New warning system can help predict extreme bushfires

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Credit: Pixabay/CC0 Public Domain

A UNSW Canberra researcher has developed a world-first warning system for extreme bushfires that can be an invaluable tool for firefighting services.

The new warning system, developed by Adjunct Professor Rick McRae, specifically looks at the environmental conditions that can lead to extreme bushfires in south-east Australia. It can provide a warning months before a fire season, by examining temperature and river flow data and determining if the coming season is likely to exhibit conditions conducive to extreme fires.

Extreme fires are ones that forge strong links with the atmosphere above, whereas other fires are driven by surface weather.

Professor McRae has authored an article in the *Australian Journal of Emergency Management* explaining the framework that underpins the warning system.

With the increasing influence of climate change, extreme bushfires are expected to be more frequent and present new challenges for fire prediction and management.

While all bushfires have the potential to be destructive and can pose a risk to lives, extreme bushfires differ to others as they often behave unpredictably and can lead to phenomena like pyrocumulonimbus—where the fire interacts with the atmosphere to create violent fire thunderstorms.

Professor McRae emphasized that the new warning system, which is still in a trial phase, was not a replacement to the current fire danger rating system, but that it should be viewed as a complementary tool to assist fire authorities identify times when the worst outcomes might eventuate.

"What we saw during the Black Summer fires suggests the bushfire rule book has been completely rewritten," Professor McRae said.

"We saw a dramatic increase in the number of extreme wildfires, including fire types that had previously been rare.

"Black Summer made it clear we need new tools to help prepare for and fight against these extreme bushfires and I hope this new predictive model can be one of those."

Extreme bushfires include those that demonstrate "deep flaming," where there is active burning simultaneously across a large fire front. The fire front of a "normal" bushfire might be tens of meters in depth, whereas an extreme bushfire might cover hundreds of meters, or even kilometers, due to spot fires igniting over a large area.

Fires driven by the foehn effect, where hot and dry winds from higher terrain exacerbate the fire, were once rare but accounted for about half of the major events during the Black Summer. Between 1980 and 2003 there were fewer than 10 fire thunderstorms recorded, however in the following 20 years there have been more than 120 of these events.

To assess the conditions under which an extreme bushfire could ignite, Professor McRae developed the Hierarchical Predictive Framework which uses the latest research and practical knowledge on extreme bushfires to assess the likelihood of occurrence. It combines his decades of operational experience with bushfires in the ACT with the ground-breaking science that has been conducted by UNSW Canberra since the 2003 bushfires.

The model uses four levels of data to inform the prediction, including an assessment of temperature anomalies and river flow levels.

Canberra was determined to be a useful location to record temperature. The average temperature across the 12 months leading up to bushfire season is compared with Bureau of Meteorology data to create the "Canberra Dipole."

When the Canberra Dipole is elevated there is the potential for synoptic weather patterns to produce trough systems in south-east Australia that exacerbate extreme fires.

The model also takes into account river flows from 17 locations across south-east Australia. While there are several ways to determine the flammability of smaller fuel sources, for example twigs and fallen leaves, determining soil dryness using river levels paints a clearer picture of the flammability of large fuels, like logs.

Professor McRae applied the model retrospectively to more than 20 years of data from previous bushfires to determine its effectiveness.

"I was able to demonstrate with a high level of accuracy that periods when these temperature and river conditions were met have previously aligned with extreme bushfires in south-east Australia," Professor McRae said.

"The next step is to use the model in the coming fire seasons to further assess its accuracy and refine the model further.

"But as things currently stand the model looks like it can be a highly effective warning system to assist fire authorities during bad fire seasons."

Further information about Professor McRae's observations and collected data are available here.

More information: Rick McRae, Operational prediction of extreme bushfires, *Australian Journal of Emergency Management* (2023). DOI: 10.47389/38.4.67

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