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Measuring the consequences of wildfires in a Bayesian network with vulnerability and exposure indicators

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Mediterranean climate type areas have always been experiencing fire events. However, population growth and expansion of urban centers into wildland areas during the 20th century (expansion of wildland-urban interface) has increased the threat to humans and their activities. Life and property losses, damage on infrastructure and crops, and forest degradation are some of the damages caused by wildfires. Although fires repeatedly occur along the Mediterranean basin, not all areas have experienced severe consequences. The extent of damage by wildfires is influenced by several factors, such as population density, vegetation type, topography, weather conditions and social preparedness [1]. Wildfire consequence estimation by means of vulnerability and exposure indicators is an essential part of wildfire risk analysis. Vulnerability indicators express the conditions that increase the susceptibility of a site to the impact of wildfires and exposure indicators describe the elements at risk [2],[3]. Appropriate indicators to measure wildfire vulnerability and exposure can vary with scale and site. The consequences can be classified into economic, social, environmental and safety, and they can be tangible (human life losses, buildings damaged) or intangible (damage of cultural heritage site). As a consequence, a variety of approaches exist and there is a lack of generalized unified easy-to-implement methodologies.

In this study we present a methodology for measuring consequences of wildfires in a Mediterranean area in the mesoscale (1 km^2 spatial resolution). Vulnerability and exposure indicators covering all consequence levels are identified and their interrelations are stressed. Variables such as building materials, roofing type, and average building values are included in the economic vulnerability level. Safety exposure is expressed by population density, demographic structure, street density and distance to closest fire station. Environmental vulnerability of protected areas and rare species is also included. Presence of cultural heritage sites, power stations and power line network influence social exposure. The conceptual framework is demonstrated with a Bayesian Network (BN). The BN model incorporates empirical observation, physical models and expert knowledge; it can also explicitly account for uncertainty in the indicators. The proposed model is applied to the island of Cyprus. Maps support the demonstration of results.

[1] Keeley, J.E.; Bond, W.J.; Bradstock, R.A.; Pausas, J.G.; Rundel, P.W. (2012): Fire in Mediterranean ecosystems: ecology, evolution and management. Cambridge University Press, New York, USA.
[2] UN/ISDR (International Strategy for Disaster Reduction (2004): Living with Risk: A Global Review of Disaster Reduction Initiatives, Geneva, UN Publications.
[3] Birkmann, J. (2006): Measuring vulnerability to natural hazards: towards disaster resilient societies. United Nations University Press, Tokyo, Japan.