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THE PRESCRIBED BURNING ATLAS: A NEW SYSTEM TO PLAN EFFECTIVE PRESCRIBED BURNS

ABOUT THIS PROJECT

Backed by five years of research measuring the effects of almost one million fire simulations, the Prescribed Burning Atlas is the key product of the *From hectares to tailor-made solutions for risk mitigation: systems to deliver effective prescribed burning across Australian ecosystems* project. The project investigated the implementation of tailor-made prescribed burning strategies to suit the biophysical, climatic and human context of bioregions in southern Australia, both now and in the future using climate change projections. The Prescribed Burning Atlas will inform prescribed burning strategies and help fire and land managers tailor their approaches to outcomes that will best reduce residual risk in a target area within available budgets.

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SUMMARY

The Prescribed Burning Atlas is a new tool backed by research to assist fire and land management agencies by presenting options for their prescribed burning strategies. Accessible via <https://prescribedburnatlas.science>, the Atlas incorporates almost one million prescribed burning simulations across varied landscapes and under different weather conditions, to explore the effects of different rates and locations of prescribed burning treatments on subsequent bushfire behaviour.

Researchers examined the residual risks across a range of management values and south eastern Australian landscapes, including the cost-effectiveness of different



You can access the
Prescribed Burning Atlas at
<https://prescribedburnatlas.science/>

▲ **Above:** THIS RESEARCH DEVELOPED THE PRESCRIBED BURNING ATLAS, A WEBSITE TO HELP FIRE AND LAND MANAGERS TAILOR THEIR PRESCRIBED BURNING STRATEGIES TO THE LOCAL ENVIRONMENT AND BUDGET. PHOTO: NSW NATIONAL PARKS AND WILDLIFE SERVICE.

strategies. The Atlas provides new insights into the effectiveness of prescribed burning in reducing the likelihood of life loss, property loss and environmental values.

By estimating the risk mitigation achieved, the Atlas will help find the most cost-effective prescribed burning strategies. It will assist fire and land managers by showing specific risk reduction benefits and costs, depending on the desired outcome, for broad scale landscape burning or smaller strategic edge burns, in different types of landscapes across New South Wales, the ACT, Victoria, Tasmania, South Australia and Queensland. Crucially, the project employs a consistent methodology which provides a level playing field for comparisons and a basis for a national system of treatment and risk accounting. The Atlas also shows the effects of climate change on prescribed burning effectiveness into the future.

While there are specific findings for different landscapes types, the Atlas

shows that there is not a 'one size fits all' approach to prescribed burning. In most cases, increasing the rate of prescribed burning reduces the risk of area burnt by bushfire, life loss, house loss, damage to roads and damage to powerlines. However, there are thresholds for various landscapes types that, once reached, the costs will increase with only negligible benefits in risk reduction. This cost-effectiveness can vary widely between different regions, mostly relating to the locations of local assets (e.g. housing) and native vegetation.

The Atlas also shows the environmental benefits, and importantly, potential damages, from too much or not enough fire in particular landscapes. In most cases, increasing rates of prescribed burning treatment can be harmful to the ecosystem, as it places more areas at risk of being burnt too frequently (that is, below the minimum tolerable fire interval).

CONTEXT

Prescribed burning is a central feature of contemporary fire management around the world, yet a quantitative basis for understanding and comparing its effectiveness at mitigating risk across different regions is lacking. This project addressed this gap and the Atlas will provide critical support to fire and land management agencies across southern Australia by undertaking a systematic investigation of the drivers of prescribed burning effectiveness.

BACKGROUND

There is widespread use of fire to reduce the amount of fuel (vegetation) in forests and grasslands across Australia. The intentions of these programs are to:

- reduce the amount of combustible vegetation as a means of reducing the intensity and slowing the progression of bushfires, and to decrease the number of spot fires. In combination, these outcomes can increase opportunities to suppress and extinguish those fires and reduce the risk to communities and structures.
- ensure that landscapes that require fire for ecological health are exposed to appropriate fire regimes.

With land management agencies moving toward planning future systems based on

risk reduction, the Atlas can be used by prescribed burning practitioners and planners as both a learning and planning support tool.

The information available through this Atlas supports the following priorities and actions for the National Disaster Risk Reduction Framework:

Priority 1: Understand disaster risk

- Identify and address data, information and resource gaps
- Address technical barriers to data and information sharing and availability
- Integrate plausible future scenarios into planning

Priority 2: Make accountable decisions

- Consider potential avoided loss (tangible and intangible) and broader benefits in all relevant decisions
- Build the capability and capacity of decision-makers to actively address disaster risk in policy, program and investment decisions

BUSHFIRE AND NATURAL HAZARDS CRC RESEARCH

The Atlas provides an ability for users to understand the likely cost, benefits and overall risk reduction for landscapes across south eastern Australia, and to compare the outcomes based on different

prescribed burning strategies – for instance, different combinations of landscape and edge-based burning approaches (where the edge is defined as a locations where flammable vegetation meets communities and the built environment).

The research was divided into two phases: fire behaviour accounting and risk accounting.

Fire behaviour accounting

At the heart of the project is predictive modelling of the effect of prescribed burning on unplanned bushfire behaviour.

Researchers used the simulation modelling tool PHOENIX RapidFire (Tolhurst et al. 2008), which is widely used by fire agencies in operations and risk planning. The model was loaded with different inputs – terrain, vegetation types, weather, ignition location, fire history – to predict bushfire properties such as rate of spread, flame height, ember density, convection and intensity. The vegetation types that were assessed included temperate forests, grasslands, savannas, deserts, woodlands and scrub.

Researchers used close to one million fire simulations across 13 case study landscapes across New South Wales, the ACT, Victoria, Tasmania, South Australia and Queensland – comprising the urban interface, remote bushland, arid grassland and sub-tropical bush (see Figure 1 below) – and estimated residual risk for management values, including loss of life, loss of property, length of road damaged, environmental impacts, length of powerline damaged and area burnt.

Risk accounting

Statistical models – specifically Bayesian decision networks – were used to estimate the risk mitigation, including cost, that can be achieved using different prescribed burning strategies in each region. The models learn the probable distributions of fire weather conditions and bushfire incidence for each location and generate risk estimates for each prescribed burning strategy. By incorporating the entire range and probability of local conditions, this process produces ‘full’ estimates of risk that can be compared between local regions. This is important, because a key objective for fire managers that will use the Prescribed Burning Atlas is the identification of effective risk reduction options.

RESEARCH FINDINGS

The technical outputs from this project are layered, allowing for multiple levels of interrogation and interpretation, including

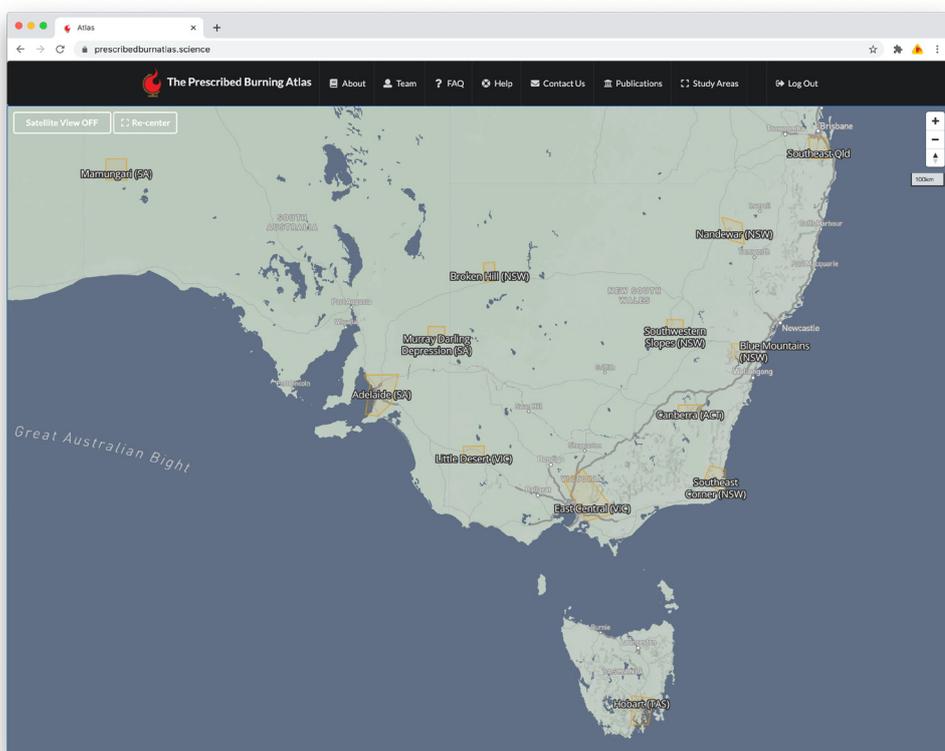


Figure 1: RESEARCHERS USED FIRE SIMULATIONS FROM 13 AREAS ACROSS AUSTRALIA: SOUTHEAST QUEENSLAND; NANDEWAR, BROKEN HILL, SOUTHWESTERN SLOPES, BLUE MOUNTAINS AND SOUTHEAST CORNER, NSW; CANBERRA, ACT; LITTLE DESERT AND EAST CENTRAL, VICTORIA; HOBART, TASMANIA; MURRAY DARLING DEPRESSION, ADELAIDE AND MAMUNGARI, SOUTH AUSTRALIA.

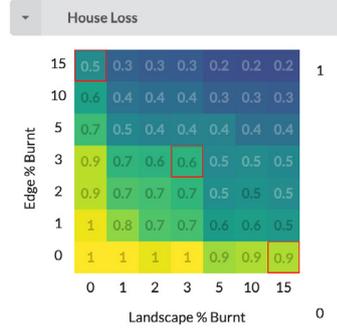
ASSESSING THE EFFECTIVENESS OF PRESCRIBED BURNING IN THE BLUE MOUNTAINS USING THE PRESCRIBED BURNING ATLAS

By conducting edge burning in the Blue Mountains, the risk of losing lives and houses during a bushfire is reduced when compared to conducting only landscape scale prescribed burning. However, the effect of edge burning on reducing the size of a bushfire is less than landscape scale prescribed burning. There is little difference between these two treatment options on reducing damage to roads and powerlines, or tolerable fire interval.

The option of conducting moderate amounts of both edge and landscape burning (that is, the aqua line) represents a compromise between the first two more extreme options. It leads to a major decrease in the risk of the ecosystem being burnt too frequently, while yielding subtle but sometimes significant changes in the risk to other values such as house loss and area burnt.

Blue Mountains (NSW)

Treatment Inspector



Clear selection

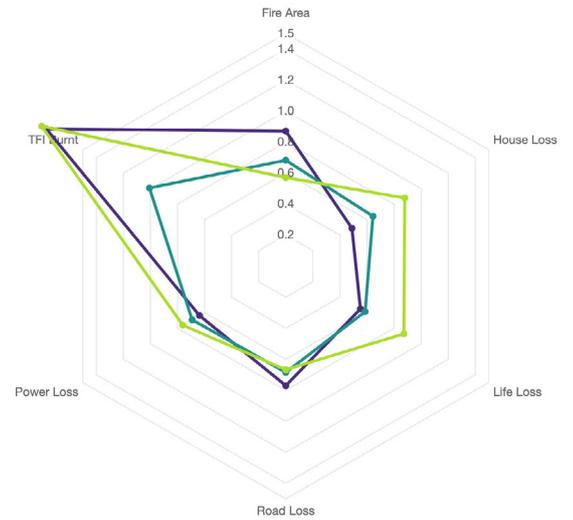
A comparison of three different prescribed burning treatment options in the Blue Mountains.

- 15% of the landscape burnt and 0% edge burnt
- 0% of the landscape and 15% edge burnt
- 3% of the landscape burnt and 3% edge burnt

Loss Analysis

Collective Losses using Landscape and Edge Treatments

Hover over points to see values.



high-level summaries, underlying data, raw data, or analysis of all three layers combined. This allowed researchers to explore the raw risk estimates, compare different combinations of case study landscapes and landscape treatments, and explore drivers and other features of risk reduction.

The findings of the project illustrate that there is no 'one size fits all' solution to prescribed burning. That is, the effectiveness of prescribed burning at mitigating risk of damage by bushfire varies considerably across landscapes. This has major implications for fire managers, suggesting

that tailored prescribed burning solutions are possible and preferable, as long as they are based on the unique risk mitigation profile for the specific landscape being assessed. Other findings, from the analysis of the 13 case study landscapes, include:

- In most cases, increasing the rate of prescribed burning treatment reduces the risk of area burnt by bushfire, life loss, house loss, damage to roads and damage to powerlines, but in many cases there are thresholds beyond which any increased rates of prescribed burning do not lead to a significant increase in benefits.

- In most cases, increasing rates of prescribed burning treatment can be harmful to the ecosystem, as it places more areas at risk of being burnt too frequently (that is, below the minimum tolerable fire interval).
- The cost-effectiveness of prescribed burning varies widely between regions, with variations relating mostly to the spatial configuration of assets and natural vegetation.
- There are interesting comparisons across different landscapes:
 - In Hobart, prescribed burning significantly reduces the costs associated with loss of housing, but the aggregate costs (including cost of burning and cost of other losses) remain relatively constant.
 - In Canberra, the most cost-effective solutions involve treatments focused at the edge rather than landscape.
 - In south east NSW, prescribed burning significantly increases the costs of fire prevention, but has only a modest impact on reducing losses from bushfires.
- Lastly, climate change is expected to reduce the positive effects of prescribed burning, due to increased frequency of extreme fire weather conditions.

END-USER STATEMENT

"It is expected that this project will trigger a significant change in the way fire management agencies deliver their hazard reduction programs and proposed fuel management activities. The ability to quantify risk and cost to life and property, as well as environmental impact and infrastructure damage under a range of different scenarios, will lead land managers to optimised burning strategies for wildfire risk mitigation. This project will support agencies to make more robust evidence-based decisions and tailor their burning programs to optimise risk reduction and cost benefits according to their needs. The results emerging from this project will be used by a broad range of stakeholders with multiple objectives. The Atlas will strengthen the narrative that the reduction in risk from prescribed burning varies depending on management value and local variations in landscapes and vegetation communities across south-eastern Australia."

Dr Felipe Aires, Fire Incident Management Section, National Parks and Wildlife Service, Department of Planning, Industry and Environment, NSW

HOW COULD THIS RESEARCH BE USED?

Prescribed burning remains a critical component of contemporary fire management in Australia and elsewhere. Researchers developed the Prescribed Burning Atlas for systematically comparing the prescribed burning effects on risk mitigation across different landscapes and management values.

The Atlas was designed to provide an easy-to-access interface to the research findings, and enable fire agencies to respond in a credible way to demands for transparent accounting of the costs and benefits of their activities. It does this by combining methodologies for assessing the effects of prescribed burning on fire behaviour and risk to management values, including costs.

The Atlas is strategic rather than tactical in nature, analysing long-term, landscape-scale effectiveness of prescribed burning (considering the unique mix of vegetation, climate, ignition probability, weather and assets), rather than pros and cons of burning individual blocks at specific dates. Further development of the Atlas could generate these fine scaled tactical insights. The Atlas is a decision support

tool and is expected to be used alongside other knowledge in the development of prescribed burning programs.

The findings of this research can be accessed via the Atlas website at <https://prescribedburnatlas.science>. This dedicated website is for fire managers, researchers and anyone else interested in research and data to support their planning, decision making and communication. It is a geographically based summary of risk for decision makers in an accessible, user-friendly format. It is unique because the key focus from the start has been the design and delivery of this new approach to understanding the costs and benefits of different prescribed burning strategies across multiple landscapes – allowing users to compare different approaches as they develop their plans.

FUTURE DIRECTIONS

While this project represents an important step forward in bushfire risk management research, a number of challenges remain to maximise its value. To address this, additional landscape types will be added to the Atlas in 2021, identify similarities between the case study landscapes, and

expand the regions covered by identifying similarities between the case study areas and other locations across southern Australia.

The modular approach that has been used to build the Atlas means that there are opportunities to add new values (e.g. agricultural impacts, human health impacts from smoke) to the Atlas or to modify existing values if appropriate. The ongoing active involvement of end-users will be crucial in ensuring uptake and translation into outcomes for fire and land management agencies.

The Atlas may also have beneficial value as a tool to support internal and external communications and education, aside from its core role in strategic planning and risk assessment. Project outputs can be used to educate stakeholders and increase knowledge about the relationships and trade-offs between biophysical drivers, planned and unplanned fires and associated costs and losses.

Finally, as the understanding of bushfire risk and the effects of bushfire management improves, it may be possible to transition from cost effectiveness analyses to a cost-benefit analyses, moving from an appraisal of costs of different management options to an assessment of their net benefit to society.

FURTHER READING

Bradstock R (2020) Prescribed burning: the view from the top down. In Leavesley A, Wouters M and Thornton R (Eds), *Prescribed Burning in Australasia: The science practice and politics of burning the bush*, Australasian Fire and Emergency Service Authorities Council.

Cirulis B, Clarke H, Boer M, Penman T, Price O and Bradstock R (2019) Quantification of inter-regional differences in risk mitigation from prescribed burning across multiple management values. *International Journal of Wildland Fire*. <https://doi.org/10.1071/WF18135>

Clarke H, Cirulis B, Bradstock R, Boer M, Penman T & Price O (2019) A new decision support tool for prescribed burning risk assessment. In AFAC19 powered by

INTERSCHUTZ Research Proceedings from the Bushfire and Natural Hazards CRC Research Forum (peer reviewed), *Australian Journal of Emergency Management*, Monograph 4, <https://www.bnhcrc.com.au/publications/biblio/bnh-6396>

Clarke H, Cirulis B, Penman T, Price O, Boer M, Bradstock R (2020) From hectares to tailor-made solutions for risk mitigation, Final report, Bushfire and Natural Hazards CRC, <https://www.bnhcrc.com.au/publications/biblio/bnh-7389>

Filkov A, Ngo T, Matthew S, Tefler S & Penman T (2020) Impact of Australia's catastrophic 2019/20 bushfire season on communities and environment: retrospective analysis and current trends,

Journal of Safety Science and Resilience, doi.org/10.1016/j.jinlssr.2020.06.009

Penman T, Clarke H, Cirulis B, Boer M, Price O & Bradstock R (2020) Cost-effective prescribed burning solutions vary between landscapes in eastern Australia, *Frontiers in Forests and Global Change*, [doi: 10.3389/ffgc.2020.00079](https://doi.org/10.3389/ffgc.2020.00079)

Prescribed Burning Atlas website (2019), Bushfire and Natural Hazards CRC, <https://prescribedburnatlas.science>

Tolhurst K, Shields B, Chong D (2008) PHOENIX: development and application of a bushfire risk-management tool, *Australian Journal of Emergency Management*, 23: 47-54, <https://ajem.infoservices.com.au/items/AJEM-23-04-11>

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