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Intelligent Decision Support System for Environmental Risk Management

IDSERM: Intelligent Decision Support System for Environmental Risk Management

Wildfire activity is strongly affected by four factors: fuels, climate weather, ignition agents and people. Where fuel is available, weather is the most important factor in shaping fire regimes in many areas of the world.

In 2009, ISO published the international standard "Risk Management –Principles and Guidelines (ISO 31000:2009)" . The ISO risk management standard, which provides generic guidelines for the management of all forms of risk, is being adopted by countries as their national standard for risk management. For example, in Australia and New Zealand, the standard has been published as AS/NZS ISO 31000:2009.
Currently there is no internationally agreed risk management standard covering all types of fire associated with forest and rural land management.
Risk is the "effect of uncertainty on objectives"and this can have positive and negative consequences
Risk Management is the "coordinated activities to direct and control an organization with regard to risk"
Risk Management Process is the "systematic application of management policies, procedures and practices to the tasks of communication, consultation, establishing the context, identifying, analyzing, evaluating, treating, monitoring and reviewing risk"
Risk Management Framework is the "set of components that provide the foundations and organizational arrangements for designing, implementing, monitoring, reviewing and continually improving risk management throughout the organization"
Risks: combining the consequences of a hazard with the likelihood of its occurrence

According to ISO 31010, risks are the combination of the consequences of an event or hazard and the associated likelihood of its occurrence. Consequences are the negative effects of a disaster expressed in terms of human impacts, economic and environmental impacts, and political/social impacts. More detail on the measurement of impacts will be provided separately in the next chapter below.
In situations where the likelihood of occurrence of a hazard of a certain intensity can be quantified we refer to the term probability of occurrence36. When the extent of the impacts is independent of the probability of occurrence of the hazard, which is often the case for purely natural hazards, such as earthquakes or storms, risk can be expressed algebraically as:

Risk = hazard impact * probability of occurrence.

Where the size of the impact influences the likelihood of occurrence, i.e. where the two terms are not independent of each other, the risk cannot be expressed simply as a product of two terms but must be expressed as a functional relationship. Likewise, where the impacts are dependent on preparedness or preventive behavior, e.g. timely evacuation, there are advantages in expressing the impact indicator in a more differentiated manner. In particular in the analysis of natural hazards, impacts are often expressed in terms of vulnerability and exposure. Vulnerability V is defined as the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

Risk=f(p*E*V)

Using the concept of vulnerability makes it more explicit that the impacts of a hazard are also a function of the preventive and preparatory measures that are employed to reduce the risk. For example, for a heat wave hazard it may be the case that behavioral preparedness measures, such as information and advice, can critically reduce the vulnerability of a population to the risk of excess death. Effective prevention and preparedness measures thus decrease the vulnerability and therefore the risk.

Depending on the particular risk analyzed, the measurement of risk can be carried out with a greater number of different variables and factors, depending inter alia on the complexity of the chain of impacts, the number of impact factors considered, and the requisite level of precision. Generally, the complexity of the modelling and the quantification of factors can be increased as long as this also improves certainty.

Motivated by the above facts, in this work, an integrated hardware/software system for environmental decision support has been developed.
The system comprises a weather station and a wireless sensor network based on the development boards Arduino Uno Rev 3 and Raspberry Pi 2. The sensor network employs the 802.15.4 protocol for wireless weather data transmission via XBee S1 transceivers and the IoT publish/subscribe protocol MQTT (MQ Telemetry Transport) for gateway communication. The proposed system estimates the forest fire risk based on statistical analysis of weather data from the environment to which a weather station is mounted. Then, the system computes the Fire Weather Index (Fosberg Index) and the Fire Risk Indicator by employing advanced artificial intelligence techniques, such as fuzzy logic, machine learning and predictive risk models, neural networks and deep learning techniques. The proposed system configuration is useful to engineers and scientists that actively participate in monitoring, detecting and predicting forest fires.

Signal processing, data acquisition

System integration and engineering

Computing

Software and imaging

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