Early Warning of Wildland Fires – A Global Synthesis

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Extended Abstract

1. Rationale: Wildland Fire, Early Warning and Sustainable Development

Sustainable development of natural vegetation systems, land-use systems and rural populations in many countries are at risk due to wildland fires that devastate valuable vegetation resources (forests and other wildlands, farmlands, pastures, plantations, etc.), in both the short-term (disruption of ecosystem processes, economic losses, humanitarian problems due to destruction of crops and other values at risk, including human health due to impacts of smoke) and the long-term (degradation of stability and productivity of ecosystems and land-use systems).

These fires often occur as consequence of extreme weather situations and inter-annual climate variability, e.g. during droughts caused by El Niño during which land-use fires escape control, or after precipitation-rich periods (e.g., La Niña) that result in rich growth of vegetation and an increased availability of fuels (combustible material). The underlying causes of damaging wildfires and excessive application of fire in land-use systems are deeply rooted in the problems of rural societies that are undergoing rapid demographic changes and are experiencing the loss of traditional knowledge and skills due to the trend of globalisation, and confrontation with external pressure on limited vegetation resources.

Secondary effects of destructive wildfires include the loss of vegetation that protects the soil. As a consequence the fire-affected sites are often degraded by wind and water erosion. Increased water runoff also leads to disastrous floods and landslides, affecting drinking water availability and quality, or leading to siltation of reservoirs.

2. Methodologies and Systems for Early Warning of Wildland Fires

Early warning (EW) of wildland fire and related hazards include a variety of methodological approaches and systems to identify precursor developments and assess / predict the escalation of the wildland fire theatre.

(a) Assessment of fuel loads. Ground measurements and to a certain extent also satellite-generated information allow to determine the amount of fuels (= combustible materials) available for wildland fire. This is important because dryness and fire risk alone do not determine the extent and severity (= severity of impact) of fire.

(b) Prediction of lightning danger. Methods exist for observing / tracking lightning activities as source of natural ignition (ground-based lightning detection systems; spaceborne monitoring of lightning activities).

(c) Prediction of human-caused fire factors. Modelling / predicting human-caused fire starts is critical, since in most countries fires are caused directly or indirectly by human activity. This field of research requires adequate consideration to socio-economic factors (ownerhips, land uses, unemployment problems, etc.).

(d) Prediction of fuel moisture content. This term is closely related to the readiness and ease of vegetation to burn. EW systems include meteorological danger indices and spaceborne information on vegetation dryness (intensity and duration of vegetation stress) and soil dryness. Prediction of inter-annual climate variability / drought, particularly related to ENSO, is important for preparedness planning in many countries.

The above referred factors are related to the ignition danger, which is associated to the starting of the fire. Once the fire stars, it is critical also to consider the propagation patterns, which are related to fuel loads, terrain characteristics and wind flows, basically.

(f) Prediction of wildfire spread and behaviour: Airborne and spaceborne monitoring of active fires allows the prediction of movements of fire fronts to areas with values at risk. The technologies used include airborne instruments to monitor fire spread in situations of reduced visibility (smoke obscured) or to cover large areas. A large number of orbiting and geostationary satellites are available to identify active fires. Numerous wildland fire behaviour models are in place that allow the prediction of spread and intensity of wildland fires.

Hazards related to wildland fire include post-fire secondary disasters (water runoff, erosion, landslides, flooding) and air pollution threatening human security and health.

(g) Assessment of smoke pollution. *In situ* air quality monitoring systems allow tracking of fire smoke pollution and issue alerts (warnings to populations). Surface wind prediction allows prediction of smoke transport from fire-affected regions to populated areas. Satellite imageries can depict smoke transport.

To predict future of fire occurrence, weather conditions, which have great impact in the beginning and spreading of the fire, should be considered in a medium- to long-term perspective.

(h) Prediction of climate variability and fire danger: During El Niño events, for example, sea temperature at the surface in the central and eastern tropical Pacific Ocean becomes substantially higher than normal. During La Niña events, the sea surface temperatures in these regions become lower than normal. These temperature changes can drive major climate fluctuations around the globe and once initiated, such events can last for 12 months or more. Droughts associated with recent El Niño events have resulted in widespread controlled burning and uncontrolled wildfires, resulting in extreme fire and smoke episodes, particularly in South East Asia and in the Americas.

(i) Prediction of climate change and fire danger: Recent Intergovernmental Panel on Climate Change (IPCC) reports have emphasized the fact that climate change is a current reality, and that significant impacts can be expected, particularly at northern latitudes, for many decades ahead. Model projections of future climate, at both broad and regional scales, are consistent in this regard. An increase in boreal forest fire numbers and severity, as a result of a warming climate with increased convective activity, is expected to be an early and significant consequence of climate change. Increased lightning and lightning fire occurrence is expected under a warming climate. Fire seasons are expected to be longer, with an increase in the severity and extent of the extreme fire danger conditions that drive major forest fire events.

Application: Policies, Gaps and Trends

Most industrial countries have early warning systems for wildland fires and institutional capabilities in place to address the above-mentioned issues. However, the majority of developing countries and countries in transition do not have in place most of the systems. These countries are seeking technical and scientific cooperation with donor countries to develop locally applicable EW systems. There is a new trend to support decentralized approaches such as the use of “simple” EW indices to be used at local (community) level.

At international level it has been recognized that the EW component in fire research and development has received less attention than fire monitoring. Consequently, it has been decided recently to push research and development in early warning of wildland fires.

The greatest challenges ahead are transfer of knowledge and adapted technologies to the grassroot levels of those population groups that are dependent on using the ecologically beneficial effects of fire in their land-use systems, while at the same time becoming increasingly vulnerable to the destructive effects of uncontrolled wildfires. These population groups cannot take advantage of sophisticated fire warning and information systems that are outside their reach.

References

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