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THE EUROPEAN FOREST FIRE INFORMATION SYSTEM (EFFIS)

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1. INTRODUCTION

Europe has suffered in the last years a large number of forest fires that has caused enormous losses in terms of human life and environmental damage. Forest fires in Europe are nowadays the result of strong strains for the use and management of the landscape. The already high population density in the Mediterranean regions, is increased during the summer months, leading to high probability of fire risk all over this region. It should be noted that the summer months coincide with the peak of the fire season. Also, the migration of rural population to the cities has resulted in a fairly abandoned landscape, in which the fuels are not utilized and are accumulated creating a dangerous continuous vegetation layer optimal for fire ignition and propagation. Also, in the last decade the growth of cities in their neighbor natural areas has resulted in an increase of a particular type of damaging fires, those that take place in the urban-forest interface. Economically not very profitable, the Mediterranean forests are often used as recreational areas, highly populated during the holidays and weekends. Fire frequency analysis finds always peaks in the number of fires on local holidays and weekends.

In spite of the damaging effect of fires at all scales (local, regional (supra-national) and global), the mechanisms to estimate fire risk or fire damage at these scales have not yet been developed. The European Commission, aware of the threat of forest fires to Europe's environment and population, set up the necessary means to develop a harmonized forest fire information system for Europe. The Joint Research Centre (JRC), in support of other services of the European Commission (EC), such as the General Directorate for Environment (DG ENV) initiated in 1999 the work towards establishing a European Forest Fires Information System (EFFIS). The forest fire activities carried out at the JRC comprise the different phases of fire monitoring. i.e. before, during and after the fire event. Only fire behavior, for which very detail local information is required, is not considered. On the prevention phase, the work has focused both on the development of systems to provide forest fire risk forecast based of existing fire risk indices, and on the development of new integrated forest fire risk indicators. Five types of forest fire risk indices, from long-term (static) risk indicators to short-term (dynamic) risk indicators have been implemented. All these indices permit the harmonized assessment of forest fire risk at the European scale. They may be used as tools for the assessment of risk situations in cases in which international cooperation in the field of civil protection is needed. In all cases, the indices were calibrated and validated using a five-year fire (1992-1997) event dataset.

Once a fire has taken place, it is necessary to evaluate the extent of the burnt area and to estimate the damage caused by the fire. An activity to estimate the annual damage caused by forest fires in the south of the EU was established. This activity has produced, for the years 2000 and 2001 the first cartography of forest fire damages in the south of the EU. All the burned areas larger than 50 ha, which account on average for 75 % of the total area burnt every year in Europe, were mapped using satellite sensor data. Further, the analysis of which types of land cover classes were affected was performed.

The envisaged EFFIS will store the existing information on forest fires at the European level as provided by the European Union Member States, and will also incorporate up-to-date information on fire risk and fire damages assessment retrieved through two of the existing modules of EFFIS, the European Forest Fire Risk Forecasting System (EFFRFS) that provides forest fire risk forecast during the peak of the fire season (May to October), and the European Forest Fire Damage Assessment System (EFFDAS), which evaluates the damage caused by forest fires through the analysis of satellite imagery. Both, the fire risk and burnt area mapping methodologies in these systems are calibrated and harmonized at the European scale. Consequently, it is possible to derive harmonized information for all Europe, and to perform the comparison of fire risk and fire damages levels between European countries and/or regions. EFFIS is a dynamic system, which incorporates up-to-date forest fires data, and permits access to forest fire information through a web interface.

2. THE EUROPEAN FOREST FIRE RISK FORECASTING SYSTEM (EFFRFS)

The EFFRFS was designed for computing several types of forest fire risk indices varying from short-term or dynamic indices to long-term or static indices. Once the indices are computed, they are distributed to the civil protection and forest fire services via Internet. Forest fire risk is influenced by many variables. These variables have a wide range of spatial and temporal variability. According to this variability forest fire risk can be classified into long-term prediction and short-term prediction [1]. The methods as well as the applications of the derived fire risk maps vary with this time frame. Long term prediction is provided by indices that are referred to as static or long-term. Short time prediction is provided by the so-called dynamic indices. On the one hand, the long-term fire risk prediction is intended for fire prevention planning, and may serve to characterized regions as subject to high or low risk of fires. On the other hand, short-term prediction is more related to fire fighting and extinction and it can be seen as a decision support mechanism for the allocation of forest fighting resources by operational fire fighting centers.

The following forest fire risks are computed in the EFFRFS:

1. Long-term (static) indices
   1.1. Probability of fire occurrence [2], [3]
   1.2. Likely damage

2. Short-term (dynamic) indices
   2.1. Meteorological fire risk (6 indices) [4]
   2.2. Vegetation stress fire risk [5]

3. Fire Potential Index [6], [7].

3. THE EUROPEAN FOREST FIRE DAMAGE ASSESSMENT SYSTEM (EFFDAS)

Burnt area mapping and forest fire damage assessment are performed as a support activity for the European Commission Directorate General of Environment. First, burnt areas are identified and classified on satellite imagery and subsequently the damage is assessed intersecting these maps of burnt areas with the CORINE land-cover database[8]. The CORINE land-cover is used since it is the only land-use map with a harmonized legend for all the European countries.

Currently, the method used in EFFDAS is based on change detection techniques using satellite imagery from IRS WiFS. Although WiFS presents an optimal ground spatial resolution for the analysis of fires at the European scale (180 meters), it is fairly limited in spectral resolution as it provides only a NIR and Red spectral bands. Enhancement of the

spectral resolution with other sensors such as MODIS has been tested with very promising results [9]. It is there foreseen that a combination of this two sensors may be used in the future for the operational mapping of burnt areas. This current methodology is explained in detail in [10].

Once the perimeter of the burnt area is identified on the satellite image, the next step is the evaluation of the forest fire damage. This is performed in a GIS environment by intersecting the classified image with a land cover database. The process involves the geo-coding of the image (warping) to the map projection of the land cover map. Warping is performed until sub-pixel registration between the two data layers is achieved.

4. QUERIES AND ANALYSIS

All the information generated in EFFIS (alphanumeric, vector and raster) is stored in an object-related database using OpenGis Simple Features Specification for vector data (Oracle) and an image extension for raster data (the raster extension has been developed internally at JRC). In addition to the derived data, a set of geographic layers that include administrative boundaries (communes, provinces and regions), the CORINE land-cover, river network are also stored to permit integrated data analysis.

Based on this common spatial data infrastructure a set of analysis functions to perform queries and extract data from the database was developed. These functions include basic statistical and geo-statistical functions for the analysis of one or more variables, and map-overlay queries. Queries can be used to extract data from the database and/or to perform an operation and display the resulting information. Any information layer present in the database can be queried as is, or in combination with any other layer through the map-overlay queries.

A time scale frame can be introduced for those layers with time dimension, such as the short-term indices (Meteorological and Vegetation Stress) and the Fire Potential Index. The time scale can by fixed for a given arbitrary period, or on a weekly, decade, monthly and yearly basis. Several statistical functions, including average, standard deviation, maximum, and minimum can be used to query the database. The main objective of the system is to allow the user to perform any space-temporal combination of queries using vector or raster layers and their attributes. The geographic unit for which a statistical operation is performed is also variable. Maps can be obtained at the pixel resolution, or at an aggregated level, i.e. commune, province, region, or country level. As in the case of the time variable features, the maps for these units can be derived using the basic statistical functions average, maximum, minimum, and standard deviation. This type of aggregation permits, for instance, comparing the results of the EFFRFS to national systems in which the fire risk mapping unit is the province or the region.

All these geo-processing functionalities were implemented as services at middle-tier level or at database-tier level using Java and C programming languages and open source software components and/or libraries.

EFFIS uses a web based client user interface to display the results of user queries; the main service is based on the standard OpenGIS Web Map Server Specification 1.1.1. Following this standard, the main emphasis was put on the development, within a common framework, of a set of GIS tools for spatial analysis that would provide the user with the capability to work with incoming data from fire risk models, remote sensing imagery, meteorological models and geo-spatial systems.

A pre-operational version of this system is active since spring 2000 and provides the fire-user community with a daily service from May to October. This service includes the computation of the fire risk indices and the delivery of these via Internet. In addition, the web interface of EFFIS allows any interested user to retrieve the fire forecast and to perform analysis on the fire risk campaign. This pre-operational version of EFFIS can be found at http://natural-hazards.jrc.it/fires/risk/products/dynamic/euffis-test.html.

5. REFERENCES

[1] Vorissis, D., 1999, Definition of the needs of suppress groups as concern of the prediction of the behavior of the wild land fires, in DELFI Proceedings, Athens, pp. 159-163.

[2] Chuvieco, E., Salas, J., Barredo, J. I., Carvacho, L., Karteris, M. & Koutsias, N., 1998, IV International Conference on Forest Fire Research, Luso-Coimbra.

[3] Sebastian Lopez, A., Salvador, R., and San-Miguel-Ayanz, J., 2001, Two models for a structural forest fire risk index at a regional scale, 2*1st EARSeL Workshop Remote sensing and GIS applications to forest fire management: New methods and sensors*, May 14-17, Paris, France.

[4] Bovio G. & Camia A., 2000, 'Description Eudic software for fire danger indices calculation', final report to JRC, Computation of meteorological fire danger indices for southern Europe, p. 14.

[5] Illera P., Fernandez A., Calle A. & Casanova J. L., 1996: "Temporal evolution of the NDVI as an indicator of forest fire danger"; International Journal of remote sensing, Vol. 17: 1093-1105.

[6] Sebastian Lopez, A., San-Miguel-Ayanz, J. and R. Burgan, 2002, Integration of satellite sensor data, fuel type maps and meteorological observations for the evaluation of forest fire risk at the pan-European scale, International Journal of Remote Sensing, Vol. 23, No. 13, pp. 2713-2719.

[7] Burgan, R.E., Klaver, R.W. & Klaver, JM., 1998, 'Fuel Models and Fire Potential from Satellite and Surface Observations', International Journal of Wildland Fire, Vol. 8: 159-170.

[8] CORINE land cover - Technical Guide, 1994. Publication EUR 12585 of the European Commission, EG, DG Environment, Nuclear Safefy, and Civil Protection. Luxembourg: Office for official publications of the European Communities.

[9] Barbosa, P. M., San-Miguel-Ayanz, J. & Schmuck, G., 2001, Remote sensing of forest fires in Southern Europe using IRS - WiFS and MODIS data, SPIE Remote Sensing Symposium, Toulouse, France, 17-21 September.

[10] Barbosa, P. M., San-Miguel-Ayanz, Martinez, B. & Schmuck, G., 2002, Barbosa, P. M., Burnt area mapping Southern Europe using IRS - WiFS imagery, IV International Conference on Forest Fire Research, Luso-Coimbra.