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Remote Sensing and GIS Applications for Forest Fire Management

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FOREWORD

In spite of being almost exclusively a Mediterranean problem, forest fire research is widely extended in the European remote sensing community. The reasons for this interest are diverse. Fire plays a key role in many environmental issues, such as land degradation, biodiversity, vegetation composition and atmospheric chemistry. Fire also implies severe risk for human lives and properties, since the new habits of urbanisation in Southern European countries extend the urban-forest interface and thus increase potential fire damages. Fire, finally, is a very suitable phenomenon to be remotely observed, because it presents unique spectral features, both when the fire is active and afterwards when it has burnt the vegetation cover.

This volume presents some of the works discussed during the EARSeL workshop that our department organised in September, 1995. This workshop was very fruitful as a forum to exchange ideas about new ways in which remote sensing and GIS technologies could help the management of forest fires.

To clarify the contents, the workshop was organised in three topics of interest which were related to the main phases of fire management: before, during and after the event. This issue of EARSeL Advances in Remote Sensing follows that scheme.

The first group of papers is focused on the determination of fire danger. Robert Burgan presents current research at the U.S. Forest Service, where satellite information is being considered to improve present fire danger rating systems.

In the European context, the most extended sensor is the AVHRR on board the NOAA satellites, since it provides the proper temporal and spectral resolution. Most of the fire danger estimation activities rely upon the multitemporal analysis of vegetation indices and surface temperature, both derived from AVHRR raw data. This is the topic of the paper by Alonso *et al.*, which intends to obtain quantitative correlations between satellite data and fuel moisture content measured on the field. Desbois and Vidal present an Stress Index based on the ratio between actual and potential evapotranspiration. The former is computed from the difference between surface and air temperature. On the other hand, the slope of the linear relationship between surface temperature and NDVI was found to be consistently related to fire occurrence by Illera *et al.*. All these three practical papers show promising approaches to arrive at operational applications of satellite data to fire danger rating in European countries.

Fire risk may also be related to the structural factors that affect fire. By structural factors, we mean those variables more permanently associated to fire ignition or fire spread. These variables may be integrated into a Geographic Information System, thus to create automatic maps for long term fire defence planning. Maselli *et al.* provide examples of this approach for the isle of Elba, in Italy. Mariel and Jappiot offer a similar structure in Les Maures forest (South of France). To apply operationally these models, one should be certain about the quality of the data. The paper by De Vliegher *et al.*, focuses on the effects of error propagation in a multilayer GIS by a Montecarlo simulation model. Another clear application of GIS-based fire risk models regards the computer simulation of fire behaviour. The paper by Lymberopoulos *et al.* is a practical example on how GIS may assist in the graphical interface of heavy computational physical models, as well as in the application of these models to practical fire suppression operations.

Once the fire starts, remote sensing can be a major source of information for fire detection and fire growth monitoring, especially in those countries where fire vigilance resources are scarce. The activities presented by Downey *et al.* in different countries are a good basis to extend satellite monitoring of fire activity world-wide. However, more suitable sensors than AVHRR should be available for obtaining high accuracy and to avoid false alarms. Meanwhile, a deep discussion about algorithms for hot-spot detection in AVHRR channel 3 data are discussed by Ceccato *et al.*.

Post-fire assessment was widely covered in the workshop, with examples taken mainly from Mediterranean countries. Prof. Karteris makes a general overview of current research on this topic. The increase in the risks of soil erosion and desertification as a result of fire is modelled by Sasikala *et al.*, Rokos and Kolokoussis and Banninger and Gallaun. The former two base their analysis on satellite images and auxiliary variables, while the latter relies on the multitemporal analysis of a modified soil adjusted vegetation index. These three works take areas burned in Greece as study cases.

New techniques for burned land mapping were also reviewed at the workshop. Caetano *et al.*, present the application of spectral mixture analysis to the reflective bands of AVHRR (plus the NDVI). The burned land endmember was found to be clearly related to actual burned areas, although the introduction of a vicinity rule improved significantly the determination of the affected surfaces. From low to high resolution, since the paper of Baulies *et al.* offers the CASI airborne sensor as a suitable alternative to determine burned land and severity of damage.

The last group of papers deal with patterns of vegetation recovery after a fire. Monitoring vegetation cover is pursued by a non-linear function of the NDVI by Viedma *et al.*. These authors found a clear dependence of regeneration trends from bioclimatological factors. Vine *et al.* study the effect of regeneration on hydrological conditions, relating satellite image interpretation to field data. Salvador and Pons show multitemporal patterns of vegetation recovery after fire on a series of MSS images. Finally Gluck and Rempel analyse the effect of fire on landscape patterns at various scales and pixel sizes.

I hope the reading of this issue will contribute to enrich the already wide flow of scientific literature on the application of remote sensing technologies to forest fires research. Much has been done, but even more needs to be pursued, since the natural patrimony of European landscapes is so very precious as to make every effort for their conservation worthwhile.

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Alcalá de Henares, July 30, 1996