Chapter 53
Soft Computing Modeling of Wild Fire Risk Indices: The Risk Profile of Peloponnesus Region in Greece

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ABSTRACT

It is essential to find ways that can reduce the risk of devastating forest fires which have multiple negative ecological and financial consequences. This preliminary research effort focuses on the implementation of an intelligent rule based fuzzy inference system evaluating wild fire risk in the forest departments of Greece. The system uses soft computing techniques and was built in the Matlab integrated environment. The whole research is related to the wild fires in Greece during the period 1983-1997 with data coming from the general forest management service. It classifies all Greek forest departments (by assigning three labels) according to their forest fire risk due to distinct parameters. The estimation of the risk indices was done by using fuzzy triangular membership functions and Einstein fuzzy conjunction T-Norms. Moreover the system produces the profile of the forest departments located in the geographic area of "Peloponnesus." This is a region located in the southern part of the country and it has a vast number of annual forest fire breakouts. Meteorological, topographic, and historical (total burned area and intervention time) features were considered for the determination of the risk indices. The system has shown a good performance which can be improved further if more data is gathered and used. Its main advantage is that it offers an innovative and reliable model that can be employed in any part of the world as a basis for natural disasters' risk estimation.

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INTRODUCTION

Forest fire risk estimation is a major issue. The necessity for more efficient allocation of fire fighting resources becomes more and more urgent, especially in the areas located around the Mediterranean basin (Portugal, Spain, France, Italy, Greece) (Dimitrakopoulos, 1994).

Wild fires are an interdisciplinary field of research and they constitute one of the most serious environmental threats. It is a fact that in our times, more and more environmental problems are caused by the climatic change which is mainly due to anthropogenic intervention. Through the international scientific community there is an increasing interest for the study of environmental disasters. Fuzzy logic has been widely recognized as a powerful tool for risk estimation and there are several such cases in the literature (Huang & Ruan, 2008).

In Greece during the last 40 years the number of forest fires has increased significantly. This is the result of human activities, such as farming, tourism, but also the result of financial development which raised the interest for building cottages in forest areas (Dimitrakopoulos, 1994). Wild fires considerably contribute in the climate change and the devalorisation of ground. The destruction of forests due to fires involves usually negative repercussions in the ground surface and also in the hydrological cycle, with the increase of surface flow, the reduction of evaporation, the increase of erosion, the appearance of extreme floods. Moreover the burning of high volumes of biomass contributes in the increase of greenhouse gasses. Thus it is well understood that there are several negative side effects.

Intelligent systems can have a major role in the protection of the environment and they offer powerful tools capable of estimating flexible risk indices even in cases with imprecise or inaccurate data. In several cases immediate action and planning is required whereas on the other hand it would take several years to gather proper data series. Approximation modeling is often required in order to carry out rational wild fire protection and prevention planning. Such systems are called to offer reliable and effective models of real world situations in the right timing. The use of fuzzy logic which is a universal approximator that can provide intelligent solutions by employing proper linguistics such as "Risky," "Not Risky," or "Extremely Risky" in order to avoid the use of irrational crisp boundaries.

Features Considered

This research effort considers the following factors related to forest fire risk:

- Intervention time which is the time required from the moment of spotting till the initiation of the fire fighting process. This parameter is very crucial, capable of determining the total burned area.
- Meteorological parameters such as temperature wind speed and relative humidity at the momentum and at the exact location of the fire incident.
- Moreover topographical data such as the average altitude and the average slope of the area are really important.
- Historical data like the annual total burned area of the forest department.

It cannot be claimed that all of the risk features were considered, however a wide range of them (having both structural and dynamic nature) was covered. It should be clarified that this is a pilot approach and thus its aim is to demonstrate the effective use of flexible soft computing modeling techniques in risk estimation.

The classification of the forest departments of Peloponnesus region is done based on the Partial Risk Indices (PRI) due to each of the above parameters independently. On the other hand an overall classification is performed based on the Unified Risk Indices (URI) which are produced

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