CSIRO PyroPage

Putting science into practice

www.csiro.au

Number 35 | **December 2023**

Improved models for initial attack success in Victoria

Fires that escape initial attack tend to cause the greatest impacts and cost the most to put out. Rapid identification of fires with the potential to escape initial suppression efforts will aid early warnings to the public and prompt planning for large fire containment. A dataset compiled from 17 years of Victorian fire incidents, along with associated weather and geographic data, was used to develop improved models of initial attack success. The models use information available when a new fire is reported, such as fire location, prevailing weather, suppression resource travel speeds, and fuel type and are more robust and applicable than previous efforts.

Initial attack

The initial development stage of a bushfire offers the best opportunity for effective suppression—it limits harmful impacts and reduces suppression costs and is a major focus of many suppression strategies. Existing models attempt to predict the probability of success of initial attack but were developed from limited datasets that necessitated assumptions that restricted their applicability and robustness. A recent project undertook to develop improved initial attack success models from a more extensive dataset.

Incident dataset

Bushfire incidents in the State of Victoria from July 2003 to June 2020 were compiled into a dataset using records from Forest Fire Management Victoria and the Country Fire Authority. The dataset is 3-4 times larger and more comprehensive than previous datasets, and includes a broader range of variables, such as concurrence of fire bans, the proximity to roads, and suppression resource travel times. The dataset also includes a range of weather variables such as fuel moisture content, grass and forest fire danger indices, and drought indices, both at the time each fire was reported and as daily extrema. Final fire area information for each fire was used to determine initial attack (IA) success: if the fire was kept to an area of five ha or less, initial attack was deemed successful.

Model development

The dataset was divided into three broad vegetation types: grasslands (n = 25,434), forests (n = 7,164) and shrublands (n = 2,556). Logistic regression models for predicting the probability of a fire being contained within 5 ha were developed for each vegetation class using 80% of the available data which were selected randomly. The remaining 20% of the data were reserved for model validation.

Improved initial attack models

The new IA models that were developed show that weather conditions, resource travel time, distance of the fire from roads, and topographic slope are the most influential variables for predicting IA success. All models included wind speed and fuel moisture content (Fig. 1), travel time and slope. Distance from roads featured in the grassland and forest models, while Drought Factor featured in the grassland and shrubland models.

The optimal probability thresholds for classifying IA success with these models were quite high (0.97 in grasslands, 0.94 in forests and 0.85 in shrublands). Fires with probabilities below these thresholds are likely to escape initial attack. These high thresholds are a result of the vast majority of the fires in the dataset that were successfully contained during initial attack (grasslands 97%, forests 94% and shrublands 91%).

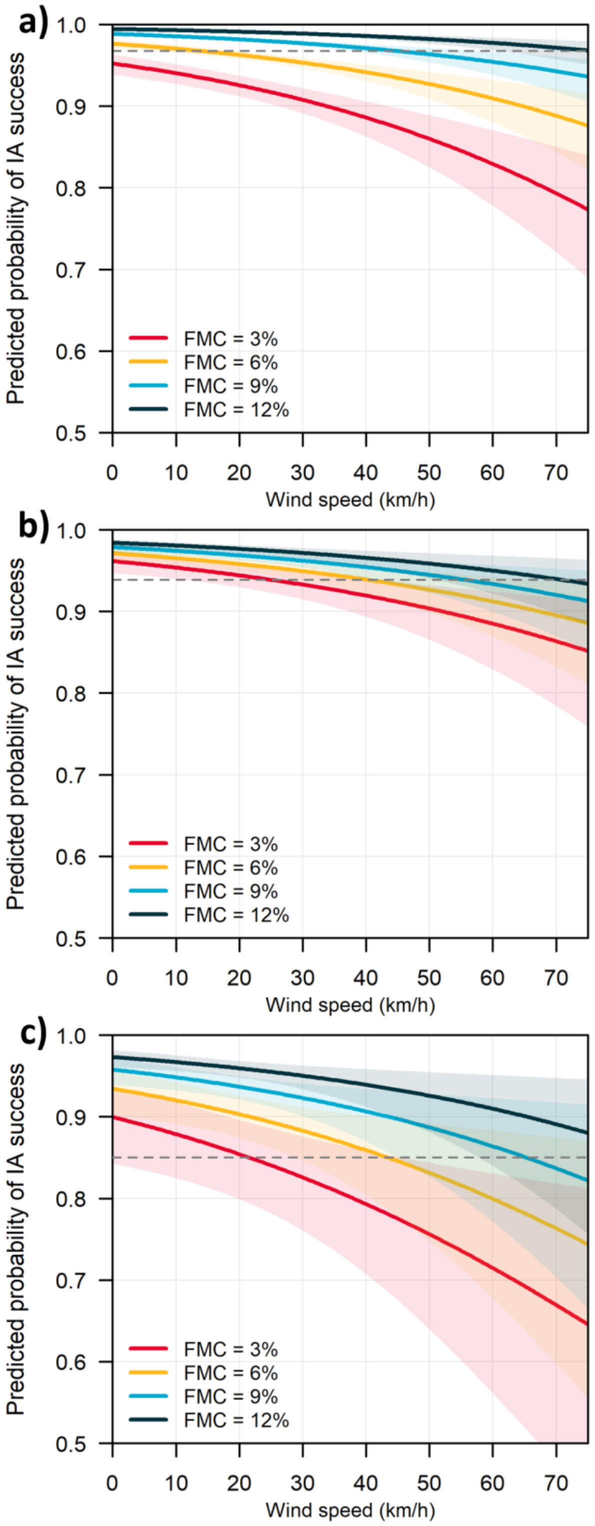

Figure 1. Plots showing the influence of wind speed and fuel moisture content on the probability of initial attack success in (a) grassland, (b) forest and (c) shrubland vegetation. All other model input variables have been held at median values. The dashed lines indicate the optimal threshold for each model.

Model limitations

The ability of each model to correctly predict if a fire will escape initial attack is limited, with around a quarter of all unsuccessful IA fires incorrectly predicted to be contained during IA in the validation dataset. This is because there was very little practical difference in the values of the input variables of fires that were contained within five ha in the dataset compared with those that were not. This could be improved with the inclusion of additional variables that influence IA but which were not available here, such as those describing fuel conditions (including fuel load and structure), fire behaviour and fire size at initial attack.

Model implementation

The models developed in this study can be easily implemented operationally as they only require readily available inputs that can be obtained from geographical information systems, weather forecasts and estimates of resource travel times. As soon as a fire's location and assigned resource response times can be reasonably estimated, the probability that the fire can be contained during IA can be predicted. If the predicted value is below the optimal threshold for the appropriate model, then there is a high possibility that the fire may escape IA efforts and fire managers should immediately consider alternate actions associated with large fires, such as ordering additional suppression resources, predicting progression, issuing urgent public warnings, and planning longer term containment strategies.

Fire managers should note that while a prediction above the optimal probability threshold indicates likely IA success, there is still a small chance that the fire could escape IA.

Further reading

Plucinski, MP, Dunstall, S, McCarthy, NF, Deutsch, S, Tartaglia, E, Huston, C, Stephenson, AG (2023) Fighting wildfires: predicting initial attack success across Victoria, Australia. *International Journal of Wildland Fire* 32, 1689-1703.

CONTACT US

t 1300 363 400
+61 3 9545 2176
e enquiries@csiro.au
w www.csiro.au

FOR FURTHER INFORMATION

Environment
Dr Andrew Sullivan
t +61 2 6246 4051
e Andrew.Sullivan@csiro.au
w https://www.csiro.au/en/about/people/business-units/Environment

An archive of this and previous CSIRO PyroPages is available from: http://research.csiro.au/pyropage