FOMFIS: A COMPUTER BASED SYSTEM FOR FOREST FIRE PREVENTION PLANNING

David Caballero

INTRODUCTION

Computer based tools entail a breakthrough advance in the forest fire services planning and management operations. Since the incipient attempts to calculate the risk of fire ignition and estimate the fire behaviour over complex terrain and non-homogeneous forest fuel patterns, the computer applications have served well to forest fire defence services planners and managers in the decision making process about what, where, when and why to use fire prevention resources and fire fighting forces.

Efficient relational databases are linked to the digital expression of the geographical elements that are stored in thematic maps. Such information systems are coupled with specialised pieces of software that forecast the meteorological and wind conditions, map the forest fuel distribution, estimate the fire ignition probabilities, and calculate the fire behaviour, for example. Other applications make use of the geographical information to help planners to distribute the resources and infrastructures over a forest fire defence domain area according the predicted fire theatre and available budget. Besides, Remote Sensing (RS) devices and techniques have been widely used to identify and quantify the changes on the vegetation patches and their spatial distribution, thus giving a reasonable estimation about the load and the conditions of the forest burnable matter (forest fuel). Finally, statistical packages and probabilistic analysis applications are used to determine the risk of ignition and fire appearance through the study of wildfire causality and its relationship with natural and socio-economic factors.

Nevertheless all these useful and powerful applications rarely belongs to the same working platform, and the efficient usage of every tool mentioned above frequently forces to count on skilful specialised personnel doing the work that, in most cases, demands just a fraction of the total system performance. These two aspects discourage forest fire defence planners to take full advantage of the existing technological solutions.

FOMFIS SYSTEM OVERVIEW

The FOMFIS project (**FO**rest fire **M**anagement and **FI**re prevention **S**ystem) is an international research initiative embracing several private and public entities from Spain, Greece, France and Italy. It is partially funded by the European Commission DG XII, within the IV R+TD Framework Programme (Environment and Climate) in the area of Natural Hazards. This project is aimed at the definition, design and implementation of a computer based system giving support to the planning process of the activities and resources distribution for the preventive operations belonging to the forest fire defence services.

The main goal of the FOMFIS project is to integrate, within the frame of a single computer application, a set of technological solutions using the same information system platform, thus allowing forest fire service personnel to accomplish accurately, timely and cost effectively their off-line planning duties.

The system operation is strongly based on the commercially available geographical information and visualisation system Arc/View 3.0, and allows to perform several inter-related but operationally

independent procedures, namely: semi-automated forest fuel mapping, socio-economic status characterisation, integral risk analysis, fire behaviour simulation, knowledge based efficiency-driven planning and valuation and reports generation. Besides, the core-system comprises several modules that have been assembled to analyse the efficiency and cost effectiveness of preventive planning proposals in terms of forest fire defence budget, resources and infrastructures allocation.

PROJECT GEOGRAPHICAL SCOPE

FOMFIS application is designed to solve forest fire planning challenges at regional (1:200,000) and local (1:25,000) scales, making use of a hierarchical architecture design, but it is the intermediate province level (1:50,000) which is giving the best operational performance in terms of accuracy vs. data requirements.

It has been established two FOMFIS test regions, hence two fire services are acting as system end-users, that should cover most of the forest fire theatre spectrum within the Mediterranean basin. Firstly Galicia region, that is located at the north-west part of Spain, is historically suffering one of the most challenging fire defence problems due to its huge fire loads (up to 10,000 fire outbreaks per year). Secondly, the North part of Evia Island (Limni Dasarheio area), at Greece, holding a large forested area that is representative of the typical Mediterranean scenario in terms of climatology, vegetation coverage and main land uses. It is periodically threatened by medium to large intense forest fires that frequently evolve over complex terrain. Besides, a third region the Landes of Aquitaine is giving support in terms of forest fire management and, eventually, it will be also included as test area.

SYSTEM OPERATION

The system has been designed as a set of closely inter-related modules acting as sub-systems that are in charge of particular tasks (Fig. 1.). A Data Acquisition System (DAS) allows data transfer from other systems and external data sources into the FOMFIS environment. Remotely sensed data is used to obtain a up-to-date forest fuel map semi- automatically. A module for the socio-economic risk (SER) analysis is yielding a map of fire appearance probability. This is coupled with the Integral Risk (IRISK) module to obtain the fire danger and the potential damage maps, taking into account the instantaneous conditions and the evolution of weather and wind. Two databases are storing the information regarding historical data relative to weather and fires. This information is used by the Probabilistic Scenarios Generation module (PSG), which is predicting a set of possible fire and weather theatres as well as their evolution over time. The generated information comprises weather and wind changes together with fire position and time of appearance. For that purpose a set of sound probabilistic algorithms are used, although the usage of deterministic user-defined conditions are also allowed, thus converting FOMFIS into a valuable 'what-if' scenarios training tool.

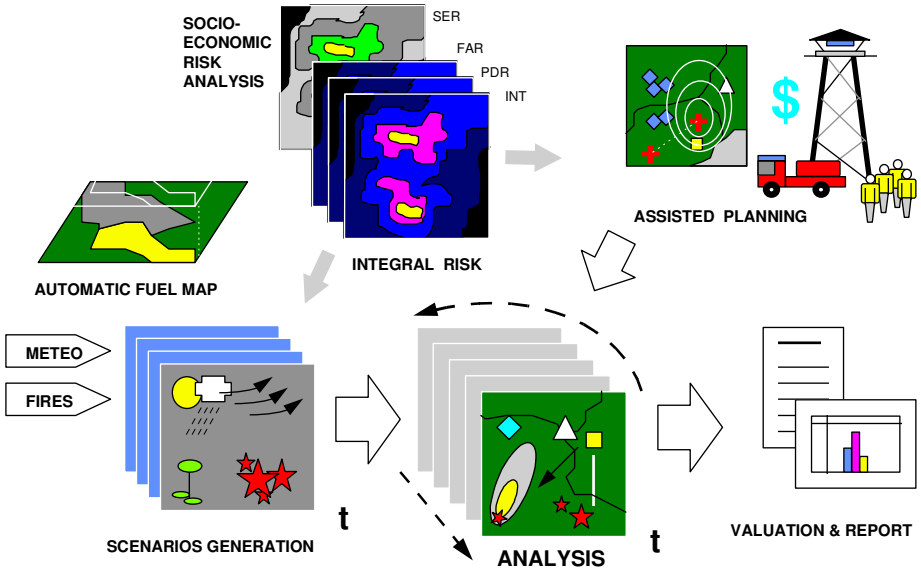

Figure 1 FOMFIS system modules and operational flow.

Besides, the system provides an interface to describe the location, type and number of fire fighting forces, infrastructures and other resources within the analysed area, giving support about the efficiency of each component according to their performance and cost. This is achieved through the Efficiency Driven Planning (EDP) module.

Finally the system runs complex simulations over a period of time using the probabilistically generated fire scenarios, embracing new fires appearance and spread, weather and wind conditions that are automatically changed, socio-economic and physical risks that are calculated together with the fire fighting forces that perform the transportation and fighting operations over the generated fires.

In this way the user is predicting complete fire campaigns with all the complexities in advance, estimating the damages, prejudices and costs of the proposed planning by analysing the resulting reports and graphics that system provides at the end of the simulation. This process can be executed several times for the same simulation time period. The system changes slightly the parameters for each iteration using probabilistic functions; thus the complete set of simulations gives the most probable tendency about the planning suitability instead of a deterministic result.

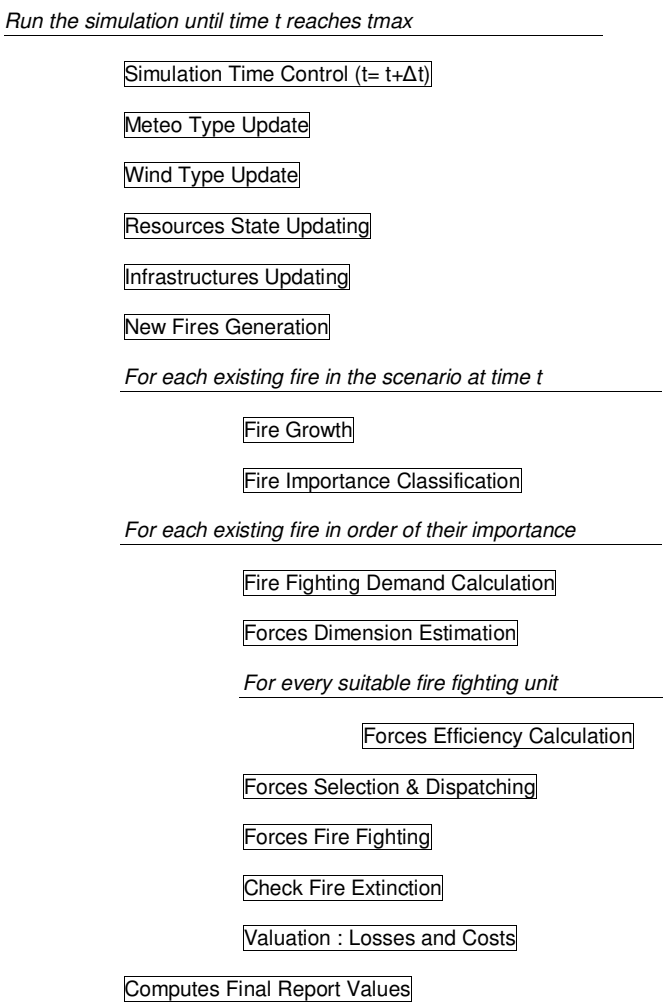

Figure 2. Planning Analysis Engine operational flow.

Simulations run predicting periods of time ranging from one week to several months. Time intervals of 15 days (shor term planning) and 3 months (mid term planning) have demonstrated to be the most appropriate as they closely reflect the planning and management terms used in the real world. All this is process is carried out by the Planning Analysis Engine (PSG) module, which operational scheme is given below (Fig. 2.):

CONCLUSIONS

Although its inherent complexity a system embracing several existing technological solutions has been set-up. Either as separate modules each giving support to several preventive planning operations or as a complete integrated simulation tool that gives an estimation of the fire scenario evolution together with the resources and infrastructures operation, FOMFIS system offers planning tools based on a geographical information system to estimate the efficiency of distributed fire defence forces and infrastructures according a given budget. The system is operating off-line, but the integrated algorithms and procedures could be adapted to work in real time through the capture of real time data.

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