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Determining wildfire suppression effectiveness

The effectiveness of wildfire suppression is difficult to evaluate as it can be assessed against a range of objectives and purposes at many scales. There is a strong and growing need for such information to support suppression planning, resource prioritisation and decision making. Two recent review articles provide a summary of the current state of suppression effectiveness research.

Critical knowledge for a range of issues

Understanding suppression effectiveness is essential for many preparatory and response fire management activities employed globally. It is influenced by many diverse, interlinked variables related to fire behaviour, environmental conditions (such as weather, fuels, terrain and accessibility) and its application (e.g. tactics, suppression resource types, techniques, decisions, firefighter training and experience). Many of these vary spatially and temporally and are difficult to measure. The number of potential combinations of these variables make every fire unique and suppression effectiveness very difficult to analyse.

Around the world, much research on the effectiveness of wildfire suppression has been undertaken over the years to address a wide variety of issues. This research can be classified by the physical scale of the aspect of interest.

Flame scale

The smallest spatial scale for investigating suppression effectiveness has focused on small fires confined within organised fuel beds, usually in laboratory settings (e.g. Fig 1). Experiments conducted at this scale provide a means for controlling and isolating variables, enabling high quality datasets suitable for rigorous statistical analysis to be generated. Research at this scale has concentrated on assessing and comparing the effectiveness of suppression chemicals, with their ability to stop or slow spreading fires used to quantify and compare their performance. The main limitation of research at this scale is the degree to which results can be applied to wildfire conditions.

Figure 1. Laboratory scale testing of suppression chemical effectiveness on standard fires in the CSIRO Pyrotron.

Fireline scale

Field observations of suppression on sections of experimental and wildfire perimeters have been used to investigate the productivity of some suppression resources and the effect of suppression on fire behaviour (e.g. Fig 2). Productivity studies have also been undertaken at this scale to develop models predicting the time taken to construct fireline. These types of models can be used to estimate fire containment times and suppression

resource requirements but have only been developed for a limited range of resource types and burning conditions.

Some resource evaluations have been based on the observed effect of suppression on fire behaviour at this scale. The collection of such observations is often opportunistic and limited by the range of environmental conditions in which they can be made. While such results can provide useful information at a scale relevant to suppression operations it is unlikely that sufficient data can be obtained to facilitate comprehensive analyses.

Figure 2. Aerial photograph of a fireline scale experiment evaluating chemical suppressants in grassland fuels.

Incident scale

The incident scale is concerned with the suppression effort undertaken across a going fire, often as a case study of a specific wildfire event. Such case studies are largely qualitative but allow consideration of the suppression operational objectives and purposes.

The application of economic modelling methods for analysing fireline production and containment of large wildfires is a recent trend at this scale. Such studies have found existing productivity models developed using non-wildfire data grossly over-estimate resource efficiency. Economic modelling of wildfire events has been limited by data availability and has not yet been able to consider many suppression tasks beyond fireline construction.

Landscape scale

The landscape scale considers suppression across much larger areas and timescales, often using fire area and containment time thresholds to quantify suppression effectiveness across many fire incidents. Such analysis has produced results that aid fire management planning across jurisdictions and provide evidence of decision-making outcomes. Most analyses at this scale use general summary variables such as fire danger indices, fuel type and suppression response attributes to explain differences in fire outcomes.

Landscape scale studies have been used to inform protocols for deployment decisions. They have also been used to evaluate the effect of policy changes in long-term datasets and justify response procedures.

Discussion

Suppression effectiveness definitions and metrics at flame, fireline and landscape scales are relatively simple and easy to apply. Defining and measuring suppression effectiveness is more difficult at the fire incident scale. Suppression effectiveness at this scale must be considered in the context of operational objectives which are influenced by many variables related to current and expected environmental and fire behaviour conditions and the availability of suitable resources.

Furthering our understanding of suppression effectiveness at all scales will lead to improved suppression responses, helping to mitigate many negative impacts that wildfires have on people, places and the environment.

Further reading

Plucinski, MP (2019) Fighting flames and forging firelines: wildfire suppression effectiveness at the fire edge. *Current Forestry Reports* 5, 1-19. doi: 10.1007/s40725-019-00084-5.

Plucinski, MP (2019) Contain and control: wildfire suppression effectiveness at incidents and across landscapes. *Current Forestry Reports* 5, 20-40. doi: 10.1007/s40725-019-00085-4.

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