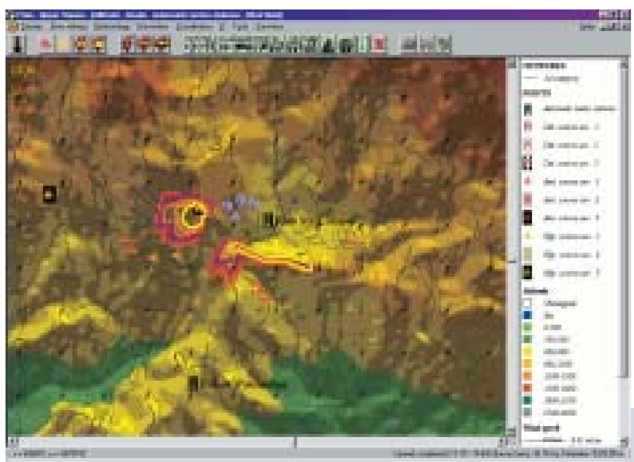

Figure 7. A distribution of fire suppression units in the target area.

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